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THE EFFECT OF ANTI-ANXIETY MEDICATION ON RECALL PERFORMANCE OF HAPPY MEMORIES USING THE 2K FACTORIAL DESIGN METHOD

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ABSTRACT

Anxiety disorders are common mental health problems and can significantly impact a person's quality of life. This study aims to examine the effect of anti-anxiety drugs, especially benzodiazepines, on individuals' ability to remember happy memories. The research method used was a 2k factorial design to identify interactions between the factors tested, namely drug A, drug T, and drug S (a representation of benzodiazepine drugs) at two different levels. The data is analyzed quantitatively by utilizing values that have been taken from the Kaggle application. This research was conducted by paying attention to the effect of anti-anxiety drugs on happy memory performance, taking into account the effects of dose, duration of use, and individual response to the drug. The 2k factorial design makes it possible to understand the interactions between the factors and how they influence the observed response. The research results obtained are the effect of the drug Triazolam is the only one that can be used to increase the influence/effect on the user's memory performance of happy memories. Apart from that, using the p-value in ANOVA (Analysis of Variance) you can find out that the main effect is statistically significant and that there is no interaction between these factors. This confirms my initial interpretation of the data based on the magnitude of the factor influence. After conducting ANOVA (Analysis of Variance, the regression results show A2, T2, and S2 (factors at dose 2) have a significant influence on the dependent variable (happy memory recall performance).

Keywords : Anxiety Disorders, Benzodiazepines, Happy Memory Recall, 2k Factorial Design, Anxiety Treatment

I. INTRODUCTION

Generalized anxiety disorder (GAD) is a prevalent and highly disabling mental health condition. Anxiety usually goes away once the trigger is overcome. However, for sufferers of anxiety disorders, the fear can be so severe that it makes it difficult to carry out daily activities. If anxiety disorder symptoms are left untreated, they can worsen and affect performance, social relationships, and even health. According to World Health Organization (WHO) describes anxiety disorders as conditions characterized by persistent, uncontrollable feelings of anxiety that can disrupt daily life. This can include disorders such as panic disorder, phobias, and post-traumatic stress disorder (PTSD). Anxiety and anxiety disorders are two different conditions. At a level that is already classified as severe, anxiety disorders can interfere with everyday life. Anxiety disorders are very common mental disorders. According to the World Health Organization, 301 million people worldwide suffered from anxiety disorders in 2019. Of this number, 58 million were children and teenagers.

There are several ways to treat anxiety disorders, namely psychotherapy and pharmacotherapy. Psychotherapy comes in many forms, but the most commonly used to treat anxiety disorders is cognitive behavioral therapy (CBT). This therapy focuses on the relationship between problems, thought patterns, and behavior. Patients are encouraged to consider all this more deeply so they can develop new habits to better cope. In addition, during drug treatment, the doctor will prescribe medications appropriate for the patient's anxiety symptoms. Examples of drugs for anti-anxiety are benzodiazepines, alprazolam(Xanax), chlordiazepoxide(Librium), Clonazepam(Klonopin), diazepam(Valium), and lorazepam, Triazolam.

Benzodiazepines have for decades been known in the literature and clinical practice for their ability to cause mental and behavioral abnormalities. Alprazolam (Xanax), and by extension, triazolam (Halcion), have a very different profile from other benzodiazepines due to their greater capacity to bind to receptors and their shorter half-lives. Benzodiazepines (triazolam) to alleviate anxiety during the duration of the procedure. However, benzodiazepines can cause adverse effects such as delirium and psychosis, which can be exacerbated by their interaction with previously prescribed medications and in those with mental health conditions (Singh et al., 2020). This drug should not be taken lightly and must be under the supervision of a doctor, because there is a risk of drug abuse due to dependence. There are at least two possible causes for the abnormal behavior produced by benzodiazepines.

Anti-anxiety medications can have complex effects on a person's happy memories. This depends on various factors, including the type of drug, dosage, duration of use, as well as the individual's response to the drug. Some anti-anxiety drugs, such as benzodiazepines (eg diazepam, alprazolam), can affect the memory consolidation process. This means that short-term use or low doses may not significantly affect happy memories immediately. However, long-term use or high doses can interfere with the brain's ability to consolidate new memories, including memories of happy experiences. Some anti-anxiety drugs, such as benzodiazepines (eg diazepam, alprazolam), can affect the memory consolidation process. This means that short-term use or low doses may not

significantly affect happy memories immediately. However, long-term use or high doses can interfere with the brain's ability to consolidate new memories, including memories of happy experiences.

