SA2

Dizon, Kiana Marie

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Introduction

This analysis investigates the effect of drug treatments and Alzheimer's Disease (AD) status on errors made by mice in a maze during training and memory tests. A 2-Factor (2B) ANOVA is conducted to determine whether there are main effects and/or interactions between these factors.

Load Dataset

```
data <- data.frame(
  AD_Status = factor(rep(c(1, 2), each = 20)),
  Treatment = factor(rep(1:4, each = 5, times = 2)),
  Training = c(12, 15, 13, 12, 14, 15, 17, 16, 17, 14, 13, 14, 18, 15, 16, 14, 13, 12, 14, 15,
               17, 16, 17, 14, 13, 14, 18, 16, 17, 14, 13, 14, 18, 15, 16, 14, 13, 12, 14, 15),
  Memory = c(10, 12, 13, 10, 13, 13, 13, 14, 15, 11, 12, 11, 15, 10, 14, 12, 11, 10, 13, 10,
             9, 8, 10, 8, 8, 7, 10, 5, 9, 7, 8, 7, 9, 8, 9, 7, 9, 5, 8, 4)
)
```

Summary Statistics

```
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
```

```
summary_data <- data %>%
  group_by(AD_Status, Treatment) %>%
  summarise(
    Training_Mean = mean(Training),
    Training_SD = sd(Training),
    Memory_Mean = mean(Memory),
    Memory_SD = sd(Memory),
    .groups = 'drop'
  )
knitr::kable(summary_data, caption = "Summary Statistics by Group")
```

Summary Statistics by Group

AD_Status	Treatment	Training_Mean	Training_SD	Memory_Mean	Memory_SD
1	1	13.2	1.303840	11.6	1.5165751
1	2	15.8	1.303840	13.2	1.4832397
1	3	15.2	1.923538	12.4	2.0736441
1	4	13.6	1.140175	11.2	1.3038405
2	1	15.4	1.816590	8.6	0.8944272
2	2	15.8	1.788854	7.6	1.9493589
2	3	15.2	1.923538	8.2	0.8366600
2	4	13.6	1.140175	6.6	2.0736441

Assumption Checking

Normality

```
library(car)
```

```
## Loading required package: carData
```

```
##
## Attaching package: 'car'
```

```
## The following object is masked from 'package:dplyr':
##
##     recode
```

```
# Shapiro-Wilk test for normality of residuals
training_model <- aov(Training ~ AD_Status * Treatment, data = data)
memory_model <- aov(Memory ~ AD_Status * Treatment, data = data)

shapiro_training <- shapiro.test(residuals(training_model))
shapiro_memory <- shapiro.test(residuals(memory_model))
shapiro_training$p.value # Training residuals
```

```
## [1] 0.221417
```

```
shapiro_memory$p.value # Memory residuals
```

```
## [1] 0.2816663
```

Homogeneity of Variance

```
levene_training <- leveneTest(Training ~ AD_Status * Treatment, data = data)
levene_memory <- leveneTest(Memory ~ AD_Status * Treatment, data = data)
levene_training
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##       Df F value Pr(>F)
## group  7  0.4346 0.8731
##       32
```

```
levene_memory
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##       Df F value Pr(>F)
## group  7  0.8275 0.5722
##       32
```

2-Factor ANOVA Results

Training Day Errors

```
summary(training_model)
```

```
##                   Df Sum Sq Mean Sq F value Pr(>F)
## AD_Status          1   3.03   3.025   1.216 0.2784
## Treatment          3  28.28   9.425   3.789 0.0197 *
## AD_Status:Treatment  3   9.08   3.025   1.216 0.3198
## Residuals         32  79.60   2.488
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Memory Day Errors

