Final Project

Ryan Chiang

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```
#install.packages("Matrix")
#install.packages("MCMCglmm")
library(Matrix)
#remove.packages("Matrix")
#install.packages("/Users/apple/Downloads/Matrix_1.2-7.1.tar", repos = "NULL", type = "source")
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(ggplot2)
library(rptR)
#library(lme4)
library(MCMCglmm)
```

```
## Loading required package: coda

## Loading required package: ape

##
## Attaching package: 'ape'

## The following object is masked from 'package:dplyr':
##
##     where
```

```
library(MPV)
```

```
## Loading required package: lattice

## Loading required package: KernSmooth
```

```
## KernSmooth 2.23 loaded
## Copyright M. P. Wand 1997-2009
```

```
## Loading required package: randomForest
```

```
## randomForest 4.7-1.1
```

```
## Type rfNews() to see new features/changes/bug fixes.
```

```
##
## Attaching package: 'randomForest'
```

```
## The following object is masked from 'package:ggplot2':
##
##     margin
```

```
## The following object is masked from 'package:dplyr':
##
##     combine
```

```
library(leaps)
library(MASS)
```

```
##
## Attaching package: 'MASS'
```

```
## The following object is masked from 'package:MPV':
##
##     cement
```

```
## The following object is masked from 'package:dplyr':
##
##     select
```

```
library(lme4)
```

```
wasp <- read.csv("../final_project_STA101/wasp.csv")
```

```
#summary(wasp)
```

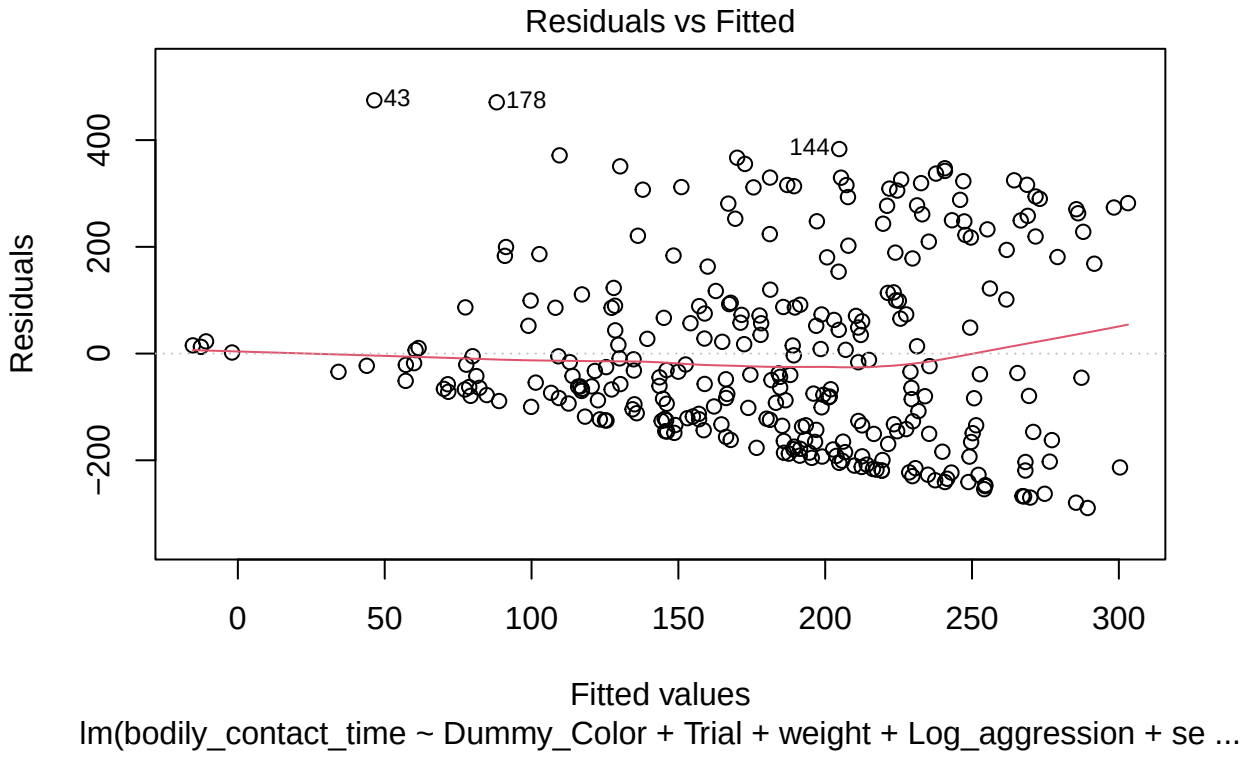
```
lm_model_affiliation <- lm(bodily_contact_time ~ Dummy_Color + Trial + weight + Log_aggression + seconds
lm_model_affiliation
```

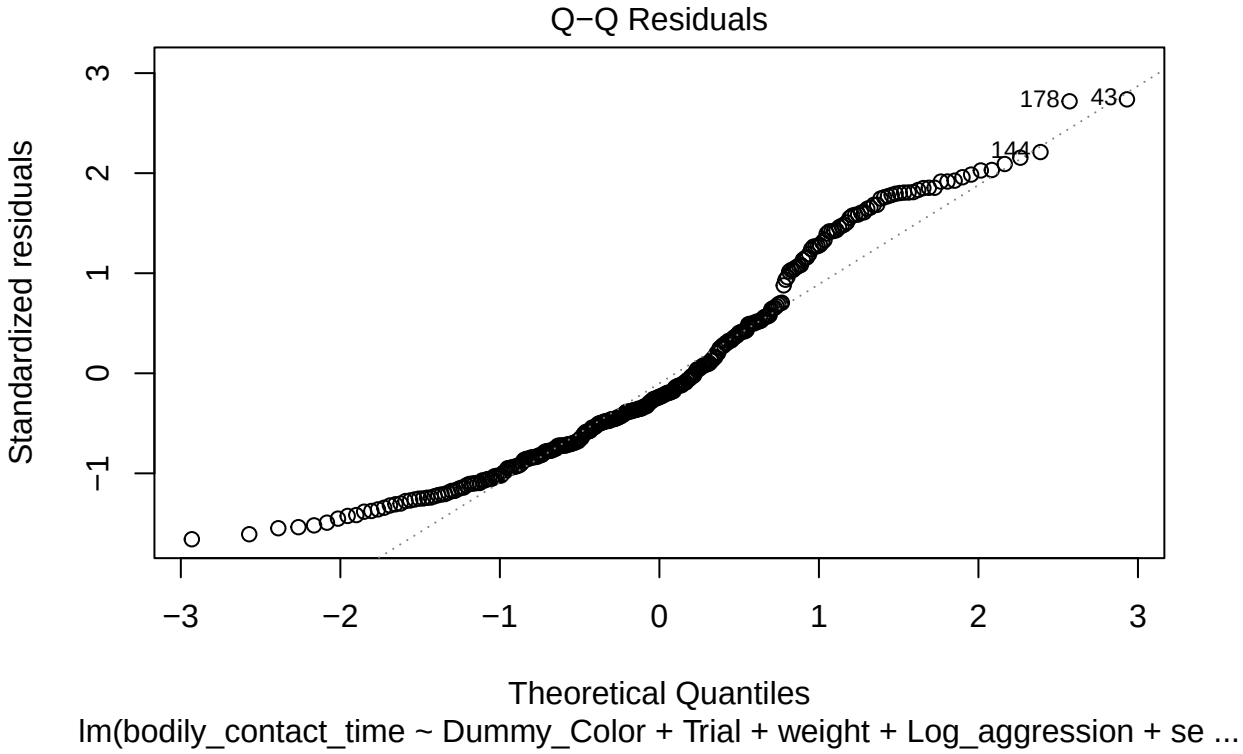
```
##
## Call:
## lm(formula = bodily_contact_time ~ Dummy_Color + Trial + weight +
##     Log_aggression + seconds_moving + anntenation + chambers_entered,
##     data = wasp)
##
```

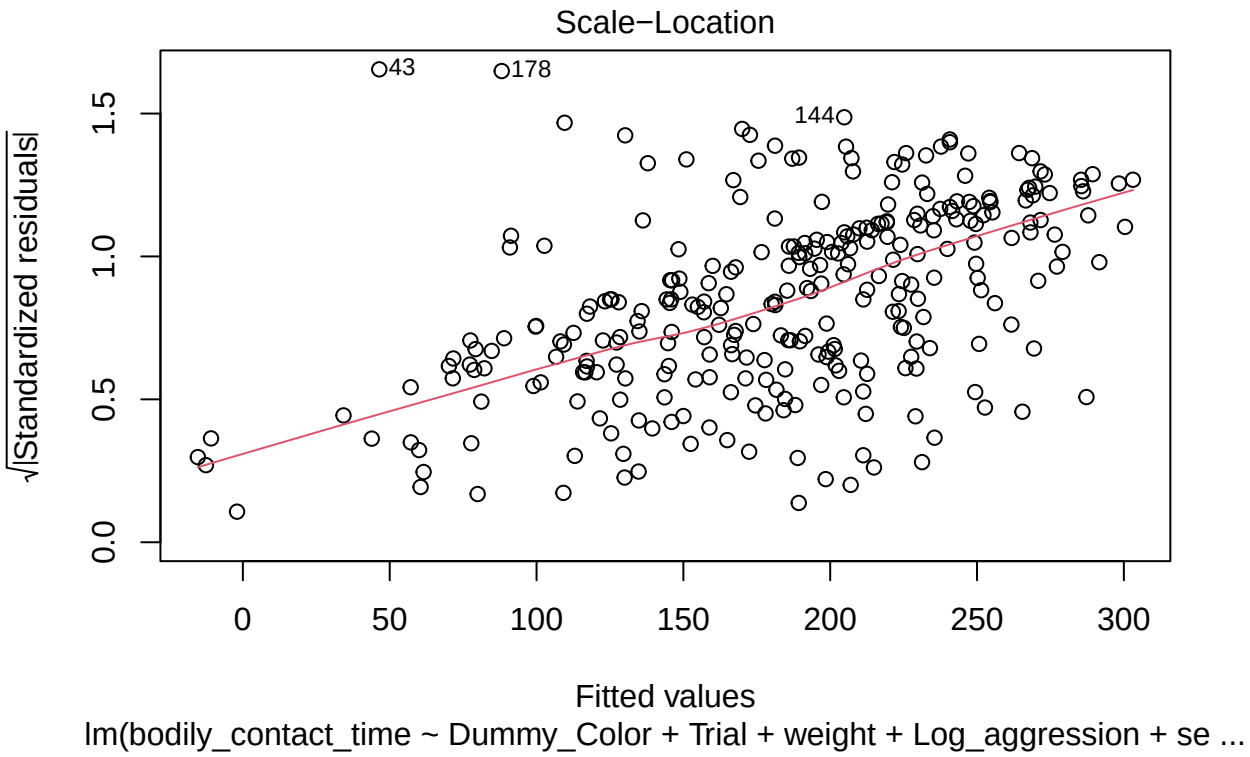
```
## Coefficients:
##            (Intercept)  Dummy_Colorgoldsilver       Dummy_Colorgreen
##              155.2345               52.2334               28.2654
##        Dummy_Colorred      Dummy_Colorsilver       Dummy_Colorwhite
##             -107.7908                6.1998               37.4223
##     Dummy_Coloryellow                 Trial                weight
##              -26.5071               21.3410              291.4209
##        Log_aggression        seconds_moving            anntenation
##              -12.7849               -0.2476               -3.7196
##      chambers_entered
##                2.3193
```

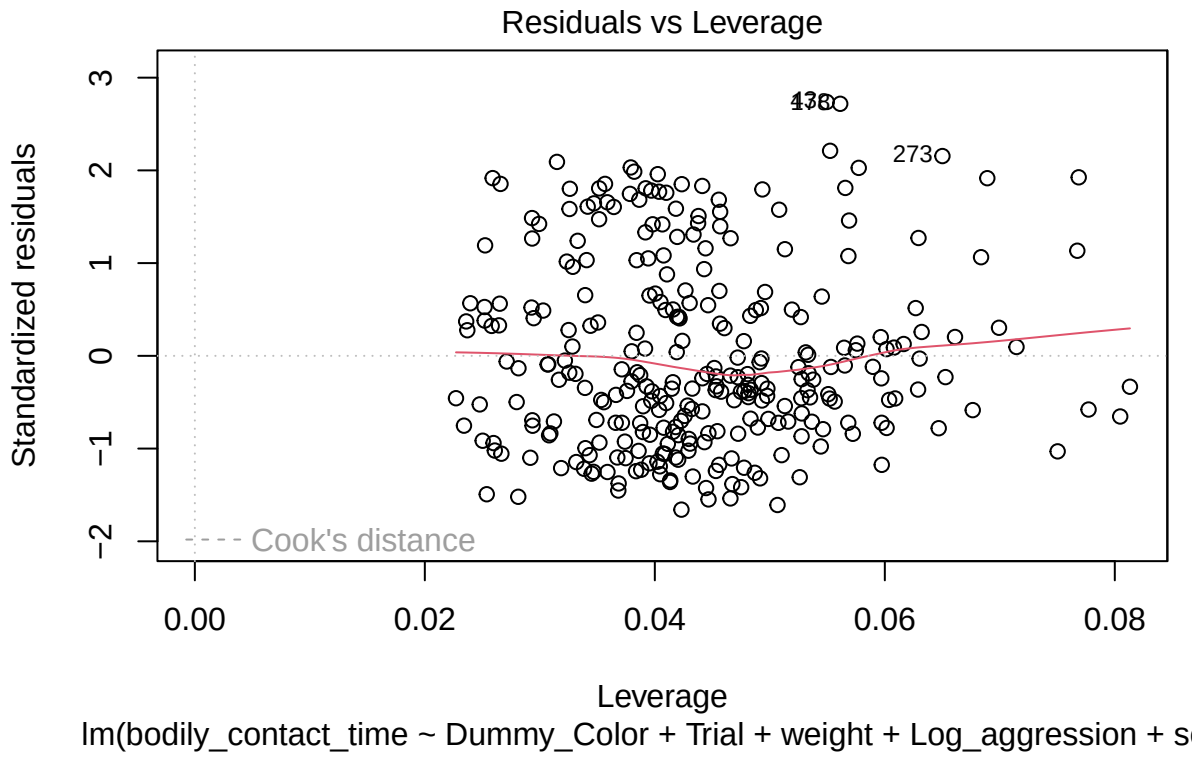
```
lm_empty_affiliation_model <- lm(bodily_contact_time ~ 1, data = wasp)
```