Research using the 2k factorial design method was previously carried out by Daniel (White & Turner, 2017) Evaluated drug dose and route of administration on patient recovery in a 2k Factorial Design experiment. Apart from that, (Daniel et al., 2020) conducted research regarding temperature and pH influencing enzyme activity in an experiment. It can be found in (Johnson & Williams, 2018) journal which contains an analysis of the impact of training and feedback methods on employee performance. Therefore, the use of this method is appropriate for the available data. So it can be determined that antianxiety medications on recall of happy memories.

II. METHODS

This research uses quantitative methods, by calculating the value of data that has been taken from the Kaggle application (Kaggle, 2024). Research begins by looking for the dataset needed for this method. Then, a literature study was carried out so that additional data could be obtained. Furthermore data were analyzed using a 2^k factorial design because this model allows the identification of interactions between the factors being tested. These interactions are important because they can provide additional insight into how these factors influence each other and how they influence the observed response. The factorial design model 2^3 is used because there are three factors that want to be evaluated, namely drug A, drug T ,and drug S, each with two levels. In a factorial design 2^3, the three factors are tested at all combinations of their levels, resulting in eight different treatment combinations. In factorial design 2^3, we can evaluate the influence of each factor separately, as well as the interaction between the three factors. This makes it possible to understand whether the effect of one factor depends on the level of another factor. By using a 2^3 factorial design, we can gain a better understanding of how the effects of drug A, drug T and drug S (Benzodiazepines) affect happy memory recall performance.

The research data used is secondary data from the Kaggle application. In the data, there are 3 factors, namely Drug A (Alprazolam), Drug T (Trizolam), and Drug S (Sugar Tablets). Each drug has 2 doses drug A has a dose (1 mg and 3 mg), drug T has a dose (0 .25 mg and 0.5 mg) ,and Drug S has a dosage (1 tab and 2 tabs). Each drug has 2 replications, namely before use and after use of the drug.

Table 1: Determination of Factors and Levels

No	Factor	Low Level	High Level
1	Alprazolam (A)	1 mg	3mg
2	Triazolam (T)	0.25mg	0.5mg
3	Sugar plum (S)	1 tab	2 tabs

The statistical inference technique used in this article uses a 2^k factorial design test. A value (significance level) of 5% is considered statistically significant. The following is a model in the 2^k factorial design method:∝

$$y_{ijk} = \mu + \tau_i + \beta_j + (\tau\beta)_{ij} + \epsilon_{ijk} \begin{cases} i = 1,2 \\ j = 1,2,3 \\ k = 1,2,3 \end{cases} \quad (1)$$

Where :

$y_{ijk}$is the response measured at the I-th observation in the I-th furnace position, j-th combustion temperature, and k-th repetition

$\mu$is the general average of the responses

$\tau_i$is the effect of factor A level i

$\beta_j$is the effect of the jth level factor B

$(\tau\beta)_{ij}$is the interaction between and$\beta_j \tau_i$

$\epsilon_{ijk}$is a random error

Table 2: The Analysis of Variance Table for the Two-Factor Factorial, Fixed Effect Model

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F_0
A Treatments	SS_A	$a-1$	$MS_A = \frac{SS_A}{a-1}$	$F_0 = \frac{MS_A}{MS_E}$
B Treatments	SS_B	$b-1$	$MS_B = \frac{SS_B}{b-1}$	$F_0 = \frac{MS_B}{MS_E}$
Interaction	SS_{AB}	$(a-1)(b-1)$	$MS_{AB} = \frac{SS_{AB}}{(a-1)(b-1)}$	$F_0 = \frac{MS_{AB}}{MS_E}$
Error	SS_E	$ab(n-1)$	$MS_E = \frac{SS_E}{abn-1}$	
Total	SS_T	$abn-1$		

Note: (Montgomery, 2013)

Then, by creating a regression model, it is hoped that it can predict the output of each factor. The following is the formula for the regression model:

$$\hat{y} = \beta_0 + \beta_1 \frac{x_1}{A} + \beta_2 \frac{x_2}{T} + \beta_3 \frac{x_3}{S} + \epsilon \quad (2)$$