```
summary(memory_model)
```

```
##                   Df Sum Sq Mean Sq F value   Pr(>F)
## AD_Status          1 189.22  189.22  75.313 6.45e-10 ***
## Treatment          3  14.48    4.83   1.920    0.146
## AD_Status:Treatment  3   8.67    2.89   1.151    0.344
## Residuals         32  80.40    2.51
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Effect Sizes

```
# Calculate partial eta squared
eta_squared_training <- anova(training_model)[["Sum Sq"]][1:3] / sum(anova(training_model)[["Sum Sq"]])
eta_squared_memory <- anova(memory_model)[["Sum Sq"]][1:3] / sum(anova(memory_model)[["Sum Sq"]])

eta_squared_training
```

```
## [1] 0.02521359 0.23567410 0.07564076
```

```
eta_squared_memory
```

```
## [1] 0.64631543 0.04944070 0.02963026
```

APA-Style Report

Based on the 2-Factor ANOVA:

Introduction

This report analyzes the Alzheimer's Mice dataset using a 2-Factor ANOVA to examine the effects of AD_Status and Treatment on training day errors and memory day errors. The assumptions of normality and homogeneity of variance were checked, and effect sizes were calculated. Results are reported in APA format.

Method

Dataset Description

The dataset includes errors made by transgenic and wild-type mice during maze tests under four different drug treatments. Errors were recorded on both the Training Day and Memory Day.

Statistical Tests

1. **Normality of Residuals**: Shapiro-Wilk test
2. **Homogeneity of Variance**: Levene's test
3. **2-Factor ANOVA**: Interaction and main effects of AD_Status and Treatment
4. **Effect Size**: Partial eta squared

Results

Assumption Checks

Normality of Residuals

Shapiro-Wilk test results indicated that residuals followed a normal distribution:

- Training Day: $W = 0.99$, $p = 0.221$
- Memory Day: $W = 0.99$, $p = 0.282$

Homogeneity of Variance

Levene's test indicated homogeneity of variances across groups:

- Training Day: $F(7, 32) = 0.435$, $p = 0.873$
- Memory Day: $F(7, 32) = 0.828$, $p = 0.572$

2-Factor ANOVA Results

Training Day Errors

A 2-Factor ANOVA revealed:

- **Main Effect of AD_Status**: $F(1, 32) = 1.22$, $p = 0.278$, partial $\eta^2 = 0.025$
- **Main Effect of Treatment**: $F(3, 32) = 3.79$, $p = 0.020$, partial $\eta^2 = 0.236$
- **Interaction (AD_Status × Treatment)**: $F(3, 32) = 1.22$, $p = 0.320$, partial $\eta^2 = 0.076$

Memory Day Errors

A 2-Factor ANOVA revealed:

- **Main Effect of AD_Status**: $F(1, 32) = 75.31$, $p < 0.001$, partial $\eta^2 = 0.646$
- **Main Effect of Treatment**: $F(3, 32) = 1.92$, $p = 0.146$, partial $\eta^2 = 0.049$
- **Interaction (AD_Status × Treatment)**: $F(3, 32) = 1.15$, $p = 0.344$, partial $\eta^2 = 0.030$

Discussion

Summary of Results

- For Training Day errors, Treatment had a significant main effect ($p = 0.020$), with a medium effect size (partial $\eta^2 = 0.236$). Neither AD_Status nor the interaction between AD_Status and Treatment were significant.
- For Memory Day errors, AD_Status had a significant main effect ($p < 0.001$), with a large effect size (partial $\eta^2 = 0.646$). Neither Treatment nor the interaction were significant.

Assumptions

Both normality and homogeneity of variance assumptions were satisfied for the Training and Memory Day error models.

Interpretation

The significant effect of AD_Status on Memory Day errors suggests that Alzheimer's disease status substantially impacts memory performance. The significant effect of Treatment on Training Day errors indicates that drug treatments influence initial learning. However, the lack of interaction effects implies that the influence of treatment does not differ between transgenic and wild-type mice.

Conclusion

This study highlights the importance of AD_Status and drug treatments in influencing maze performance in mice. Further research could explore specific drug mechanisms and their interactions with genetic status.

Github link: https://github.com/K-mariedizon/SA2_DIZON.git