

Change in memory score after taking Alprazolam

2019314199 통계학과 김동환

paired T-test & Wilcox signed rank test

1. About data

이 데이터는 편두통 예방제인 벤조디아제핀의 일종인 Alprazolam의 복용 후, 기억을 회상하는 능력을 측정한 점수의 차이를 수집한 데이터이다. 능력의 평가는 이미지 회상검사를 이용하여 측정하였다.

2. Source

Ahn, S., et al. (2020). Memory Test on Drugged Islanders Data. Kaggle.
<https://www.kaggle.com/datasets/steveahn/memory-test-on-drugged-islanders-data>

3. Purpose of Analysis

Alprazolam의 복용이 기억(슬픔, 행복)을 더 증폭 시키는지 알아보기 위함을 목적으로 한다.

4. Results

1) paired T-test

$t = -6.1256$, $P\text{-value} = 7.603e-07$

H_0 can be rejected at $\alpha = 0.05$.

약물의 복용은 기억을 더 증폭시킨다.

2) Signed rank test

$P\text{-value} = 0.01994$

H_0 can be rejected at $\alpha = 0.05$.

약물의 복용은 기억을 더 증폭시킨다.

R

[code]

```
> drugAdata <- read.csv('C:/Users/admin/Desktop/바이오통계/바이오통계2주(~3.12)/drugAdata.csv')

> t.test(drugAdata[, 'Mem_Score_Before'], drugAdata[, 'Mem_Score_After'], alternative='less', paired=T)

> wilcox.test(drugAdata[, 'Mem_Score_Before'], drugAdata[, 'Mem_Score_After'], paried=T, exact=F)
```

[Result]

```
> t.test(drugAdata[, 'Mem_Score_Before'], drugAdata[, 'Mem_Score_After'], alternative='less', paired=T)

      Paired t-test

data:  drugAdata[, "Mem_Score_Before"] and drugAdata[, "Mem_Score_After"]
t = -6.1256, df = 27, p-value = 7.603e-07
alternative hypothesis: true mean difference is less than 0
95 percent confidence interval:
 -Inf -9.931801
sample estimates:
mean difference
 -13.75714

> wilcox.test(drugAdata[, 'Mem_Score_Before'], drugAdata[, 'Mem_Score_After'], paried=T, exact=F)

      wilcoxon rank sum test with continuity correction

data:  drugAdata[, "Mem_Score_Before"] and drugAdata[, "Mem_Score_After"]
W = 249.5, p-value = 0.01994
alternative hypothesis: true location shift is not equal to 0
```

SAS

[code]

```
❏ PROC IMPORT datafile='C:\Users\admin\Desktop\바이오통계\바이오통계 2주차(~3.12)\drugAdata.csv'
  dbms = csv
  out = drugA;
  getnames=Yes;
❏ proc print data=drugA;
  run;
❏ PROC UNIVARIATE data=drugA;
  VAR Diff;
  run;
❏ PROC TTEST data=drugA sides=U;
  PAIRED Mem_Score_After*Mem_Score_Before;
  run;
```

[Result]

1)TTEST Procedure

SAS 시스템					
The TTEST Procedure					
Difference: Mem_Score_After - Mem_Score_Before					
N	Mean	Std Dev	Std Err	Minimum	Maximum
28	13.7571	11.8840	2.2459	-8.3000	39.0000
Mean	95% CL Mean	Std Dev	95% CL Std Dev		
13.7571	9.9318	Infity	11.8840	9.3957	16.1757
DF	t Value	Pr > t			
27	6.13	<.0001			

2)Signed Rank Test

SAS 시스템					
UNIVARIATE 프로시저					
변수: Diff					
위치모수 검정: Mu0=0					
검정	통계량		p 값		
스튜던트의 t	t	6.125565	Pr > t	<.0001	
부호	M	9	Pr >= M	0.0009	
부호 순위	S	182.5	Pr >= S	<.0001	

R

[code]

```
> mind<-read.csv("C:/Users/admin/Desktop/바이오통계/바이오통계 2주차(~3.12)/Theory of mind in  
remitted bipolar disorder.csv")  
  
> BD1<-mind %>% filter(Type=='BD1')  
  
> BD1_sample<-BD1 %>% sample_n(25)  
  
> control<-mind %>% filter(Type=='Control')  
  
> control_sample<-control %>% sample_n(25)  
  
> var.test(BD1_sample[, 'Right_answers'], control_sample[, 'Right_answers'])  
  
> t.test(BD1_sample[, 'Right_answers'], control_sample[, 'Right_answers'], var.equal=T)  
  
> wilcox.test(BD1_sample[, 'Right_answers'], control_sample[, 'Right_answers'], exact=F)
```