A: Factor 1 (level 1; level 2)

T: Factor 2 (level 1; level 2)

S:Factor 13(level 1 ; level 2)

The hypothesis in this research is to test the influence of drug A (Alprazolam), drug T (Triazolam) ,and drug S (Sugar palm) on the performance (duration) of remembering happy memories with a hypothesis in the form of:

H_0 = There is no significant difference between each factor

H_1 = There is a significant difference between each factor

III. RESULTS AND DISSCUSSION

Table 3: Data on memory performance of happy memories

Factor			Replication (second)		Total	Levels	
A	Q	S	1	2		Dose 1	Dose 2
1	1	1	63.3	61.96	(1)=125.26	A (1mg)	A (3 mg)
2	1	1	57.63	56.93	a= 114.56	T (0.25	T(0.5mg)
1	2	1	71.53	69.2	t= 140.73	mg)	S(2 tabs)
2	2	1	65.86	64.16	at= 130.03	S (1 tab)	
1	1	2	50.3	49.46	s= 99.76		
2	1	2	44.63	44.43	as= 89.06		
1	2	2	58.53	56.7	ts= 115.23		
2	2	2	52.86	51.66	ats= 104.53		

We will look for the main effect and intersection effect from the data above, as follows

Table 4: results of the effect of each factor

Combination	A	Q	S	AT	US	T.S	ATS
Results	−5.35	7,735	−12.75	0	0	0	0

The effect of T(Triazolam drug) is positive; This suggests that increasing the T drug from a dose of 0.25mg to a dose of $0{,}5\ mg$ in the process will increase the influence/effect on the user's happy memories. The effect of A (Alprazolam drug) and the effect of S (Sugar drug) are negative; This shows that increasing the drug from dose 1 to dose 2 in the process will not increase (have no effect/decrease) the influence/effect on the user's happy memories. The interaction effect has a value of 0, which means that the influence of AT, AS, TS, and ATS does not significantly influence the influence/effect on the user's memory of happy memories. The temporary conclusion that can be drawn is that the influence of T is the only one that can be used to increase the influence/effect on the user's performance of remembering happy memories.

3.1. Analysis with Anova

Table 5: Contrasts of each Factor

Combination	A	Q	S	AT	US	T.S	ATS
Results	−42.8	61.88	−102	0	0	0	0

Table 6: Sum Square of each factor

Combination	A	Q	S	AT	US	T.S	ATS
Results	114.49	239.32	650.25	0	0	0	0

The following is a manual ANOVA calculation

$$SS_T = \sum_{i=1}^{2}\sum_{j=1}^{2}\sum_{k=1}^{n} {y_{ijk}}^2 - \frac{y^2}{8n} \quad \text{..... (3)}$$

$$SS_T = 53.820{,}07 - 52.808{,}04 \quad \text{..... (4)}$$

$$SS_T = 1.012{,}03 \quad \text{..... (5)}$$

$$SS_E = SS_T - SS_A - SS_T - SS_S - SS_{AT} - SS_{TS} - SS_{AS} - SS_{ABT} \quad \text{..... (6)}$$

$$SS_E = 7{,}97 \quad \text{..... (7)}$$

Table 7: Overall results of manual ANOVA

Source Of Variation	Sum Of Squares	Degrees Of Freedom	Mean Square	Fq
A	114,49	1	114,49	113.6
Q	239,32	1	239,32	237.1
S	650,25	1	650,25	644.6
AT	0	1	0	0
US	0	1	0	0
T.S	0	1	0	0
ATS	0	1	0	0
Error	7.97	8	0.996	
Total	1.709,83	15		

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
A	1	114.6	114.6	113.6	5.26e-06	***
T	1	239.2	239.2	237.1	3.14e-07	***
S	1	650.3	650.3	644.6	6.20e-09	***
A:T	1	0.0	0.0	0.0	0.996	
A:S	1	0.0	0.0	0.0	1.000	
T:S	1	0.0	0.0	0.0	1.000	
A:T:S	1	0.0	0.0	0.0	1.000	
Residuals	8	8.1	1.0			

Figure 1: ANOVA results using R Studio

Using SSA, SSB, and SSAB the full ANOVA is summarized in the Table 7. I note from Figure 1 that the main effects of drug A, drug T, and drug S are significant (all three have very small p-values). Based on the p-value, I conclude that the main effect is statistically significant and there is no interaction between these factors. This confirms my initial interpretation of the data based on the magnitude of the factor influence.

