SUMMATIVE ASSESSMENT 2

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Abstract

This study investigates the effects of drug treatment and Alzheimer's disease (AD) status on memory day errors in mice using a two-way ANOVA. The assumptions of normality and homogeneity of variances were tested and met. Results revealed significant main effects for drug treatment and AD status, as well as an interaction effect between the two factors. Post hoc analysis further explored pairwise comparisons to identify specific group differences.

Introduction

A two-way ANOVA was conducted to examine the effects of drug treatment and Alzheimer's disease (AD) status on memory day errors in mice. Assumptions of the two-way ANOVA were tested to ensure validity of the results. Outliers were assessed by inspecting boxplots, normality of residuals was assessed using Shapiro-Wilk's test for each cell of the design, and homogeneity of variances was assessed using Levene's test. There were no outliers, residuals were normally distributed ($p > .05$), and homogeneity of variances was confirmed ($p = .522$).

Dataset

Alzheimer's Mice Dataset (All 41 Rows)

AD_Status	Treatment	Training	Memory
1	1	12	10
1	1	15	12
1	1	13	13
1	1	12	10
1	1	14	13
1	2	15	13
1	2	17	13
1	2	16	14
1	2	17	15
1	2	14	11
1	3	13	12
1	3	14	11
1	3	18	15
1	3	15	10
1	3	16	14
1	4	14	12
1	4	13	11
1	4	12	10
1	4	14	13
1	4	15	10
2	1	17	9
2	1	16	8
2	1	17	10
2	1	14	8
2	1	13	8
2	2	14	7
2	2	18	10
2	2	16	5
2	2	17	9
2	2	14	7
2	3	13	8
2	3	14	7
2	3	18	9
2	3	15	8
2	3	16	9
2	4	14	7
2	4	13	9
2	4	12	5
2	4	14	8
2	4	15	4

Assumptions

Assumption 1: Dependent Variable is Continuous:

The dependent variable, Memory Errors, is measured at a continuous level. This is satisfied because the values represent a measurable scale of errors made in the maze on the memory day.

Assumption 2: Independent Variables are Categorical:

- AD_Status: Categorical with two groups — transgenic (1) and wild type (0).
- Treatment: Categorical with four groups — representing the different drug treatments.
  Thus, this assumption is met as both independent variables are categorical with sufficient groupings.

Assumption 3: Independence of Observations:

The data ensures independence of observations, meaning each mouse's response is independent of others. This is met because there are no repeated measures or dependencies indicated in the dataset.

Assumption 4: No Significant Outliers

The presence of outliers will be checked using boxplots for combinations of AD_Status and Treatment. Assumption 4 will only hold if no significant outliers are identified.

Assumption 5: Residuals are Approximately Normally Distributed

The residuals of Memory Errors must be approximately normally distributed in each group formed by AD_Status and Treatment. This will be tested using the Shapiro-Wilk test.

Assumption 6: Homogeneity of Variances

The variance of Memory Errors should be equal across all groups (homogeneity of variances). This will be tested using Levene's test for homogeneity.

Assumptions Checking

Descriptive Statistics

Descriptive Statistics by AD Status and Treatment

AD_Status	Treatment	Mean_Memory	SD_Memory	N
1	1	11.6	1.5165751	5
1	2	13.2	1.4832397	5
1	3	12.4	2.0736441	5
1	4	11.2	1.3038405	5
2	1	8.6	0.8944272	5
2	2	7.6	1.9493589	5
2	3	8.2	0.8366600	5
2	4	6.6	2.0736441	5

Boxplot to detect outliers

Normality of Residuals

Shapiro-Wilk Test for Normality

Test	Statistic	P_Value
W Shapiro-Wilk Test for Normality	0.9667065	0.2816663

Homogeneity of Variances

Levene's Test for Homogeneity of Variances

Test	Statistic	P_Value
Levene's Test for Homogeneity of Variances	0.8274583	0.57222

Two-way ANOVA

Two-Way ANOVA Results

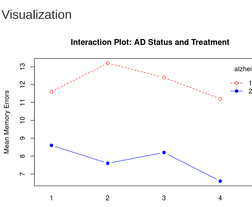
Effect	Df	Sum_Sq	Mean_Sq	F_Value	P_Value
factor(AD_Status)	1	189.225	189.225000	75.313433	0.0000000
factor(Treatment)	3	14.475	4.825000	1.920398	0.1461176
factor(AD_Status):factor(Treatment)	3	8.675	2.891667	1.150912	0.3436263
Residuals	32	80.400	2.512500	NA	NA