```
plot(lm_model_affiliation)
```




Q−Q Residuals
Standardized residuals
Theoretical Quantiles
lm(bodily_contact_time ~ Dummy_Color + Trial + weight + Log_aggression + se ...
178
43
144
−3
−2
−1
0
1
2
3


Scale−Location
43
178
144
√|Standardized residuals|
0.0
0.5
1.0
1.5
0
50
100
150
200
250
300
Fitted values
lm(bodily_contact_time ~ Dummy_Color + Trial + weight + Log_aggression + se ...




```
n = nrow(wasp)
```

```
aff_backward.model.BIC = stepAIC(lm_model_affiliation,  scope = list(lower = lm_empty_affiliation_model
aff_forward.model.BIC = stepAIC(lm_empty_affiliation_model,  scope = list(lower = lm_empty_affiliation_
```

```
## Start:  AIC=3096.71
## bodily_contact_time ~ 1
##
##                     Df Sum of Sq      RSS    AIC
## + seconds_moving     1    291403  9858807 3093.8
## <none>                           10150210 3096.7
## + chambers_entered   1    183378  9966832 3097.0
## + Trial              1    177237  9972973 3097.2
## + anntenation        1     43558 10106652 3101.1
## + Log_aggression     1     21167 10129043 3101.8
## + weight             1      8887 10141323 3102.1
## + Dummy_Color        6    556433  9593776 3114.2
##
## Step:  AIC=3093.78
## bodily_contact_time ~ seconds_moving
##
##                     Df Sum of Sq     RSS    AIC
## + Trial              1    261705 9597101 3091.5
## <none>                           9858807 3093.8
## + anntenation        1     36697 9822110 3098.4
```

```
## + weight            1     10036 9848770 3099.2
## + Log_aggression    1      5211 9853596 3099.3
## + chambers_entered  1      4165 9854642 3099.3
## + Dummy_Color       6    638176 9220630 3108.1
##
## Step:  AIC=3091.51
## bodily_contact_time ~ seconds_moving + Trial
##
##                    Df Sum of Sq     RSS    AIC
## <none>                          9597101 3091.5
## + anntenation       1     58302 9538799 3095.4
## + Log_aggression    1     14556 9582545 3096.8
## + weight            1     10214 9586887 3096.9
## + chambers_entered  1      4212 9592889 3097.1
## + Dummy_Color       6    500220 9096881 3109.8
```

```
aff_FB.model.BIC = stepAIC(lm_empty_affiliation_model,  scope = list(lower = lm_empty_affiliation_model
aff_BF.model.BIC = stepAIC(lm_model_affiliation,  scope = list(lower = lm_empty_affiliation_model, uppe
```