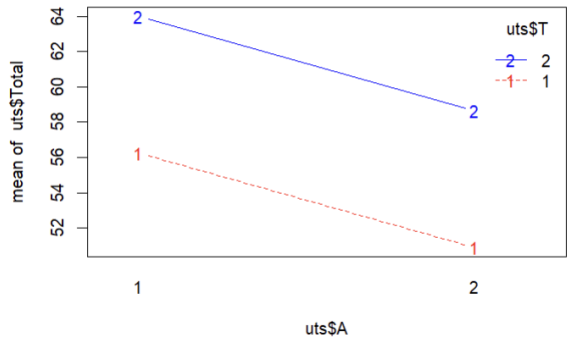

Figure 2: Interaction Plot between Drug A and Drug T

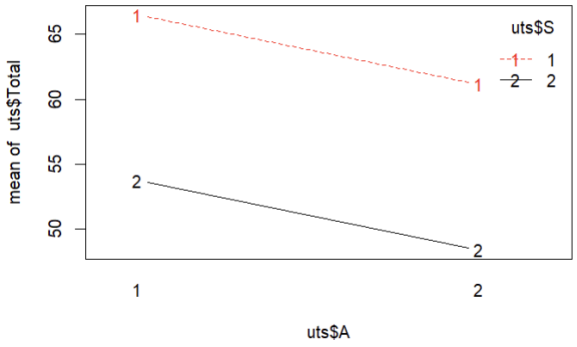

Figure 3: Interaction Plot between Drug A and Drug S

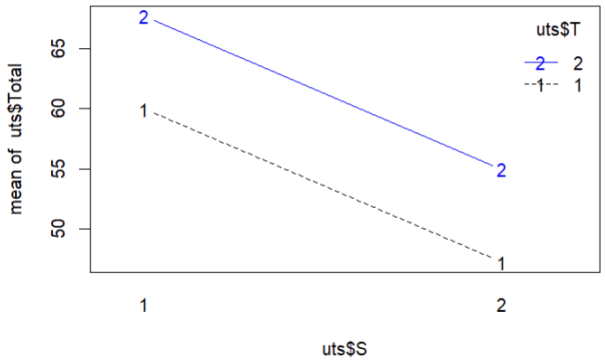

Figure 4: Interaction Plot between Drug T and Drug S

In Figure 2, the interaction plot shows that the effect of drug A does not depend on drug factor T. Then in Figure 3, the interaction plot shows that the effect of Drug A does not depend on drug factor S. Likewise, in Figure 4, the interaction plot shows that the effect of Drug T does not depend on Drug

factor S. The conclusion that can be drawn is that each factor, whether Drug A, Drug T or Drug S, has no interaction with each other.

3.2. Prediction of Output from each Factor

Regression Hypothesis

H_0 = There is no significant interaction between the factors

H_1 = There is a significant interaction between each factor

Model Regression

$\hat{y} = 57{,}45 + \left(\frac{-5{,}35}{2}\right)x_1 + \left(\frac{7{,}735}{2}\right)x_2 + \left(\frac{-12{,}75}{2}\right)x_3$ ..... (8)

A: Alprazolam (1 mg; 3 mg)

Q: Trizolam drug (0.25 mg; 0.5mg)

S: Sugar palm (1 tab; 2 tabs)

Residual and Adequency Models

- When Drug A is at a low level($x_1 = 1\ mg$), Drug T is at a low level, and Drug S is at a low level. The prediction is($x_2 = 0{,}25\ mg$)($x_3 = 1\ tab$

$\hat{y} = 57{,}45 + \left(\frac{-5{,}35}{2}\right)1 + \left(\frac{7{,}735}{2}\right)0{,}25 + \left(\frac{-12{,}75}{2}\right)1 = 49{,}366$ ..... (9)

- When Drug A is at a high level($x_2 = 3\ mg$), Drug T is at a low level, and Drug S is at a low level, the prediction is($x_2 = 0{,}25\ mg$)($x_3 = 1\ tab$