[Result]

```
> var.test(BD1_sample[, 'Right_answers'], control_sample[, 'Right_answers'])  
  
      F test to compare two variances  
  
data:  BD1_sample[, "Right_answers"] and control_sample[, "Right_answers"]  
F = 4.2087, num df = 24, denom df = 24, p-value = 0.008065  
alternative hypothesis: true ratio of variances is not equal to 1  
95 percent confidence interval:  
 1.854623 9.550603  
sample estimates:  
ratio of variances  
    4.208654  
  
> t.test(BD1_sample[, 'Right_answers'], control_sample[, 'Right_answers'], var.equal=F)  
  
      welch Two sample t-test  
  
data:  BD1_sample[, "Right_answers"] and control_sample[, "Right_answers"]  
t = -3.5461, df = 34.796, p-value = 0.00114  
alternative hypothesis: true difference in means is not equal to 0  
95 percent confidence interval:  
 -7.674377 -2.085623  
sample estimates:  
mean of x mean of y  
    44.56    49.44
```

```
> wilcox.test(BD1_sample[, 'Right_answers'], control_sample[, 'Right_answers'], exact=F)

      wilcoxon rank sum test with continuity correction

data:  BD1_sample[, "Right_answers"] and control_sample[, "Right_answers"]
w = 143, p-value = 0.00101
alternative hypothesis: true location shift is not equal to 0
```

SAS

*랜덤 샘플링을 했더니 R과 결과가 다르게 나왔습니다. R에서 샘플링한 데이터로 진행했어야 했는데, 깜빡했습니다. 그래서 이 부분은 참고용으로 봐주시면 감사하겠습니다.

[code]

```
PROC IMPORT datafile="C:\Users\admin\Desktop\바이오통계\바이오통계
2주차 (~3.12)\BD1.csv"
  dbms =csv
  out= BD1;
  getnames=Yes;

proc surveyselect data=BD1
  method=srs
  n=25
  out=BD1_Con_sample
  seed=12345;
  strata Type;
  keep Type Right_answers;
  where Type in ('BD1', 'Con');
run;
PROC print data=BD1_Con_sample;
run;

PROC TTEST data=BD1_Con_sample;
Class Type;
Var Right_answers;
run;

PROC NPAR1WAY wilcoxon data=BD1_Con_sample;
Class Type;
Var Right_answers;
run;
```

[Result]

1)T-test

SAS 시스템							
The TTEST Procedure							
Variable: Right_answers							
Type	Method	N	Mean	Std Dev	Std Err	Minimum	Maximum
BD1		25	45.2800	4.6235	0.9247	33.0000	56.0000
Con		25	48.8800	3.4919	0.6984	42.0000	56.0000
Diff (1-2)	Pooled		-3.6000	4.0970	1.1588		
Diff (1-2)	Satterthwaite		-3.6000		1.1588		

Type	Method	Mean	95% CL Mean	Std Dev	95% CL Std Dev
BD1		45.2800	43.3715 47.1885	4.6235	3.6102 6.4320
Con		48.8800	47.4386 50.3214	3.4919	2.7266 4.8578
Diff (1-2)	Pooled	-3.6000	-5.9299 -1.2701	4.0970	3.4165 5.1183
Diff (1-2)	Satterthwaite	-3.6000	-5.9344 -1.2656		

Method	Variances	DF	t Value	Pr > t
Pooled	Equal	48	-3.11	0.0032
Satterthwaite	Unequal	44.658	-3.11	0.0033

Equality of Variances				
Method	Num DF	Den DF	F Value	Pr > F
Folded F	24	24	1.75	0.1763

2) Wilcoxon rank sum test

SAS 시스템					
The NPARIWAY Procedure					
Wilcoxon Scores (Rank Sums) for Variable Right_answers Classified by Variable Type					
Type	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
BD1	70	4122.0	6650.0	362.335717	58.885714
Con	119	13833.0	11305.0	362.335717	116.243697
Average scores were used for ties.					

Wilcoxon Two-Sample Test					
Statistic	Z	Pr < Z	Pr > Z	t Approximation	
				Pr < Z	Pr > Z
4122.000	-6.9756	<.0001	<.0001	<.0001	<.0001
Z includes a continuity correction of 0.5.					