```
BIC(aff_backward.model.BIC)
```

```
## [1] 3937.21
```

```
BIC(aff_forward.model.BIC)
```

```
## [1] 3937.21
```

```
BIC(aff_FB.model.BIC)
```

```
## [1] 3937.21
```

```
BIC(aff_BF.model.BIC)
```

```
## [1] 3937.21
```

```
aff_BF.model.BIC
```

```
##
## Call:
## lm(formula = bodily_contact_time ~ Trial + seconds_moving, data = wasp)
##
## Coefficients:
##    (Intercept)           Trial  seconds_moving
##       163.6369         26.9257         -0.2055
```

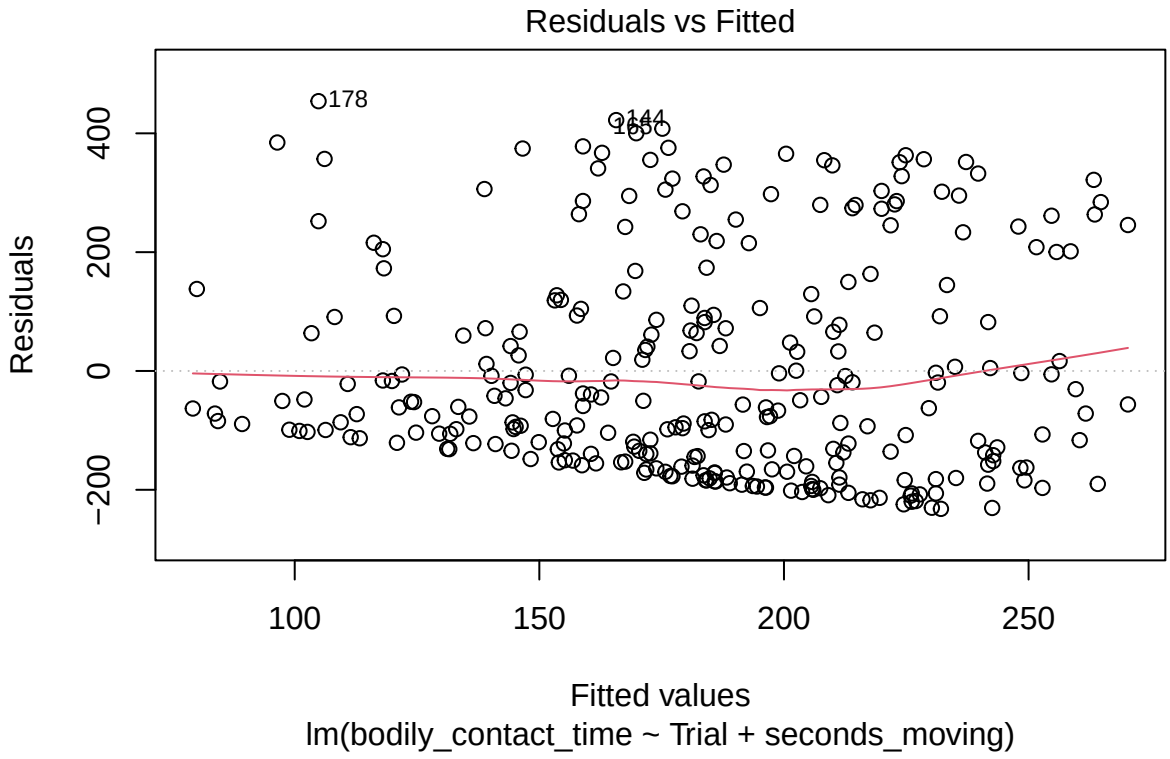
```
confint(aff_BF.model.BIC)
```

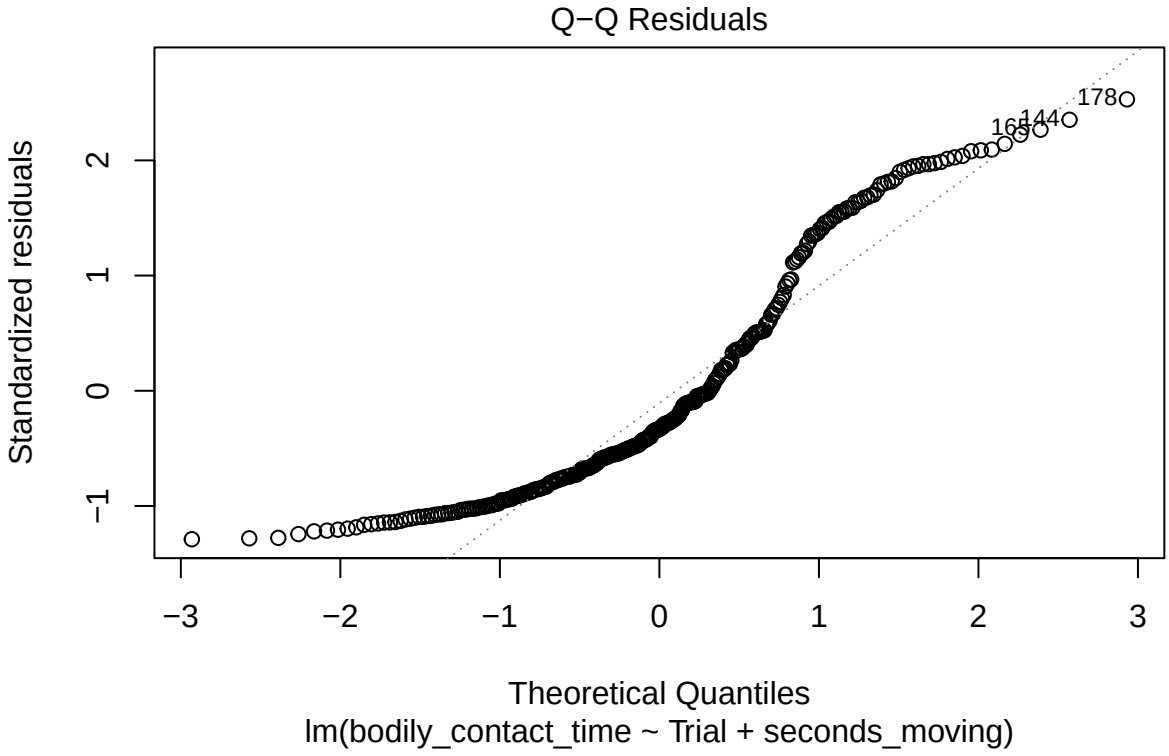
```
##                     2.5 %       97.5 %
## (Intercept)    109.0359340 218.23782494
## Trial            8.1782302  45.67314211
## seconds_moving  -0.3249099  -0.08611324
```

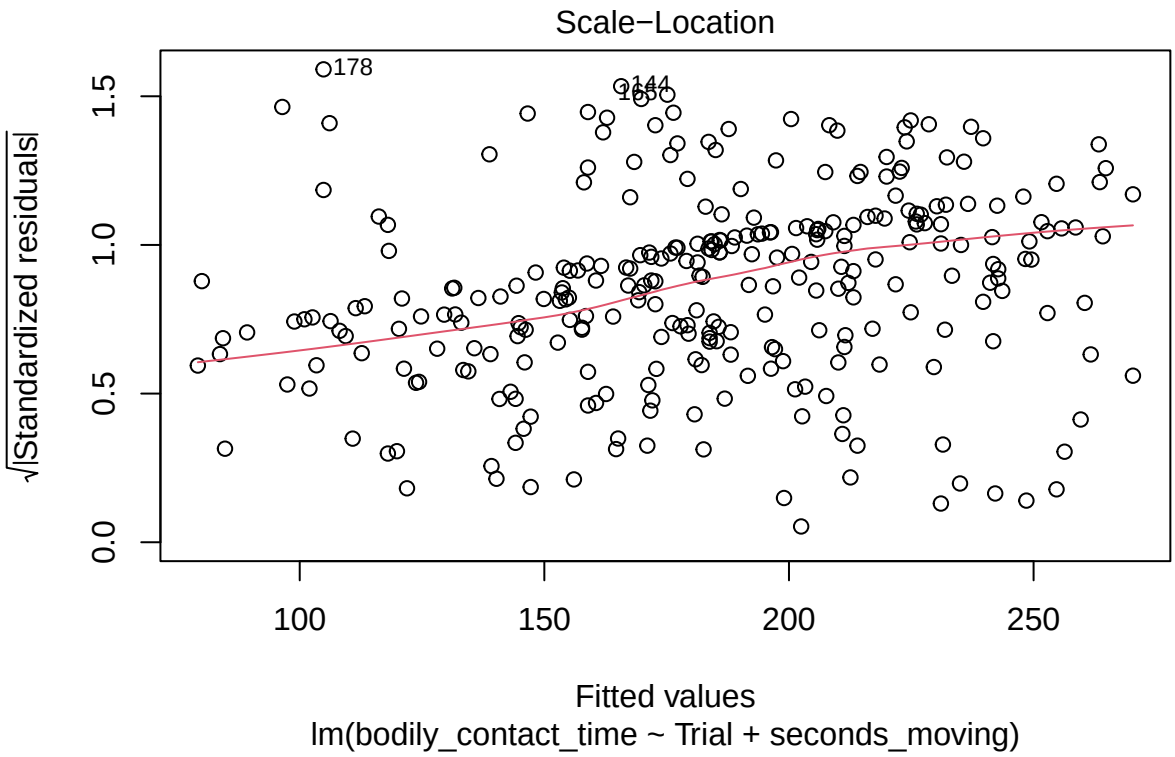
```
lmer_model_affilitation <- lmer(bodily_contact_time ~ Trial + seconds_moving + (1|Wasp.ID), data = wasp
BIC(lmer_model_affilitation)
```

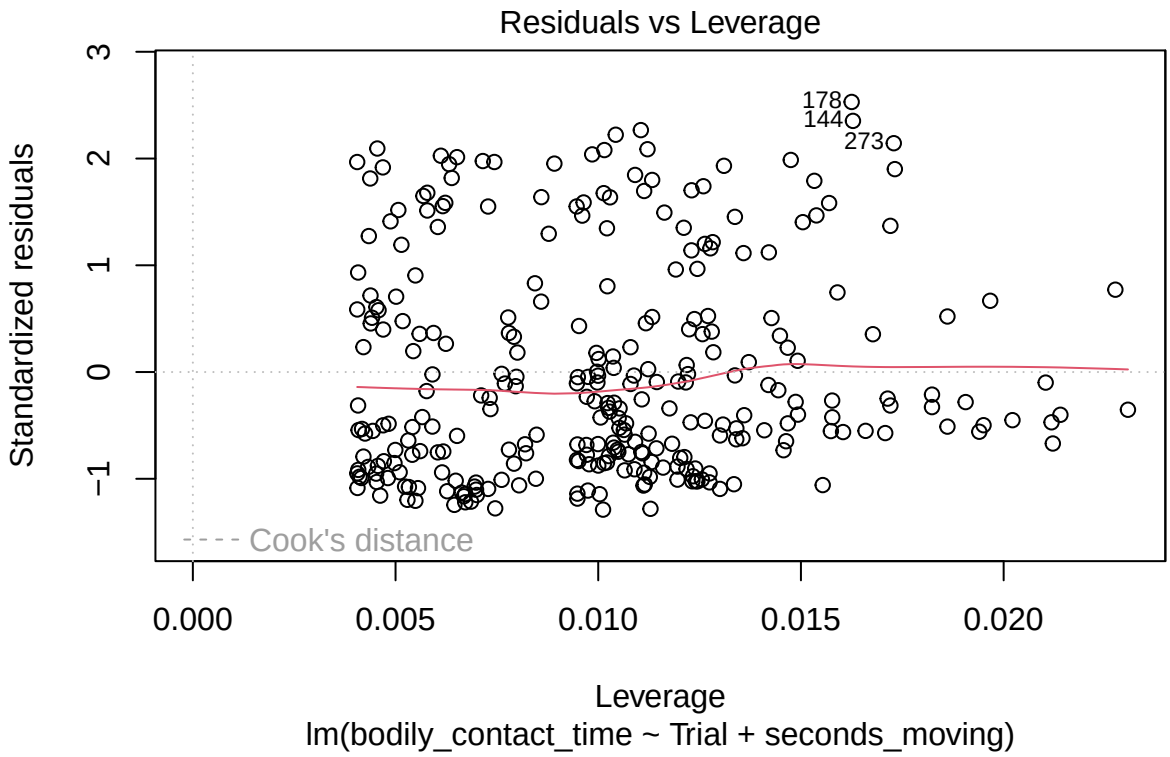
```
## [1] 3898.763
```

