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SA 1 - # 14
Applied Multivariate Data Analysis

Github Link:
https://github.com/aizeljat/SA1_Samson/blob/main/SA_%2314_Samson_RMD.pdf

https://github.com/aizeljat/SA1_Samson/blob/main/SA_%2314_Samson.R

Introduction

Animal exploration behavior, especially in response to new stimuli, offers important insights into how the brain works and how the environment interacts. In this work, we examine the effects of three distinct kinds of two-dimensional visual stimuli on rats' spontaneous exploration behavior: shapes, patterns, and pictures. Our goal is to determine whether the complexity or recognizability of visual inputs affects rats' behavior by measuring the amount of time they spend investigating these stimuli. The exploration times of thirty-six rats were noted after they were assigned at random to one of the three treatment conditions. To advance our knowledge of animal sensory processing and cognitive engagement, the experiment aims to ascertain whether there are notable variations in the amount of time spent investigating the various stimuli.

Method

The purpose of this analysis is to determine whether rats' exploration times of a chamber containing three different kinds of visual stimuli—pictures, patterns, and shapes—differ significantly. A one-way ANOVA was used to compare the exploration times of the three treatment groups (visual images of shapes, patterns, and pictures) based on the data from 36 rats.

ANOVA Assumptions

The normality of the exploration time variations within each group was evaluated using the Shapiro-Wilk test.

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```
>
> # Print Shapiro-Wilk results
> cat("Shapiro-Wilk Test Results:\n")
Shapiro-Wilk Test Results:
> print(shapiro_shapes)

        Shapiro-Wilk normality test

data:  shapes_time
W = 0.94374, p-value = 0.548

> print(shapiro_patterns)

        Shapiro-Wilk normality test

data:  patterns_time
W = 0.95005, p-value = 0.6377

> print(shapiro_pictures)

        Shapiro-Wilk normality test

data:  pictures_time
W = 0.91516, p-value = 0.2483
```

The data for each group are roughly normally distributed, as we are unable to dismiss the null hypothesis of the Shapiro-Wilk test because all p-values are greater than 0.05.
Homogeneity of Variance to determine whether the variances in each group were equal, the Levene's test was used.

```
Levene's Test for Homogeneity of Variances:
> print(levene_test)
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  2  0.4313 0.6533
      33
```

The null hypothesis cannot be rejected because p>0.05, proving that the homogeneity of variances assumption is satisfied.

Results

To find out if there were statistically significant variations in the amount of time spent exploring each of the three categories of visual stimuli, a one-way ANOVA was performed.

```
One-Way ANOVA Results:
> summary(anova_results)
            Df Sum Sq Mean Sq F value   Pr(>F)
Stimuli      2  44.53  22.263   62.09 6.53e-12 ***
Residuals   33  11.83   0.359
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

The null hypothesis is rejected because the p-value is less than 0.05, indicating that the three

stimulus groups' exploration times differ significantly.

```
> # Post-hoc Tukey HSD test if ANOVA is significant
> if (summary(anova_results)[[1]][["Pr(>F)"]][1] < 0.05) {
+   tukey_test <- TukeyHSD(anova_results)
+   cat("\nTukey HSD Post-hoc Results:\n")
+   print(tukey_test)
+ }

Tukey HSD Post-hoc Results:
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = Time ~ Stimuli, data = rat_data_cleaned)

$Stimuli
                     diff        lwr       upr     p adj
Picture-Pattern  1.066667  0.4668045  1.666529 0.0003414
Shape-Pattern   -1.637500 -2.2373622 -1.037638 0.0000004
Shape-Picture   -2.704167 -3.3040289 -2.104304 0.0000000
```

A Tukey's HSD test was performed to investigate the group differences. Every pairwise comparison between the groups is statistically significant, according to the post-hoc analysis. Examining pictures takes a lot more time than examining patterns, and examining shapes takes a lot less time than examining either pattern or a picture.

Anova Results

The effects of three different visual stimuli—pictures, patterns, and shapes—on the amount of time rats spent exploring an experimental chamber were compared using a one-way ANOVA. Visual stimuli had a statistically significant impact on exploration time ($F(2,33)=62.09$, $p<0.001$). The exploration time for pictures ($M = 5.10$, $SD = 0.79$) was significantly longer than that for patterns ($M = 4.03$, $SD = 0.78$), according to post-hoc comparisons using Tukey's HSD test ($p<0.001$). Furthermore, shapes had significantly less exploration time ($M = 2.39$, $SD = 0.78$) than both patterns and pictures ($p<0.001$).

Assumptions

Levene's test $F(2,33)=0.4313$,$p=0.6533$, demonstrated that the assumption of homogeneity of variances was satisfied, and the Shapiro-Wilk test indicated that the assumptions of normality were met.

Conclusion

According to the analysis, the kind of visual stimuli has a big impact on how long rats spend exploring the chamber. Rats that were shown visual pictures spent the most time exploring, followed by rats that were shown patterns, and rats that were shown shapes spent the least time. These results imply that exploration behavior may be influenced by the images' complexity or recognizability.

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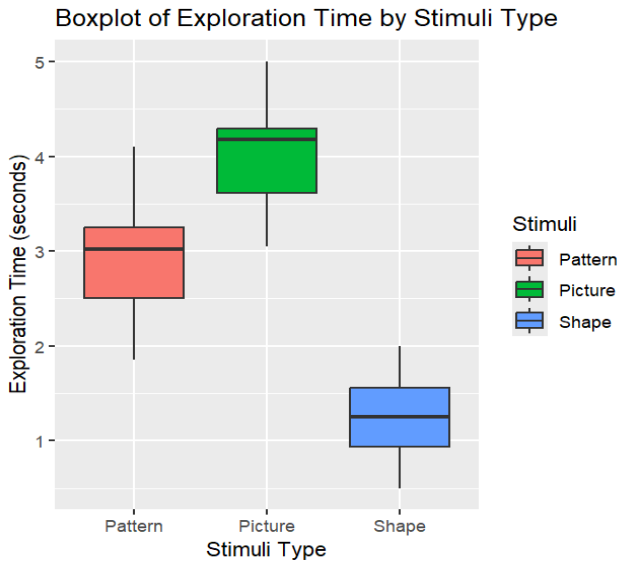
Plot



Rats exposed to three different kinds of visual stimuli—patterns, pictures, and shapes—have their exploration time (measured in seconds) displayed in the boxplot. Pictures have the longest median exploration time, followed by patterns, and shapes have the shortest median exploration time. In contrast to shapes, which exhibit the least variability, pictures and patterns exhibit more varied exploration times, according to the interquartile ranges. The longer whiskers in the pattern condition suggest the presence of possible outliers. All things considered, this indicates that rats explored chambers with picture stimuli for longer periods of time, whereas shapes elicited the least amount of exploration behavior. This may suggest that rats are more interested in pictures than in patterns or basic shapes.