Kruskal-Wallis Test		
Chi-Square	DF	Pr > ChiSq
48.6779	1	<.0001

Test for Theory of mind performance

2019314199 통계학과 김동환

Two Sample T-test & Wilcoxon rank sum test

1. About data

이 데이터는 치료된 조울증환자 70명, 119명의 대조군의 MiniPons 테스트 점수이다. MiniPons test는 얼굴표정, 몸짓, 목소리 억양 등 비언어적 단서들을 가지고 다른 사람을 공감하고 이해하는 능력(Theory of mind)을 평가한다.

2. Source

Espinós, U., Fernández-Abascal, E. G., & Ovejero, M. (2019). Theory of mind in remitted bipolar disorder: Interpersonal accuracy in recognition of dynamic nonverbal signals. PloS one, 14(9), e0222112. <https://doi.org/10.1371/journal.pone.0222112>

3. Purpose of Analysis

양극성 장애를 앓았던 사람과 일반 사람간에 Theory of Mind 점수에 차이가 있는지 판별한다.

4. Results

1) t-test

> check common variance first

$$H_0: \sigma_1^2 = \sigma_2^2$$

F-value = 4.2087, P-value = 0.0008065

The null hypothesis of common variance can be rejected at $\alpha = 0.05$

>t-test

$$H_0: \mu_1 = \mu_2$$

$\sigma_1^2 = \sigma_2^2$ is not accepted,

t=-3.5461, P-value = 0.00114

H_0 can be rejected at $\alpha = 0.05$

2) Wilcoxon rank sum test

P-value = 0.00101

H_0 can be rejected at $\alpha = 0.05$

두 그룹의 모평균은 $\alpha = 0.05$ 유의한 차이가 있다.

R

[code]

```
> drugdata <- read.csv('C:/Users/admin/Desktop/바이오통계/바이오통계 2주차(~3.12)/drugdata.csv')
```

```
> model <- aov(Diff ~ Happy_Sad_group + Drug + Drug*Happy_Sad_group, data = drugdata)
```

```
> anova(model)
```

```
> TukeyHSD(model)
```

```
> anova(model)
Analysis of Variance Table

Response: Diff
              Df Sum Sq Mean Sq F value    Pr(>F)
Happy_Sad_group      1      9.7      9.69   0.1011    0.7509
Drug                 2  4280.3  2140.14  22.3234 1.92e-09 ***
Happy_Sad_group:Drug  2    88.4    44.18   0.4609    0.6314
Residuals          192 18407.0    95.87
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
> TukeyHSD(model)
Tukey multiple comparisons of means
 95% family-wise confidence level

Fit: aov(formula = Diff ~ Happy_Sad_group + Drug + Drug * Happy_Sad_group, data = drugdata)

$Happy_Sad_group
      diff      lwr      upr    p adj
S-H 0.4424242 -2.302512  3.18736 0.7509005

$Drug
      diff      lwr      upr    p adj
S-A -9.6984848 -13.724447 -5.672523 0.0000001
T-A -10.0196970 -14.045659 -5.993735 0.0000001
T-S -0.3212121  -4.347174  3.704750 0.9806132
```

SAS

[code]

```
❏ PROC IMPORT datafile='C:\Users\Wadmin\Desktop\바이오통계\바이오통계 2주차(~3.12)\drugdata.csv'  
  dbms = csv  
  out = drug;  
  getnames=Yes;  
  
❏ proc print data=drug;  
  run;  
  
❏ PROC ANOVA data=drug;  
  CLASS Happy_Sad_group Drug;  
  MODEL Diff = Happy_Sad_group Drug Happy_Sad_group*Drug;  
  MEANS Drug / Tukey;  
  run;
```

[Result]

1) The ANOVA Procedure

SAS 시스템

The ANOVA Procedure

Dependent Variable: Diff

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	4378.33333	875.66667	9.13	<.0001
Error	192	18406.97758	95.86967		
Corrected Total	197	22785.31091			

R-Square	Coeff Var	Root MSE	Diff Mean
0.192156	331.3981	9.791306	2.954545

Source	DF	Anova SS	Mean Square	F Value	Pr > F
Happy_Sad_group	1	9.689091	9.689091	0.10	0.7509
Drug	2	4280.278485	2140.139242	22.32	<.0001
Happy_Sad_group*Drug	2	88.365758	44.182879	0.46	0.6314

2)Tukey Test

SAS 시스템

The ANOVA Procedure

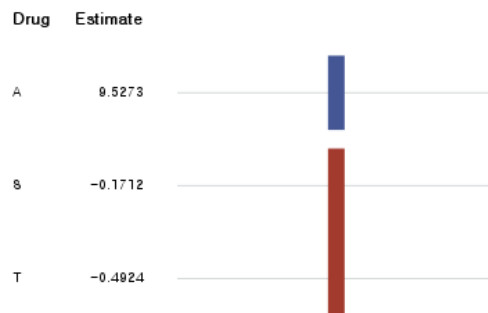
Tukey's Studentized Range (HSD) Test for Diff

Note: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than REGWQ.