```
plot(aff_backward.model.BIC)
```

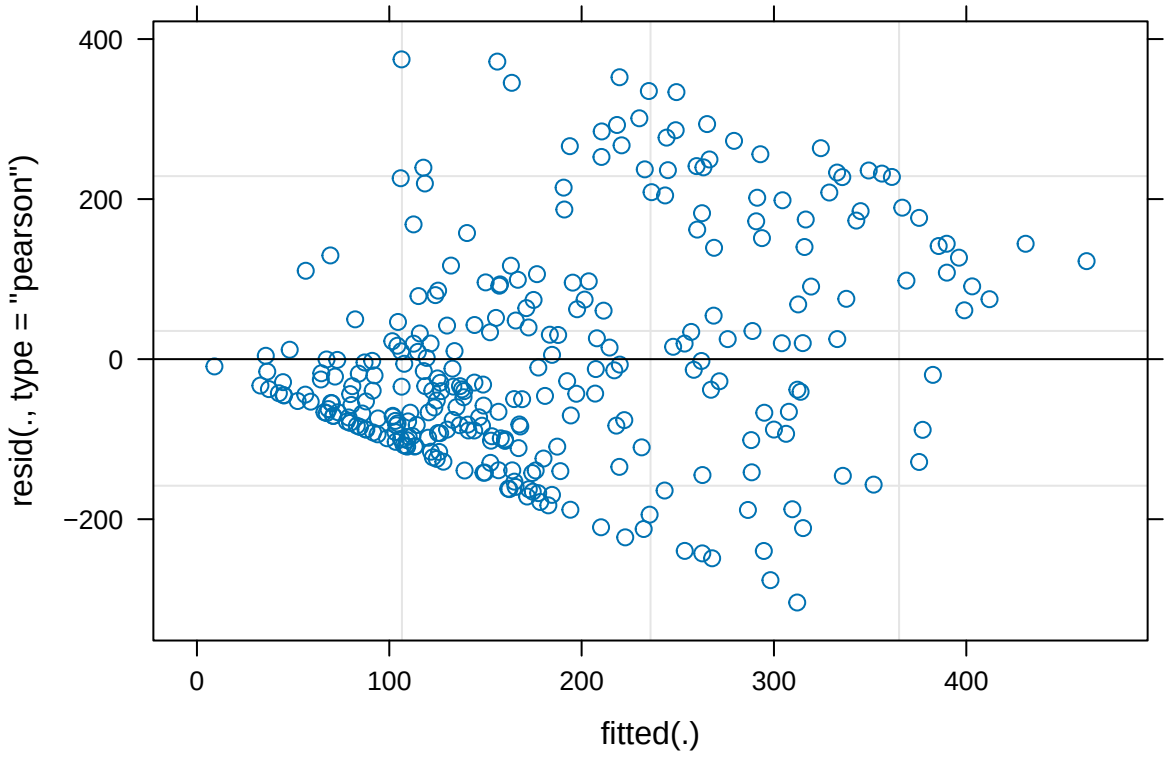



Q−Q Residuals
Standardized residuals
Theoretical Quantiles
lm(bodily_contact_time ~ Trial + seconds_moving)
178
144
165
−3
−2
−1
0
1
2
3

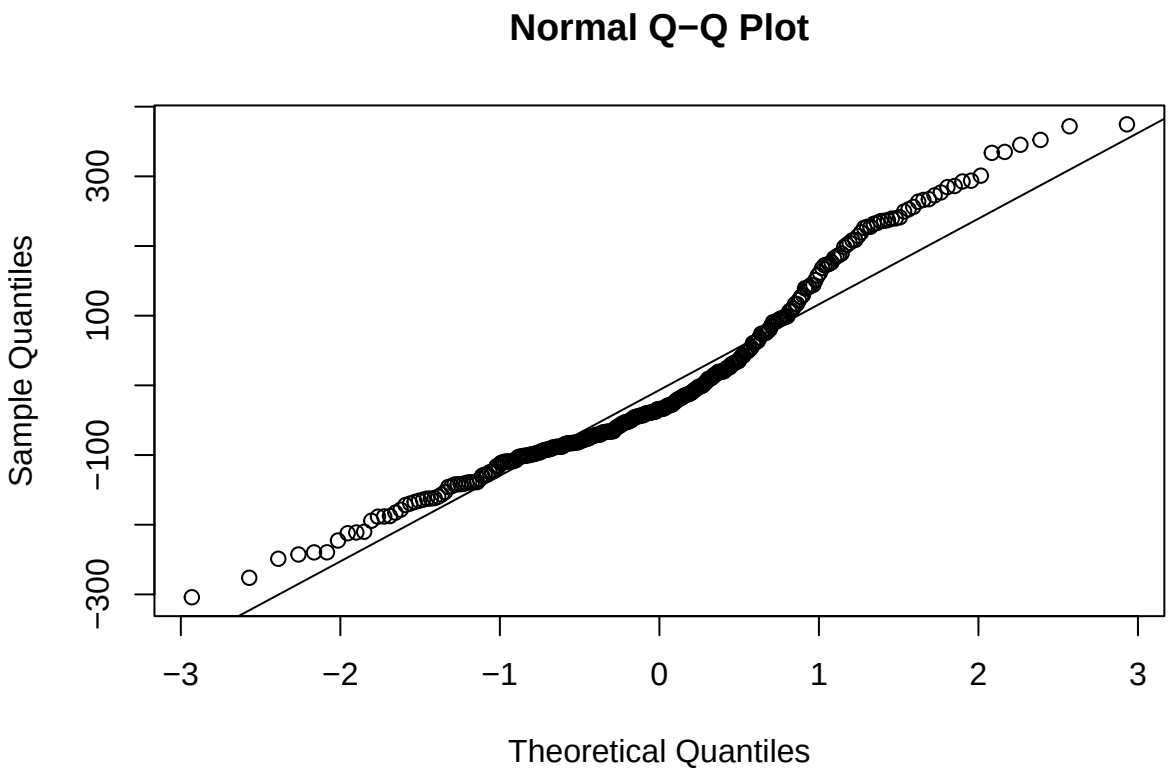

Scale−Location
178
144
√|Standardized residuals|
0.0
0.5
1.0
1.5
100
150
200
250
Fitted values
lm(bodily_contact_time ~ Trial + seconds_moving)




```
plot(lmer_model_affilitation)
```




```
qqnorm(resid(lmer_model_affilitation))
qqline(resid(lmer_model_affilitation))
```

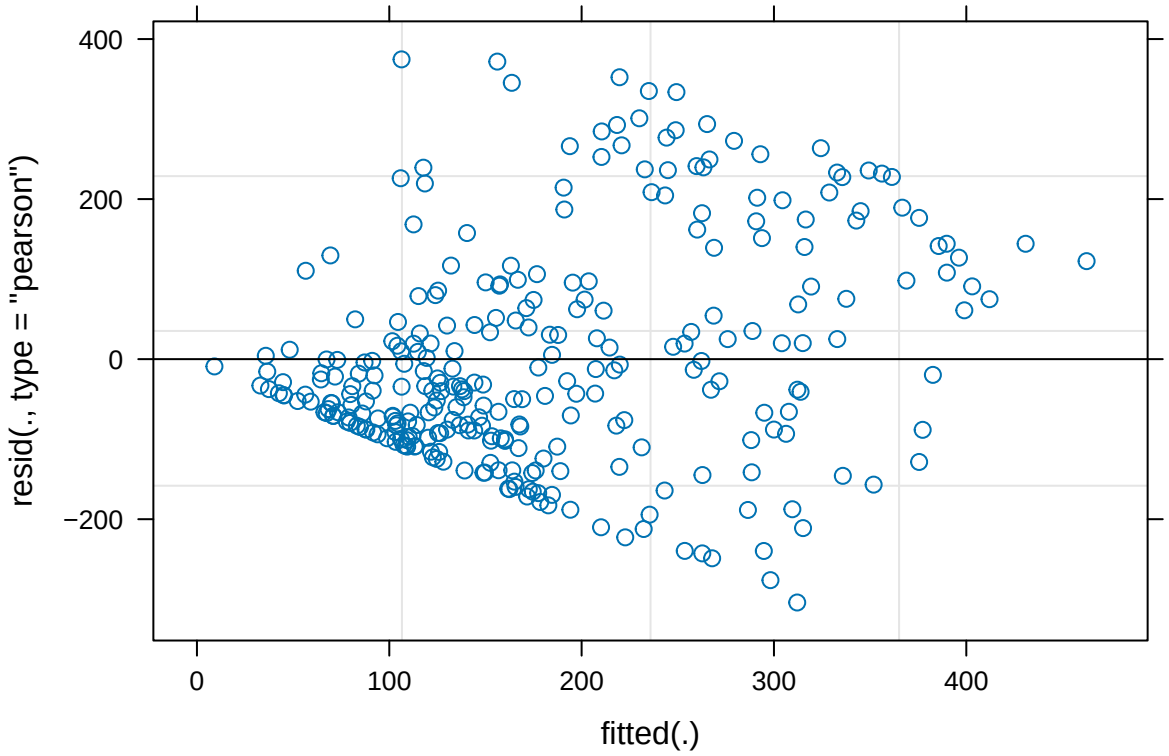



