Adverse Effects of Benzodiazepines and Mood-Related Memories on Memory Recall Performance
Analysis of Variance

Introduction

Benzodiazepines have been shown to disrupt the positive effects of long-term potentiation between cells on memory recall and learned associations (Breggin, 1998). By differentiating the adverse long-term effects of Alprazolam (long-term) and Triazolam (short-term), a better diagnosis may be administered to patients to mitigate any damage to the brain's metacognition and memory recall ability. Further research has also shown that simply recalling specific memories associated with strong emotions will cause said emotions to be materialized in the present time and influence future thoughts for a short period (approximately 10 minutes). For example, it was observed that enhanced activity during the recall of positive relative to neutral autobiographical memories (Speer et al., 2014), and Individuals in negative moods were significantly less likely to show false memory effects (Storbeck & Clore, 2005).

Method

Given the presence of four factors with various levels, an ANOVA 2 Way will be applied in the first moment to test if there are differences between at least one of the levels of each factor (Drug; Dosage; Happy_Sad_group), as well as to test if there is an interaction between the Drug and the Dosage. In a second moment, if any of the factors are shown to be significant, post hoc tests (Tuckey) will be applied.

Dataset

The origin of the dataset was the open-source Kaggle (Memory Test on Drugged Islanders Data | Kaggle). It displays 198 rows and 9 columns which contain the following information: first_name; last_name; age; Happy_Sad_group (H, S); Dosage(1,2,3); Drug(Alprazolam (A), Triazolam (T), Sugar (S)); Mem_Score_Before; Mem_Score_After; Diff(Mem_Score_After- Mem_Score_Before).

Data Pre Processing

For a better analysis, two steps had to be taken before the ANOVA could be applied. First, Nulls and Duplicates were verified, and none was found. Second, the variables Happy_Sad_group, Dosage and Drug were converted into factors.

Data Analysis

Statistics and Vizualizations

In order to bettet under understand the data behaviour, statistics were obtained (present in script) and boxplots as well as interaction plots were made for the variables Drug, Dosage and Happy_Sad_group.

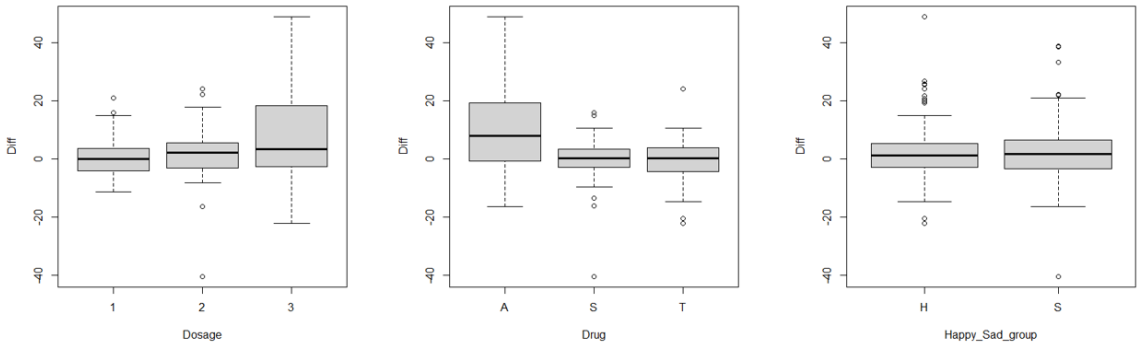

Figure 1 Boxplots for Dosage, Drug and Happy_Sad_group, all by Diff.

The dosage 3 seems to have a larger impact on memory recall compared with the other 2 dosasges, with mostly positive values. Drug A, Alprazolam, seems to have the bigest impact on memory recall when compared with Triazolam and the placebo, mostly with positive values. It is also possible to observe that the Happy_Sad_group variable doesn't seem to show much diference between Happy and Sad memories in terms of memory recall.

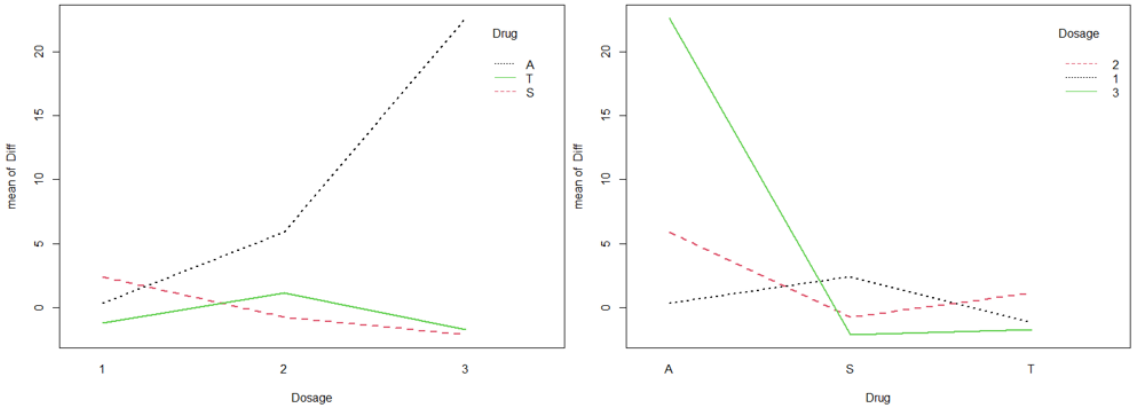

Figure 2 Interaction plots for Dosage and Drug

On Figure 2 is possible to observe the effect o Drug while moving through the levels of Dosage (Left) and the effect of the Dosage while moving through the levels of Drug (Right). There seems to be interaction between Drug and Dosage on the memory recal given that the lines cross while heading in different directions.

