

```

suppressMessages(library(car))
# Data Adapted from
# Field, A.P. (2013) Discovering statistics using SPSS: and
# sex and drugs and rock 'n' roll (4th Ed). London: Sage.

# https://mcfromnz.wordpress.com/2011/03/02/anova-type-iiii-ss-explained/

viagra = data.frame(
  "dose" = rep(c("Placebo", "Low", "High"), times=c(9,8,13)),
  "targ_lib" = c(3,2,5,2,2,2,7,2,4,
                7,5,3,4,4,7,5,4,
                9,2,6,3,4,4,4,6,4,6,2,8,5),
  "part_lib" = c(4,1,5,1,2,2,7,4,5,
                5,3,1,2,2,6,4,2,
                1,3,5,4,3,3,2,0,1,3,0,1,0)
)

psych::describeBy(viagra[,2:3], group=viagra$dose, skew=F, range=F)

```

```

group: High
      vars n mean  sd  se
targ_lib  1 13 4.85 2.12 0.59
part_lib  2 13 2.00 1.63 0.45
-----

```

```

group: Low
      vars n mean  sd  se
targ_lib  1  8 4.88 1.46 0.52
part_lib  2  8 3.12 1.73 0.61
-----

```

```

group: Placebo
      vars n mean  sd  se
targ_lib  1  9 3.22 1.79 0.60
part_lib  2  9 3.44 2.07 0.69

```

```
summary(lm(targ_lib ~ dose,data=viagra, contrasts=list('dose'=contr.SAS))->lm0)
```

Call:

```
lm(formula = targ_lib ~ dose, data = viagra, contrasts = list(dose = contr.SAS))
```

Residuals:

```

      Min       1Q   Median       3Q      Max
-2.8462 -1.2222 -0.8462  1.1538  4.1538

```

Coefficients:

```

              Estimate Std. Error t value Pr(>|t|)
(Intercept)   3.2222     0.6224   5.177 1.89e-05 ***
dose1          1.6239     0.8096   2.006  0.0550 .
dose2          1.6528     0.9072   1.822  0.0796 .
---

```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 1.867 on 27 degrees of freedom
Multiple R-squared: 0.1518, Adjusted R-squared: 0.08896
F-statistic: 2.416 on 2 and 27 DF, p-value: 0.1083

```
# sequential or Type-I  
anova(lm0)
```

Analysis of Variance Table

```
Response: targ_lib  
      Df Sum Sq Mean Sq F value Pr(>F)  
dose    2  16.844   8.4219   2.4159 0.1083  
Residuals 27  94.123   3.4860
```

```
# Type-III  
Anova(lm0,type=3)
```

Anova Table (Type III tests)

```
Response: targ_lib  
      Sum Sq Df F value    Pr(>F)  
(Intercept) 93.444  1 26.8054 1.891e-05 ***  
dose         16.844  2   2.4159   0.1083  
Residuals   94.123 27  
---  
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary(update(lm0, ~. + part_lib)->lm1)
```

Call:

```
lm(formula = targ_lib ~ dose + part_lib, data = viagra, contrasts = list(dose = contr.SAS))
```

Residuals:

```
      Min       1Q   Median       3Q      Max  
-3.2622 -0.7899 -0.3230  0.8811  4.5699
```

Coefficients:

```
      Estimate Std. Error t value Pr(>|t|)  
(Intercept)  1.7892     0.8671   2.063  0.0492 *  
dose1        2.2249     0.8028   2.771  0.0102 *  
dose2        1.7857     0.8494   2.102  0.0454 *  
part_lib     0.4160     0.1868   2.227  0.0348 *  
---  
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 1.744 on 26 degrees of freedom
Multiple R-squared: 0.2876, Adjusted R-squared: 0.2055
F-statistic: 3.5 on 3 and 26 DF, p-value: 0.02954

```
# sequential or Type-I
anova(lm1)
```

Analysis of Variance Table

```
Response: targ_lib
      Df Sum Sq Mean Sq F value Pr(>F)
dose    2  16.844   8.4219   2.7701 0.08117 .
part_lib 1  15.076  15.0757   4.9587 0.03483 *
Residuals 26  79.047   3.0403
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Type-III
Anova(lm1,type=3)
```

Anova Table (Type III tests)

```
Response: targ_lib
      Sum Sq Df F value Pr(>F)
(Intercept) 12.943  1  4.2572 0.04920 *
dose        25.185  2  4.1419 0.02745 *
part_lib    15.076  1  4.9587 0.03483 *
Residuals   79.047 26
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary(update(lm1,~.+ part_lib:dose)->lm2)
```

Call:

```
lm(formula = targ_lib ~ dose + part_lib + dose:part_lib, data = viagra,
    contrasts = list(dose = contr.SAS))
```

Residuals:

```
      Min       1Q   Median       3Q      Max
-3.2837 -0.6274 -0.1201  0.6299  3.9351
```

Coefficients:

```
      Estimate Std. Error t value Pr(>|t|)
(Intercept)  0.59416    1.05743   0.562  0.57940
dose1        4.68950    1.26940   3.694  0.00114 **
dose2        1.71722    1.60191   1.072  0.29439
part_lib     0.76299    0.26716   2.856  0.00872 **
dose1:part_lib -0.98174    0.38432  -2.554  0.01740 *
dose2:part_lib  0.05737    0.43403   0.132  0.89594
```

```
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 1.563 on 24 degrees of freedom
Multiple R-squared:  0.4717,    Adjusted R-squared:  0.3617
F-statistic: 4.286 on 5 and 24 DF,  p-value: 0.006295
```

```
# sequential or Type-I
anova(lm2)
```

Analysis of Variance Table

Response: targ_lib

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
dose	2	16.844	8.4219	3.4480	0.04827	*
part_lib	1	15.076	15.0757	6.1722	0.02035	*
dose:part_lib	2	20.427	10.2133	4.1815	0.02767	*
Residuals	24	58.621	2.4425			

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```
# Type-III
```

```
Anova(lm2,type=3)
```

Anova Table (Type III tests)

Response: targ_lib

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	0.771	1	0.3157	0.579405
dose	36.558	2	7.4836	0.002980 **
part_lib	19.922	1	8.1565	0.008715 **
dose:part_lib	20.427	2	4.1815	0.027667 *
Residuals	58.621	24		

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1