```
shapiro.test(resid(lmer_model_affilitation))
```

```
##
##  Shapiro-Wilk normality test
##
## data:  resid(lmer_model_affilitation)
## W = 0.95022, p-value = 1.777e-08
```

```
#Group.aff = rep("Lower",nrow(wasp)) #Creates a vector that repeats "Lower" n times
#Group.aff[wasp$bodily_contact_time < median(wasp$bodily_contact_time)] = "Upper" #Changing the appropr
#Group.aff = as.factor(Group.aff) #Changes it to a factor, which R recognizes as a grouping variable.
#fligner.test(lmer_model_affilitation$residuals, Group.aff)
```

```
plot(lmer_model_affilitation)
```




```
lm_model_ant <- lm(anntenation ~ Dummy_Color + Trial + weight + Log_aggression + seconds_moving + bodily
lm_model_ant
```

```
##
## Call:
## lm(formula = anntenation ~ Dummy_Color + Trial + weight + Log_aggression +
##     seconds_moving + bodily_contact_time + chambers_entered,
##     data = wasp)
##
## Coefficients:
##           (Intercept)  Dummy_Colorgoldsilver       Dummy_Colorgreen
##              3.842039              -0.213593               0.546385
##        Dummy_Colorred      Dummy_Colorsilver       Dummy_Colorwhite
##              0.499150               0.257893               0.920762
##     Dummy_Coloryellow                  Trial                 weight
##             -0.909314               0.340920               6.853397
##        Log_aggression         seconds_moving    bodily_contact_time
##              0.681158               0.002366              -0.001398
##      chambers_entered
##             -0.188734
```

```
lm_empty_ant <- lm(anntenation ~ 1, data = wasp)
```

```
ant_backward.model.BIC = stepAIC(lm_model_ant,  scope = list(lower = lm_empty_ant, upper= lm_model_ant)
ant_forward.model.BIC = stepAIC(lm_empty_ant,  scope = list(lower = lm_empty_ant, upper= lm_model_ant),
```

```
## Start:  AIC=748.14
## anntenation ~ 1
##
##                       Df Sum of Sq    RSS    AIC
## + Log_aggression       1   103.378 3532.7 745.30
## <none>                             3636.0 748.14
## + Trial                1    35.743 3600.3 750.91
## + bodily_contact_time  1    15.603 3620.4 752.56
## + weight               1     6.094 3629.9 753.34
## + seconds_moving       1     3.708 3632.3 753.53
## + chambers_entered     1     1.808 3634.2 753.69
## + Dummy_Color          6    91.455 3544.6 774.75
##
## Step:  AIC=745.3
## anntenation ~ Log_aggression
##
##                       Df Sum of Sq    RSS    AIC
## <none>                             3532.7 745.30
## + Trial                1    23.620 3509.0 749.00
## + bodily_contact_time  1    12.176 3520.5 749.97
## + weight               1     6.480 3526.2 750.44
## + chambers_entered     1     5.970 3526.7 750.49
## + seconds_moving       1     0.289 3532.4 750.96
## + Dummy_Color          6    69.089 3463.6 773.59
```

```
ant_FB.model.BIC = stepAIC(lm_empty_ant,  scope = list(lower = lm_empty_ant, upper= lm_model_ant), k = l
ant_BF.model.BIC = stepAIC(lm_model_ant,  scope = list(lower = lm_empty_ant, upper= lm_model_ant), k = l
```