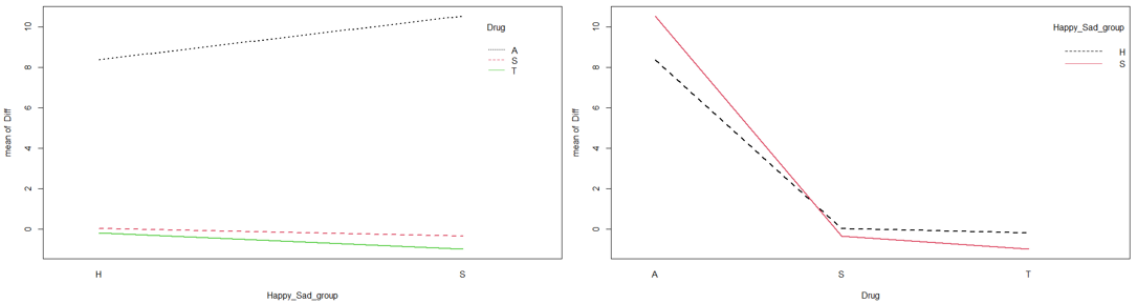

Figure 3 Interaction plots for Drug and Dosage

On Figure 3 is possible to observe the effect o Drug while moving through the levels of Happy_Sad_group (Left) and the effect of the Happy_Sad_group while moving through the levels of Drug (Right). There seems not to be interaction between Drug and type of priming on the memory recal given that the lines do not cross while heading in equal directions.

ANOVA 2 Way

From the previou analysis there seems to exist differences between atleast one level of Drug and Dosage as well as interaction between both of this factors but are this efects significant?

To answer this question a Two-Way ANOVA was perfomed with the folowing model:$Y_{ijl} = \mu + \alpha_i + \beta_j + \gamma_{ij} + \varepsilon_{ijl}$ $i = A, B, C;\ j = 1, 2, 3;\ l = 1, \ldots, n$. Were α_i is the Drug β_j the Dosage, γ_{ij} the interaction between Drug and Dosage and ε_{ijl} the error.

Results

Using an alpha significance of 0.05, the ANOVA analysis has shown that Dosage and Drug were significant as their p-values were 0.000118 and 3.56e-13 respectively. It was also found that the interaction between the two were significant with a p-value of 1.01e-13.

Post Hoc Analysis

Within the additive model, it is possible to do further testing about the main effects to verify between each levels that are significant differences.

A Tukey HSD test was used to correctly adjust for the accumulation of type 1 error alphas and found that there were significant differences between Alprazolam and Sugar (placebo) with a p-value of 0.0000001 as well as between Alprazolam and Triazolam with a p-value of 0. In terms of Dosages there were also observed significant difrences between Dosage 3 and Dosage 1 with a p-value of 0.0011268.

Residuals Analysis

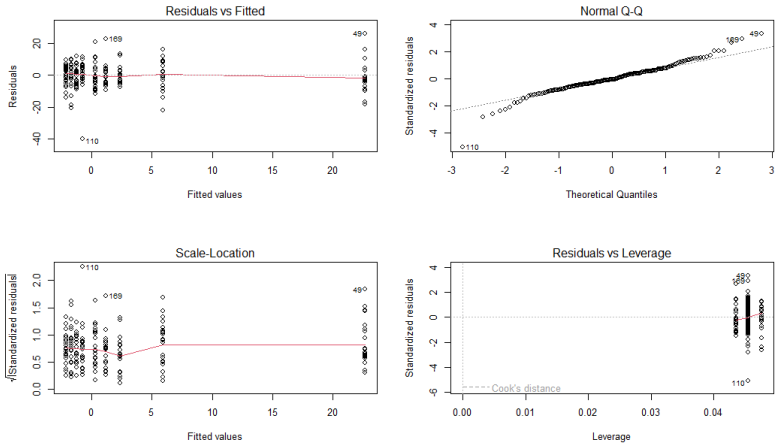

Figure 4 Residuals vs Fitted, Normal Q-Q plot, Scale-Location and Residuals vs Leverage

Portrayed in Figure 4 are the plotting of residuals, the normal Q-Q plot, the Standardized Residuals, and the Leverage plot. The residual plot lacks any pattern and the variance follows a pattern of constancy. The Q-Q plot shows a slight problem in normality at the tail ends, however is assumed to be sufficient given the Shapiro-Wilk test with a p-value of 3.181e-06.

Discussion

Through the above analysis it was possible to see that there is no satistical significant evidence for an alpha of 0.05, atleast with this data that the type of priming (Happy vs Sad) impact memory recall. It was observed satistical significant evidence for and alpha of 0.05 that Drug and Dosage interact, with Dosage 3 using Alprazolam having the higest, in this case positive impact on memory recall. It was also posible to observe that Alprazolam shows to be statisticaly diferent with an alpha of .01 than Triazolam and Sugar. Is interesting that Triazolam did not show statistical differences when compared with sugar. In terms of Dosages there was statistical signifcant evidence that Dosage 3 difers from Dosage 1 for an alpha of .01.

This conclusions indicate that Alprazolam when used in dose 3 actualy improved memory recall on average. Triazolam seems to have no positive impact on memory recall showing no differences from the placebo, when compared to Alprazolam with all doses. If dose 1 is used, both drugs seem to be have the same efect on memory recall.