$\hat{y} = 57{,}45 + \left(\frac{-5{,}35}{2}\right)3 + \left(\frac{7{,}735}{2}\right)0{,}25 + \left(\frac{-12{,}75}{2}\right)1 = 44$ ..... (10)

- When Drug A is at a low level($x_1 = 1\ mg$), Drug T is at a high level, and Drug S is at a low level, the prediction is($x_2 = 0{,}5\ mg$)($x_3 = 1\ tab$

$\hat{y} = 57{,}45 + \left(\frac{-5{,}35}{2}\right)1 + \left(\frac{7{,}735}{2}\right)0{,}5 + \left(\frac{-12{,}75}{2}\right)1 = 50{,}3$ ..... (11)

- When Drug A is at a high level($x_2 = 3\ mg$), Drug T is at a high level, and Drug S is at a low level, the prediction is($x_2 = 0{,}5\ mg$)($x_3 = 1\ tab$

$\hat{y} = 57{,}45 + \left(\frac{-5{,}35}{2}\right)3 + \left(\frac{7{,}735}{2}\right)0{,}5 + \left(\frac{-12{,}75}{2}\right)1 = 44{,}98$ ..... (12)

- When Drug A is at a low level($x_2 = 1\ mg$), Drug T is at a low level, and Drug S is at a high level, the prediction is($x_2 = 0{,}25\ mg$)($x_3 = 2\ tab$)

$\hat{y} = 57{,}45 + \left(\frac{-5{,}35}{2}\right)1 + \left(\frac{7{,}735}{2}\right)0{,}25 + \left(\frac{-12{,}75}{2}\right)2 = 42{,}99$ ..... (13)

- When Drug A is at a high level($x_2 = 3\ mg$), Drug T is at a low level, and Drug S is at a high level, the prediction is($x_2 = 0{,}25\ mg$)($x_3 = 2\ tab$)

$\hat{y} = 57{,}45 + \left(\frac{-5{,}35}{2}\right)3 + \left(\frac{7{,}735}{2}\right)0{,}25 + \left(\frac{-12{,}75}{2}\right)2 = 37{,}64$ ..... (14)

- When Drug A is at a low level($x_2 = 1\ mg$), Drug T is at a high level, and Drug S is at a high level, the prediction is($x_2 = 0{,}5\ mg$)($x_3 = 2\ tab$)

$\hat{y} = 57{,}45 + \left(\frac{-5{,}35}{2}\right)1 + \left(\frac{7{,}735}{2}\right)0{,}5 + \left(\frac{-12{,}75}{2}\right)2 = 43{,}95$ ..... (15)

- When all three factors are at a high level($x_1 = 3; x_2 = 0{,}5; x_3 = 2$)

$\hat{y} = 57{,}45 + \left(\frac{-5{,}35}{2}\right)3 + \left(\frac{7{,}735}{2}\right)0{,}5 + \left(\frac{-12{,}75}{2}\right)2 = 38{,}6$ ..... (16)

Table 8: Results of the regression model using R studio

	Estimate	Std.Error	t value	Pr(>|t|)
Intercept	6.263e+01	7.102e01	88.190	3.05e-13***
A2	-5.350e+00	1.004e+00	-5.327	0.000705***
T2	7.735e+00	1.004e+00	7.702	5.74e-05***
S2	-1.275e+01	1.004e+00	-12.695	1.39e-06***
A2 : T2	-5.000e-03	1.420e+00	-0.004	0.997277
A2 : S2	7.744e-15	1.420e+00	0.000	1.000000
T2 : S2	1.066e-14	1.420e+00	0.000	1.000000
A2:T2:S2	-1.643e-14	2.009e+00	0.000	1.000000

From this output, it can be seen that the residual value ranges from -1.1650 to 1.1650, with a median of 0.0000. A median value close to 0 indicates that overall, the residuals have a distribution that tends to be symmetrical around 0. The intercept has a very small p-value (3.05e-13), which indicates very high statistical significance.

Discusses the coefficients between factors, namely A2:T2, A2:S2, T2:S2 and A2:T2:S2. The coefficient for the interaction between the variables A2:T2, A2:S2, T2:S2, and A2:T2:S2 has a very large p-value, so the interaction is not significant at a significant level of confidence. Therefore, in the regression model, the interaction between these variables did not have a significant effect on the dependent variable (happy memory recall performance).