```
BIC(ant_backward.model.BIC)
```

```
## [1] 1590.999
```

```
BIC(ant_forward.model.BIC)
```

```
## [1] 1590.999
```

```
BIC(ant_BF.model.BIC)
```

```
## [1] 1590.999
```

```
BIC(ant_FB.model.BIC)
```

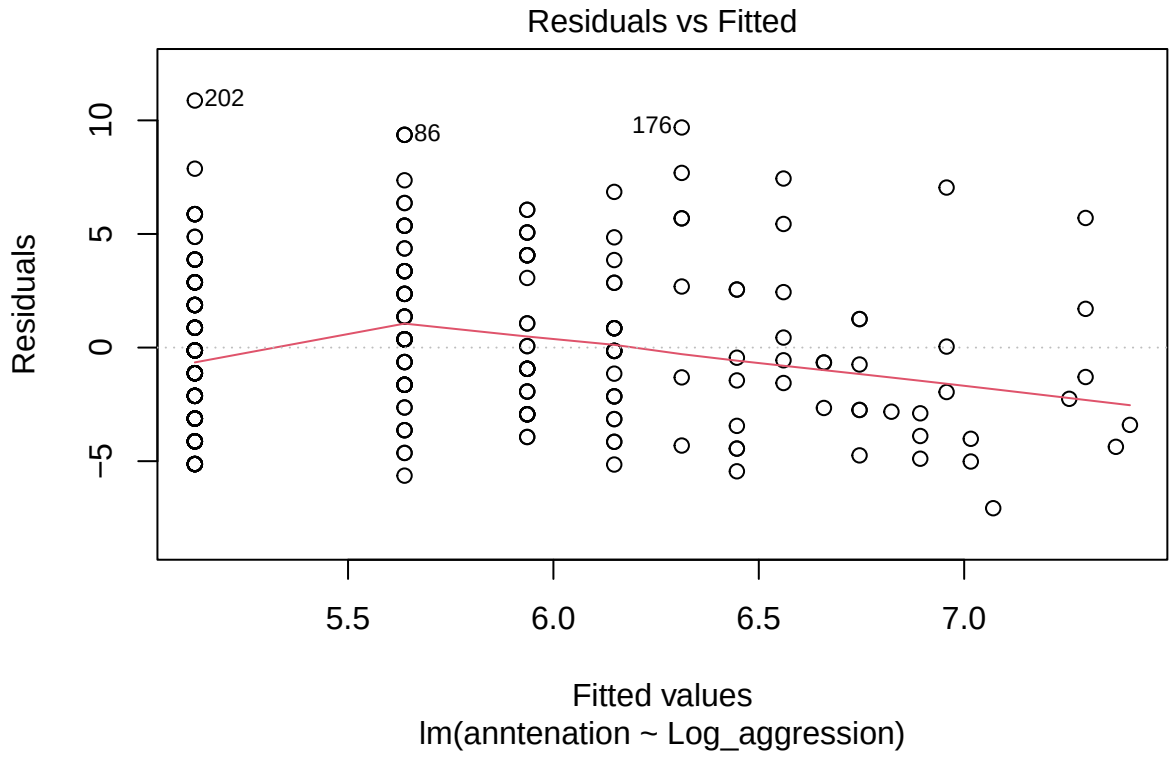
```
## [1] 1590.999
```

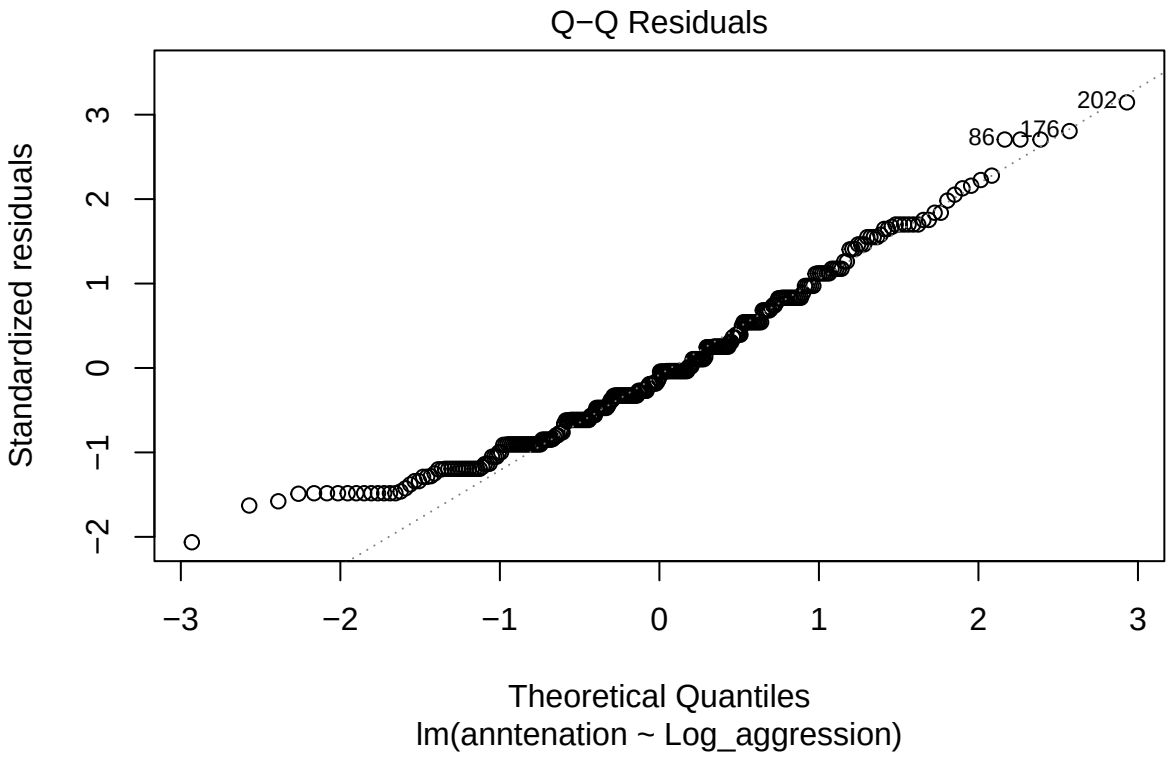
```
ant_BF.model.BIC
```

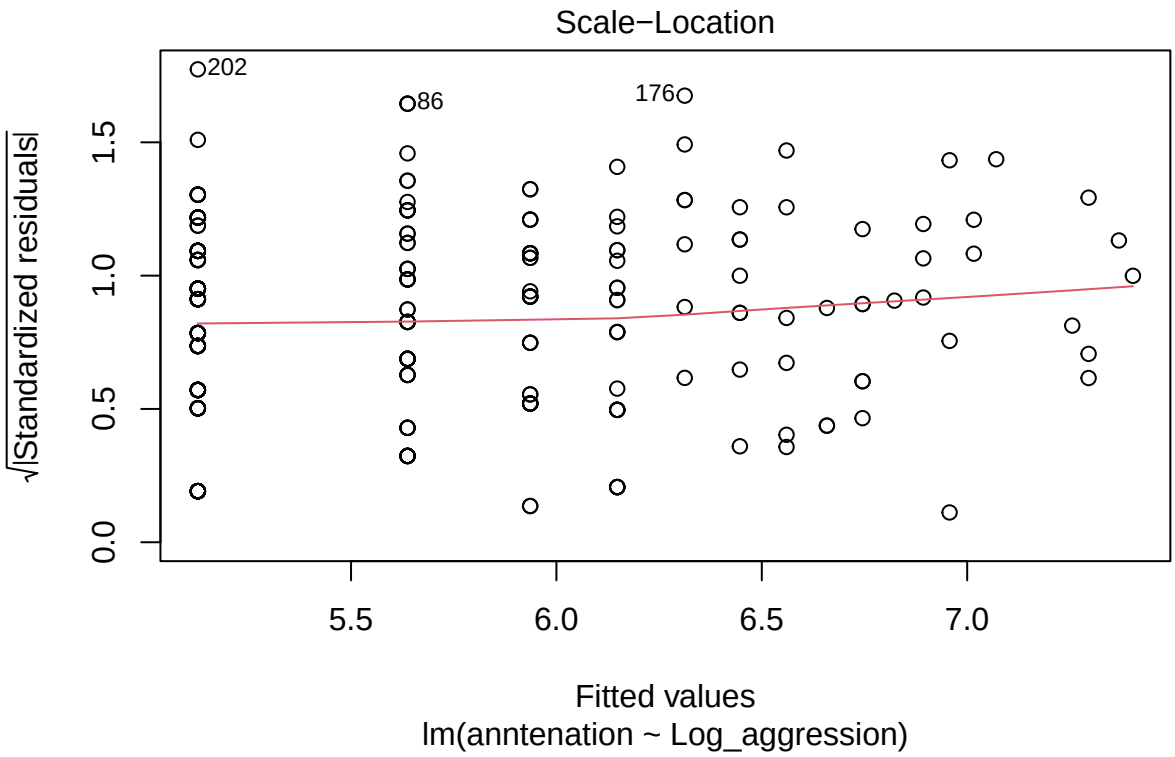
```
##
## Call:
## lm(formula = anntenation ~ Log_aggression, data = wasp)
##
## Coefficients:
##    (Intercept)  Log_aggression
##         5.1270          0.7365
```

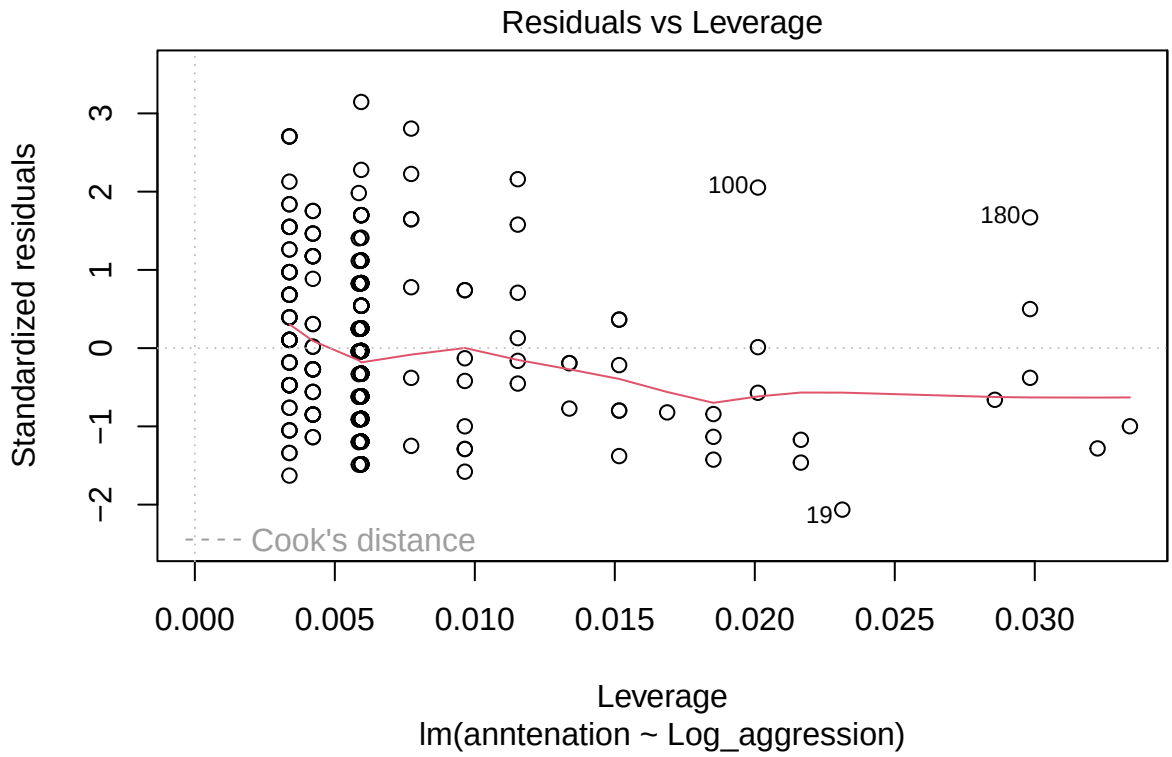
```
lmer_model_ant <- lmer(anntenation ~ Log_aggression + (1|Wasp.ID), data = wasp)
```

```
plot(ant_BF.model.BIC)
```

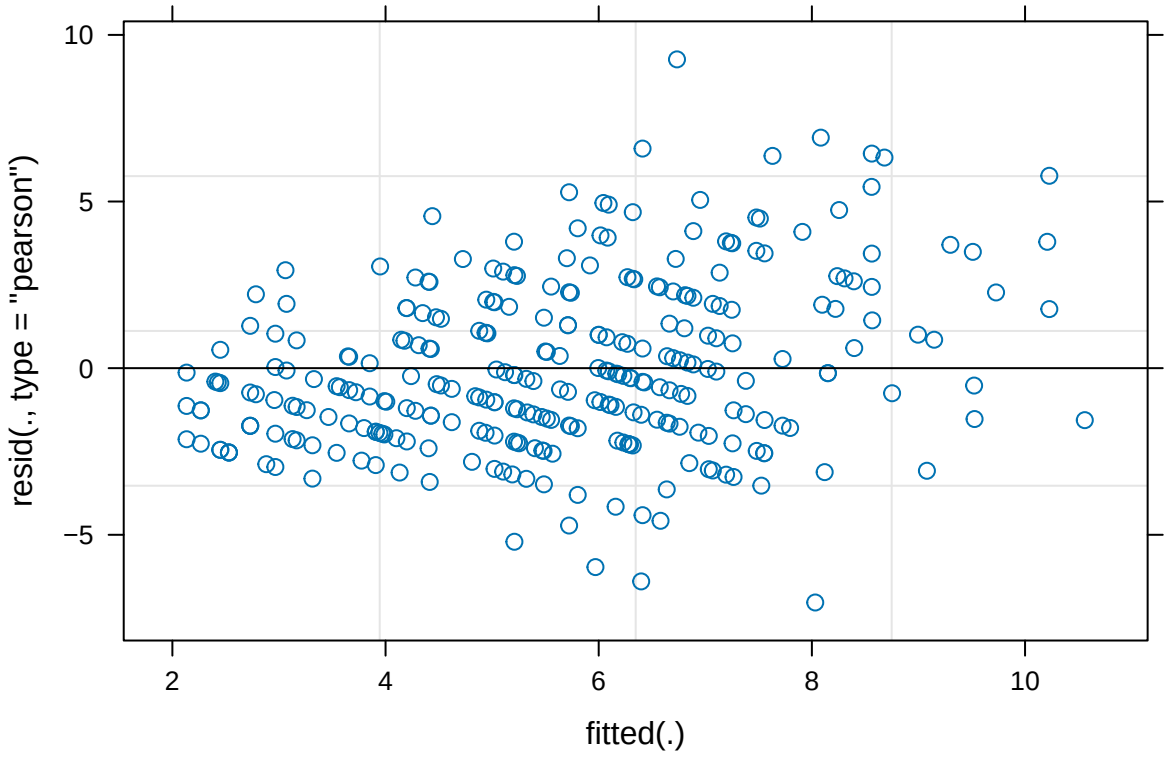



Q−Q Residuals
Standardized residuals
−2
−1
0
1
2
3
202
86
176
−3
−2
−1
0
1
2
3
Theoretical Quantiles
lm(anntenation ~ Log_aggression)

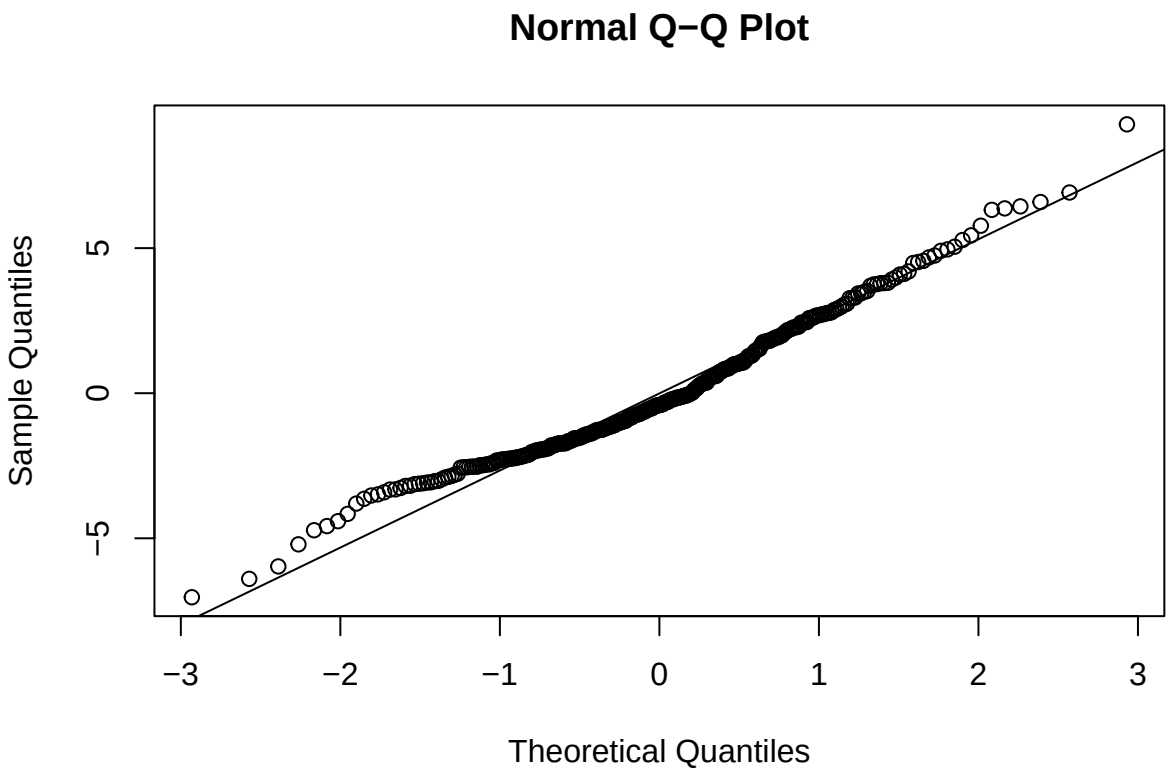

Scale−Location
202
86
176
√|Standardized residuals|
0.0
0.5
1.0
1.5
5.5
6.0
6.5
7.0
Fitted values
lm(anntenation ~ Log_aggression)