Alpha	0.05
Error Degrees of Freedom	192
Error Mean Square	95.86967
Critical Value of Studentized Range	3.34042
Minimum Significant Difference	4.026

Diff Tukey Grouping for Means of Drug (Alpha = 0.05)

Means covered by the same bar are not significantly different.



Memory Test on Drugged Islanders Data

2019314199 통계학과 김동환

Two-way ANOVA & Tukey test

1. About data

이 데이터는 약물 실험에 대한 내용으로, 해당 약물들의 효과를 조사하기 위해 행해진 실험의 결과이다. 실험 약물은 알프라조람(A), 트리아졸람(T), 플라시보 약물인 설탕(S)이며, 행복한 기억과 슬픈 기억에 대해 약물 복용 시 어떠한 영향(강화,약화)이 있는지 이미지 회상검사를 통해 복용 전과 후의 점수 차이를 산출하였다

2. Source

Ahn, S., et al. (2020). Memory Test on Drugged Islanders Data. Kaggle.
<https://www.kaggle.com/datasets/steveahn/memory-test-on-drugged-islanders-data>

3. Purpose of Analysis

편두통 예방제인 벤조디아제핀의 장기 사용 기억력에 어떤 영향이 있는지, 알아보는 것을 목적으로 한다.

4. Results

Analysis of Variance Table

1) Test for the interaction $(\alpha\beta)_{ij} = 0$

기억의 종류(행복,슬픔)과 약물 종류의 교호작용

F-value = 0.4609, P-value = 0.6314

no significant interaction at $\alpha = 0.05$.

2) Test for the emotion effect

$H_0: \alpha_1 = \alpha_2$

F-value = 0.1011, P-value=0.7509

H_0 cannot be rejected at $\alpha = 0.05$.

3) Test for the drug type effect

$H_0: b_1=b_2=b_3$

F-value = 22.3234, P-value=1.92e-09

약물의 종류(A,T,S)에 따라 이미지 회상 검사 점수에 차이가 있다.

4) Multiple comparision

A가 T,S들과 각각 차이가 있다.

R

[Code]

```
mind_dat<-read.csv("C:/Users/admin/Desktop/Theory of mind in remitted bipolar disorder.csv")

aov_model<-aov(Right_answers~Type,data=mind_dat)

anova(aov_model)

install.packages('agricolae');library(agricolae)

duncan.test(aov_model,'Type',alpha=0.05,console=TRUE)

kruskal.test(mind_dat[, 'Right_answers'],mind_dat[, 'Type'])
```

[RESULT]

1)ANOVA

```
> anova(aov_model)
Analysis of Variance Table

Response: Right_answers
          Df Sum Sq Mean Sq F value    Pr(>F)
Type         3  2289.3   763.09  39.568 < 2.2e-16 ***
Residuals  273  5265.0    19.29
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
> library(agricolae)
> duncan.test(aov_model,'Type',alpha=0.05,console=TRUE)
```

2)Kruskal-wallis rank sum test

```
> kruskal.test(mind_dat[, 'Right_answers'],mind_dat[, 'Type'])

      Kruskal-wallis rank sum test

data:  mind_dat[, "Right_answers"] and mind_dat[, "Type"]
Kruskal-wallis chi-squared = 86.353, df = 3, p-value < 2.2e-16
```

3)Duncan test

```
> duncan.test(aov_model, 'Type', alpha=0.05, console=TRUE)

Study: aov_model ~ "Type"

Duncan's new multiple range test
for Right_answers

Mean Square Error: 19.28565

Type, means

      Right_answers      std      r Min Max
BD1      45.14286 4.852269  70  28  56
BD2      45.65306 4.745836  49  33  55
Control  50.23529 3.704569 119  39  58
UD       42.71795 4.973343  39  32  53

Groups according to probability of means differences and alpha level( 0.05 )

Means with the same letter are not significantly different.

      Right_answers groups
Control  50.23529      a
BD2      45.65306      b
BD1      45.14286      b
UD       42.71795      c
```

SAS

[Code]

```
❏ PROC IMPORT datafile='C:\Users\Wadmin\Desktop\바이오통계\바이오통계 2주차(~3.12)\Theory of mind in remitted bipolar disorder.csv'
  dbms = csv
  out = mind;
  getnames=Yes;

❏ proc print data=mind;
run;

❏ proc anova data=mind;
  class Type;
  model Right_answers=Type;
run;

❏ proc npar1way data=mind wilcoxon;
  class Type;
  var Right_answers;
run;

❏ proc GLM data=mind;
  class Type;
  model Right_answers=Type;
  MEANS Type/Duncan;
run;
```