The coefficients A2, T2, and S2 also have very small p-values. However, the interactions between the factors A2:T2, A2:S2, T2:S2, and A2:T2:S2 have very large p-values, which shows that This interaction is not significant at the significant confidence level (5%). The conclusion is to reject H0 for the Intercept, A2, T2, and S2 coefficients because the p-value is very small, so they have a significant influence on the dependent variable (happy memory memory performance). The results failed to reject H0 for the interaction between factors A2:T2, A2:S2, T2:S2, and A2:T2:S2 due to the large p-value, so there was not enough evidence to state that this interaction was significant in the model.

3.3. Residual histogram and Anderson-Darling test

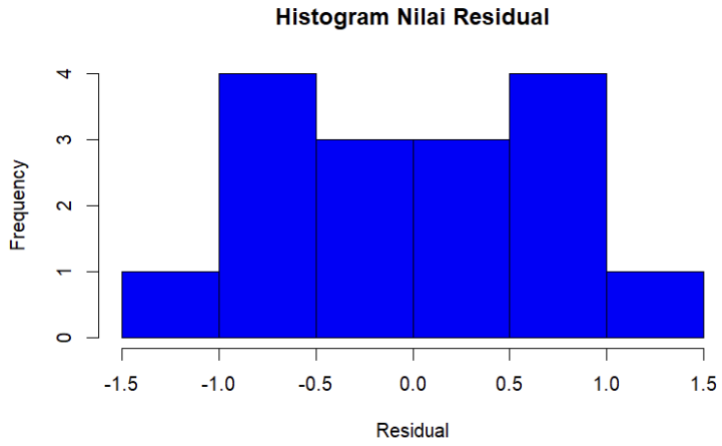

Figure 6: Histogram of residual values

It can be seen from the Histogram graph of residual values that the distribution of residual values is even, but each residual has a frequency level that tends to be different.

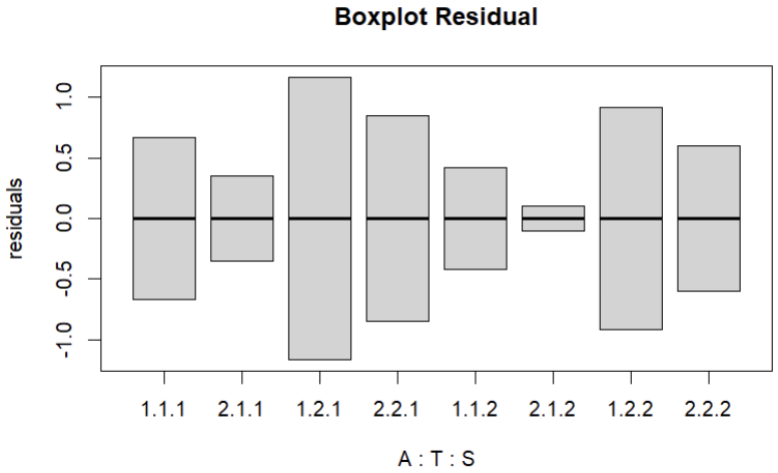

Figure 7. Residual Boxplot

From the boxplot above, it can be seen that there are no outliers combination of values from factors A, T ,and S.

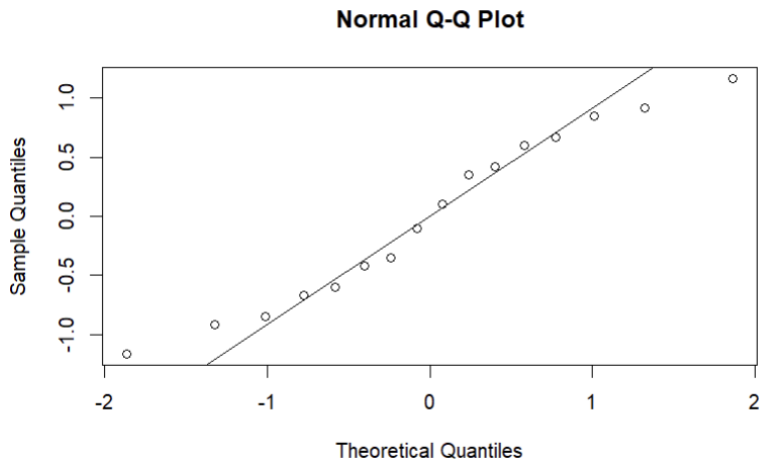

Figure 8: Normal QQ plot

Based on the plot above, it can be seen that around the line there is a lot of data that is close to each other, even though there is a gap at the beginning and end of the data. However, the average data are close to each other and close to the line. So it can be concluded that the data is normally distributed.