```
plot(lmer_model_ant)
```




```
qqnorm(resid(lmer_model_ant))
qqline(resid(lmer_model_ant))
```




```
shapiro.test(resid(lmer_model_ant))
```

```
##
##  Shapiro-Wilk normality test
##
## data:  resid(lmer_model_ant)
## W = 0.9772, p-value = 0.0001166
```

###mixed effect model better.

```
BIC(lmer_model_ant)
```

```
## [1] 1555.338
```

```
lm_model_agg <- lm(Log_aggression ~ Dummy_Color + Trial + weight + bodily_contact_time + seconds_moving
lm_model_agg
```

```
##
## Call:
## lm(formula = Log_aggression ~ Dummy_Color + Trial + weight +
##     bodily_contact_time + seconds_moving + anntenation + chambers_entered,
##     data = wasp)
##
```

```
## Coefficients:
##           (Intercept)  Dummy_Colorgoldsilver       Dummy_Colorgreen
##             0.3166691             0.5499208            -0.0585080
##        Dummy_Colorred      Dummy_Colorsilver       Dummy_Colorwhite
##            -0.0641304             0.5887456            -0.1366981
##     Dummy_Coloryellow                 Trial                weight
##            -0.1920834            -0.0390310             0.5698611
##   bodily_contact_time         seconds_moving            anntenation
##            -0.0002190             0.0007041             0.0310535
##      chambers_entered
##            -0.0144865
```

```
lm_empty_agg <- lm(Log_aggression ~ 1, data = wasp)
```

```
agg_backward.model.BIC = stepAIC(lm_model_agg,  scope = list(lower = lm_empty_agg, upper= lm_model_agg)
agg_forward.model.BIC = stepAIC(lm_empty_agg,  scope = list(lower = lm_empty_agg, upper= lm_model_agg),
```

```
## Start:  AIC=-124.63
## Log_aggression ~ 1
##
##                       Df Sum of Sq    RSS     AIC
## + Dummy_Color          6   29.3719 161.21 -140.03
## + anntenation          1    5.4185 185.16 -127.48
## <none>                             190.58 -124.63
## + seconds_moving       1    3.5797 187.00 -124.55
## + Trial                1    2.4368 188.15 -122.75
## + chambers_entered     1    2.1703 188.41 -122.33
## + bodily_contact_time  1    0.3974 190.18 -119.56
## + weight               1    0.0109 190.57 -118.96
##
## Step:  AIC=-140.03
## Log_aggression ~ Dummy_Color
##
##                       Df Sum of Sq    RSS     AIC
## + anntenation          1    3.6845 157.53 -141.19
## <none>                             161.21 -140.03
## + seconds_moving       1    2.3637 158.85 -138.71
## + bodily_contact_time  1    1.3528 159.86 -136.84
## + chambers_entered     1    1.0123 160.20 -136.21
## + Trial                1    0.1200 161.09 -134.56
## + weight               1    0.0778 161.13 -134.49
##
## Step:  AIC=-141.19
## Log_aggression ~ Dummy_Color + anntenation
##
##                       Df Sum of Sq    RSS     AIC
## <none>                             157.53 -141.19
## + seconds_moving       1   2.24455 155.28 -139.74
## + chambers_entered     1   1.15309 156.37 -137.67
## + bodily_contact_time  1   1.04936 156.48 -137.47
## + Trial                1   0.26916 157.26 -136.00
## + weight               1   0.03459 157.49 -135.56
```

```
agg_FB.model.BIC = stepAIC(lm_empty_agg,  scope = list(lower = lm_empty_agg, upper= lm_model_agg), k = l
agg_BF.model.BIC = stepAIC(lm_model_agg,  scope = list(lower = lm_empty_agg, upper= lm_model_agg), k = l
```

```
BIC(agg_backward.model.BIC)
```

```
## [1] 704.5164
```

```
BIC(agg_forward.model.BIC)
```

```
## [1] 704.5164
```

```
BIC(agg_BF.model.BIC)
```

```
## [1] 704.5164
```

```
BIC(agg_FB.model.BIC)
```

```
## [1] 704.5164
```

```
agg_BF.model.BIC
```

```
##
## Call:
## lm(formula = Log_aggression ~ Dummy_Color + anntenation, data = wasp)
##
## Coefficients:
##           (Intercept)  Dummy_Colorgoldsilver       Dummy_Colorgreen
##               0.33147                0.53597               -0.02882
##        Dummy_Colorred      Dummy_Colorsilver       Dummy_Colorwhite
##              -0.02245                0.59191               -0.09271
##     Dummy_Coloryellow            anntenation
##              -0.15931                0.03224
```