[RESULT]

1) The ANOVA Procedure

SAS 시스템		
The ANOVA Procedure		
Class Level Information		
Class	Levels	Values
Type	4	BD1 BD2 Con UD
Number of Observations Read		277
Number of Observations Used		277

SAS 시스템					
The ANOVA Procedure					
Dependent Variable: Right_answers					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	2289.270038	763.090013	39.57	<.0001
Error	273	5264.982670	19.285651		
Corrected Total	276	7554.252708			
R-Square	Coeff Var	Root MSE	Right_answers Mean		
0.303044	9.327946	4.391543	47.07942		
Source	DF	Anova SS	Mean Square	F Value	Pr > F
Type	3	2289.270038	763.090013	39.57	<.0001

2)Kruskal-wallis Test

SAS 시스템					
The NPARIWAY Procedure					
Wilcoxon Scores (Rank Sums) for Variable Right_answers Classified by Variable Type					
Type	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
BD1	70	7483.50	9730.0	578.273194	106.907143
BD2	49	5649.00	6811.0	507.766836	115.285714
Con	119	22444.00	16541.0	658.720065	188.605042
UD	39	2926.50	5421.0	462.828027	75.038462
Average scores were used for ties.					
Kruskal-Wallis Test					
Chi-Square	DF	Pr > ChiSq			
86.3535	3	<.0001			

3) Duncan Test

SAS 시스템

The GLM Procedure

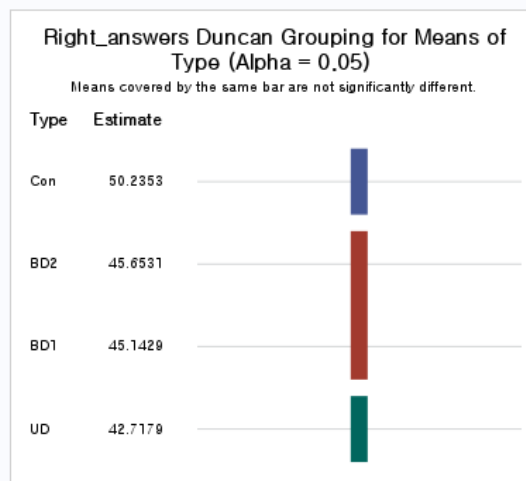
Duncan's Multiple Range Test for Right_answers

Note: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	273
Error Mean Square	19.28565
Harmonic Mean of Cell Sizes	58.19175

Note: Cell sizes are not equal.

Number of Means	2	3	4
Critical Range	1.603	1.687	1.744



Test for Theory of mind performance

2019314199 통계학과 김동환

One-way ANOVA & Kruskal-wallis rank sum test & Duncan test

1. About data

이 데이터는 치료된 조울증환자 119명(BD1:70,BD2:49), 우울증환자 39명, 119명의 대조군의 MiniPons 테스트 점수이다. MiniPons test는 얼굴표정, 몸짓, 목소리 억양 등 비언어적 단서들을 가지고 다른 사람을 공감하고 이해하는 능력(Theory of mind)을 평가한다.

2. Source

Espinós, U., Fernández-Abascal, E. G., & Ovejero, M. (2019). Theory of mind in remitted bipolar disorder: Interpersonal accuracy in recognition of dynamic nonverbal signals. PLoS one, 14(9), e0222112. <https://doi.org/10.1371/journal.pone.0222112>

3. Purpose of Analysis

양극성 장애를 앓았던 사람들이 타인의 비언어적 행동을 정확하게 판단 할 수 있는 능력에 이상이 없는지를 조사하는 것을 목적으로 한다.

4. Results

H0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4$

조울증(BD1,BD2),우울증,정상 그룹간 MiniPons test 점수의 차이가 없다.

1) Analysis of Variance Table

H0: $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4$

F-value: 39.568 , P-value= $p(F > 39.568) = 2.2e-16$

H0 can be rejected at $\alpha = 0.05$

2) Kruskal-Wallis rank sum test

Kruskal-Wallis chi-squared = 86.353

P-value = 2.2e-16

H0 can be rejected at alpha=0.05

3) Multiple comparison

	ans	groups
3	50.23529	a
2	45.65306	b
1	45.14286	b
4	42.71795	c

Group 1,2는 Group 3,4와 차이가있다.