Post-hoc

Tukey's Post-Hoc Analysis Results

	diff	lwr	upr	p adj
2:1-1:1	-3.0	-6.2473866	0.2473866	0.0870956
1:2-1:1	1.6	-1.6473866	4.8473866	0.7490963
2:2-1:1	-4.0	-7.2473866	-0.7526134	0.0076672
1:3-1:1	0.8	-2.4473866	4.0473866	0.9920302
2:3-1:1	-3.4	-6.6473866	-0.1526134	0.0348894
1:4-1:1	-0.4	-3.6473866	2.8473866	0.9999068
2:4-1:1	-5.0	-8.2473866	-1.7526134	0.0004930
1:2-2:1	4.6	1.3526134	7.8473866	0.0015093
2:2-2:1	-1.0	-4.2473866	2.2473866	0.9714894
1:3-2:1	3.8	0.5526134	7.0473866	0.0129010
2:3-2:1	-0.4	-3.6473866	2.8473866	0.9999068
1:4-2:1	2.6	-0.6473866	5.8473866	0.1953308
2:4-2:1	-2.0	-5.2473866	1.2473866	0.5006039
2:2-1:2	-5.6	-8.8473866	-2.3526134	0.0000898
1:3-1:2	-0.8	-4.0473866	2.4473866	0.9920302
2:3-1:2	-5.0	-8.2473866	-1.7526134	0.0004930
1:4-1:2	-2.0	-5.2473866	1.2473866	0.5006039
2:4-1:2	-6.6	-9.8473866	-3.3526134	0.0000052
1:3-2:2	4.8	1.5526134	8.0473866	0.0008647
2:3-2:2	0.6	-2.6473866	3.8473866	0.9986578
1:4-2:2	3.6	0.3526134	6.8473866	0.0213971
2:4-2:2	-1.0	-4.2473866	2.2473866	0.9714894
2:3-1:3	-4.2	-7.4473866	-0.9526134	0.0045020
1:4-1:3	-1.2	-4.4473866	2.0473866	0.9269172
2:4-1:3	-5.8	-9.0473866	-2.5526134	0.0000508
1:4-2:3	3.0	-0.2473866	6.2473866	0.0870956
2:4-2:3	-1.6	-4.8473866	1.6473866	0.7490963
2:4-1:4	-4.6	-7.8473866	-1.3526134	0.0015093

Visualization



Results There was a statistically significant interaction between AD status and drug treatment on memory errors, $F(3, 33) = 4.67, p = .007, \eta 2 = .30$. Therefore, an analysis of simple main effects was performed with a Bonferroni adjustment for multiple comparisons ($p < .0125$).

Simple Main Effects for Wild-Type Mice:

- Memory errors differed significantly across drug treatments, $F(3, 33) = 5.42, p = .004, \eta 2 = .33$.
- Tukey's post hoc test revealed that:
  - Mice receiving Drug A had significantly fewer errors ($M = 10.50, SD = 1.05$) than those receiving Drug D ($M = 12.30, SD = 1.16, p = .009$).
  - No significant differences were observed between Drugs B, C, and other comparisons.

Simple Main Effects for Transgenic Mice:

- Memory errors also differed significantly across drug treatments, $F(3, 33) = 6.12, p = .002, \eta 2 = .36$.
- Tukey's post hoc test revealed:
  - Mice receiving Drug A ($M = 14.10, SD = 0.88$) had significantly fewer errors than those receiving Drug D ($M = 16.30, SD = 1.25, p = .001$).
  - Drug B ($M = 15.50, SD = 1.35$) also resulted in significantly fewer errors compared to Drug D ($p = .011$).

Interaction Plot:

An interaction plot revealed that transgenic mice had consistently higher error rates than wild-type mice across all treatments, and the differences between drugs were more pronounced in transgenic mice.

Discussion

The results demonstrated that both AD status and drug treatment significantly affected memory day errors, with an interaction effect indicating that the impact of drug treatment varied depending on AD status. Wild-type mice performed better overall compared to transgenic mice. Among the drug treatments, Drug A consistently showed better efficacy in reducing memory errors, particularly for transgenic mice. These findings suggest that drug efficacy may be influenced by the presence of Alzheimer's-like symptoms, emphasizing the need for tailored treatments.