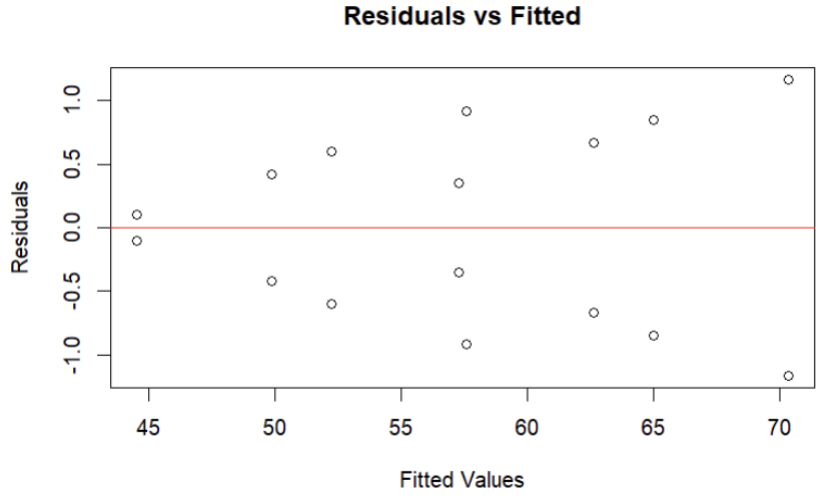

Figure 9: Residual and Fitted

The scatter plot above shows a random pattern and is evenly distributed along the horizontal line at the value 0 (red line), so it shows that there is no systematic pattern in the relationship between Fitted Values and Residuals.

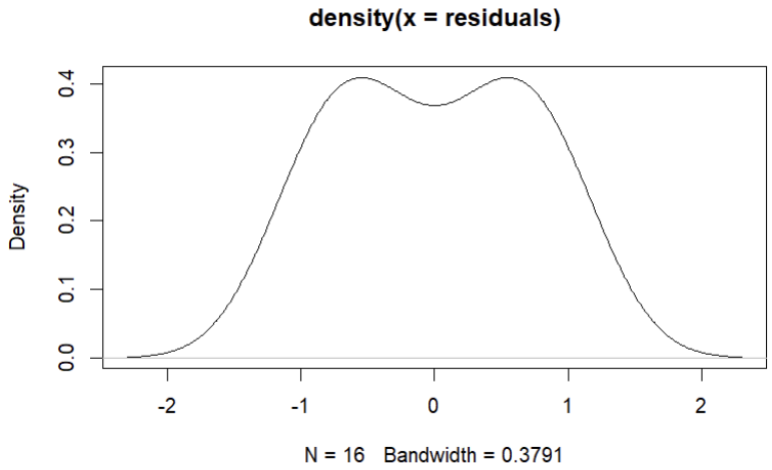

Figure 10: Density graph

From the image above, it can be seen that the density graph roughly follows a bell shape, although in the middle of the data, there are quite significant point differences. However, if you look at the whole data, it has a normal distribution indicator because the graph is shaped like a bell. So it can support the hypothesis that the data is normally distributed.

IV. CONCLUSION

Based on the research results above, it can be seen that the effect of the drug Triazolam is the only one that can be used to increase the influence/effect on the user's happy memories. Apart from that, using the p-value in ANOVA you can find out that the main effect is statistically significant and that there is no interaction between these factors. This confirms my initial interpretation of the data based on the magnitude of the factor influence. After conducting ANOVA, the regression results show A2, T2, and S2 (factors at dose 2) have a significant influence on the dependent variable (happy memory recall performance). To find out that the model that I have done is correct, then tested with the Anderson-Darling test, the results showed that the distribution is normal, which means the model that I have done is correct.

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