```
confint(agg_BF.model.BIC)
```

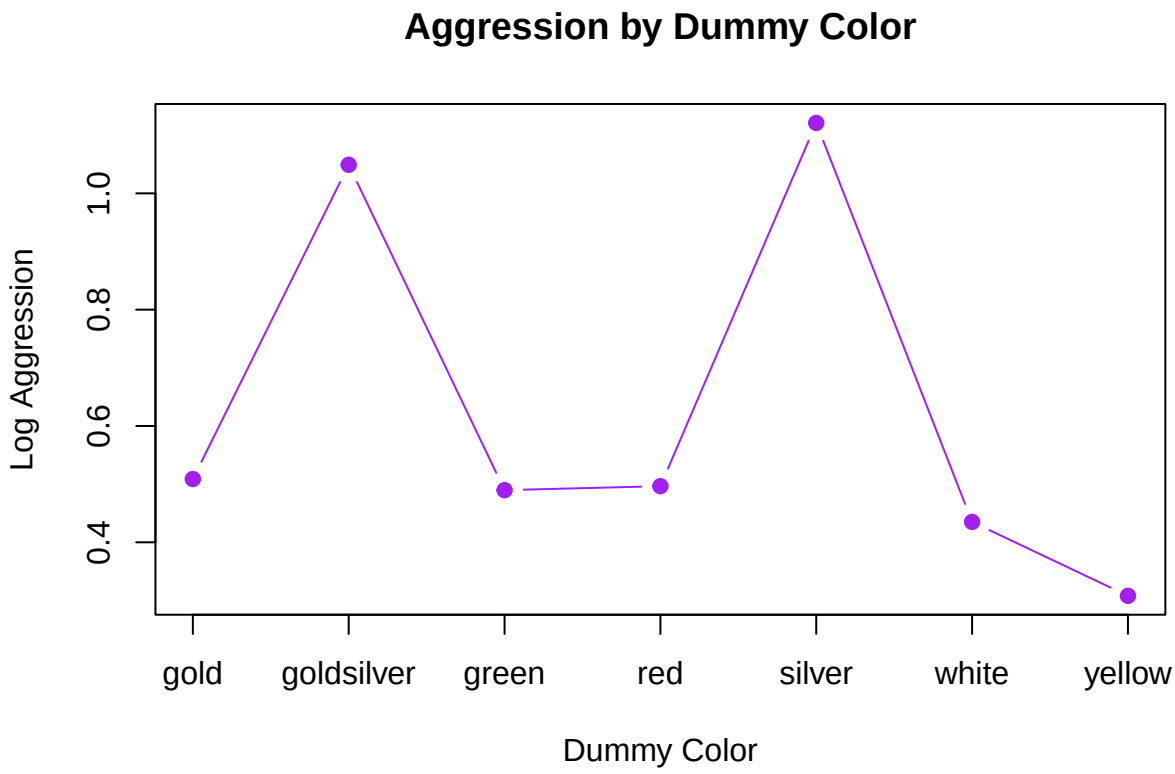
```
##                              2.5 %     97.5 %
## (Intercept)            0.088915645 0.57401911
## Dummy_Colorgoldsilver  0.254389237 0.81754111
## Dummy_Colorgreen      -0.347165274 0.28952096
## Dummy_Colorred        -0.367823461 0.32293161
## Dummy_Colorsilver      0.315677715 0.86813840
## Dummy_Colorwhite      -0.414073162 0.22865845
## Dummy_Coloryellow     -0.484804522 0.16619211
## anntenation            0.007790959 0.05669036
```

###anova on color

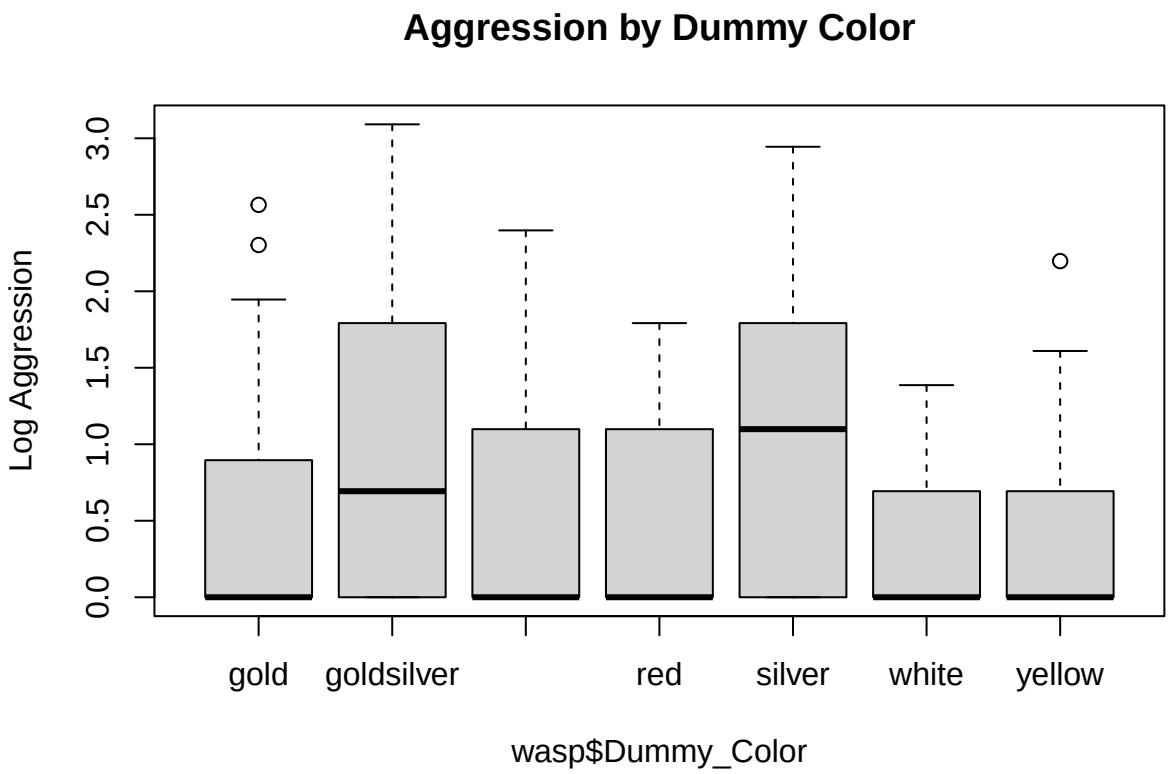
```r
library(asbio)
```

```
## Loading required package: tcltk
```

```r
group.means = by(wasp$Log_aggression,wasp$Dummy_Color,mean)  # First argument is Y, second is grouping
plot(group.means,xaxt = "n",pch = 19,col = "purple",xlab = "Dummy Color",ylab = "Log Aggression",main =
axis(1,1:length(group.means),names(group.means)) #Adding in our own X axis names
```




```r
boxplot(wasp$Log_aggression ~ wasp$Dummy_Color, main = "Aggression by Dummy Color",ylab = "Log Aggressi
```




```
bonfCI(wasp$Log_aggression,as.factor(wasp$Dummy_Color), conf.level = 0.95)
```

```
##
## 95% Bonferroni confidence intervals
##
##                            Diff    Lower    Upper  Decision Adj. p-value
## mugold-mugoldsilver   -0.54036 -0.98317 -0.09756 Reject H0     0.004651
## mugold-mugreen         0.01915 -0.48138  0.51968    FTR H0            1
## mugoldsilver-mugreen   0.55951  0.06451  1.05452 Reject H0     0.012841
## mugold-mured            0.0123 -0.53075  0.55534    FTR H0            1
## mugoldsilver-mured     0.55266   0.0147  1.09061 Reject H0     0.038013
## mugreen-mured         -0.00685 -0.59324  0.57953    FTR H0            1
## mugold-musilver       -0.61233 -1.04607 -0.17858 Reject H0     0.000437
## mugoldsilver-musilver -0.07197 -0.49933   0.3554    FTR H0            1
## mugreen-musilver      -0.63148 -1.11839 -0.14456 Reject H0     0.001867
## mured-musilver        -0.62462 -1.15515  -0.0941 Reject H0      0.00761
## mugold-muwhite         0.07374 -0.43116  0.57865    FTR H0            1
## mugoldsilver-muwhite    0.6141  0.11467  1.11354 Reject H0     0.004173
## mugreen-muwhite        0.05459 -0.49666  0.60585    FTR H0            1
## mured-muwhite          0.06145 -0.52868  0.65157    FTR H0            1
## musilver-muwhite       0.68607  0.19465  1.17749 Reject H0     0.000536
## mugold-muyellow        0.20083 -0.30868  0.71034    FTR H0            1
## mugoldsilver-muyellow  0.74119   0.2371  1.24528 Reject H0     0.000201
## mugreen-muyellow       0.18168  -0.3738  0.73716    FTR H0            1
## mured-muyellow         0.18853 -0.40554  0.78261    FTR H0            1
```

```
## musilver-muyellow      0.81316  0.31701   1.3093 Reject H0      1.9e-05
## muwhite-muyellow       0.12709 -0.43234  0.68651    FTR H0            1
```

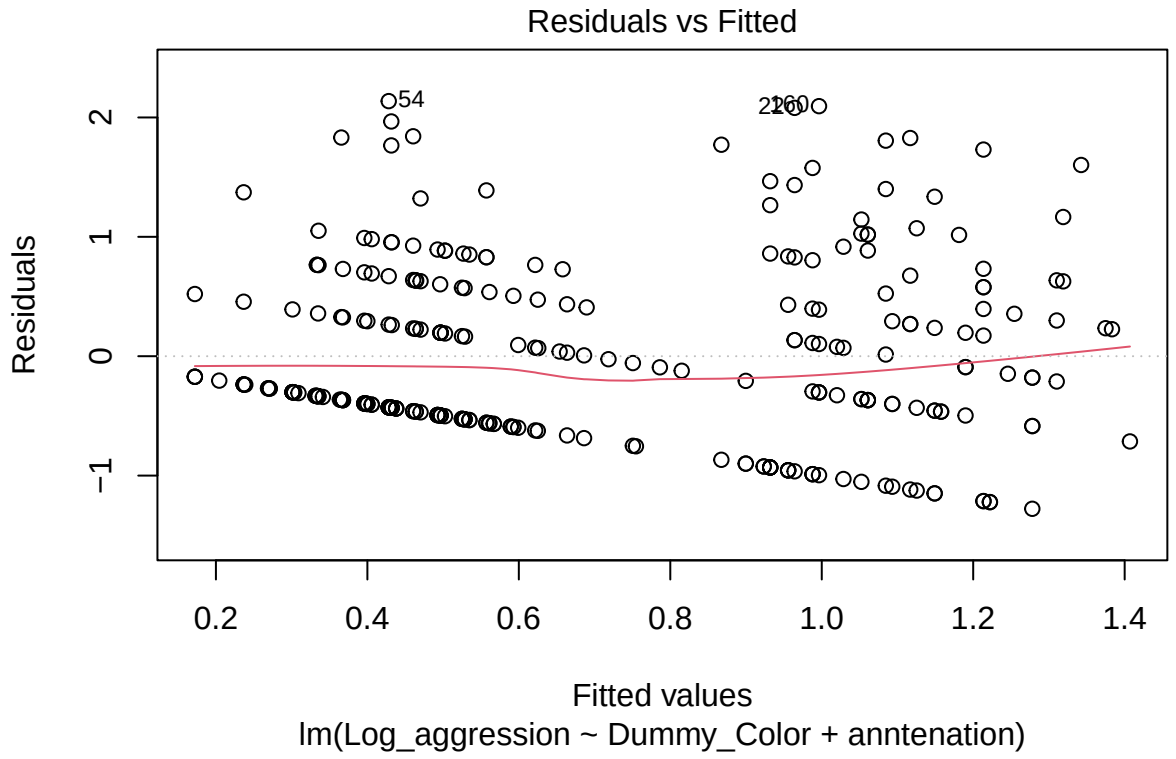
```
shapiro.test(resid(agg_BF.model.BIC))
```

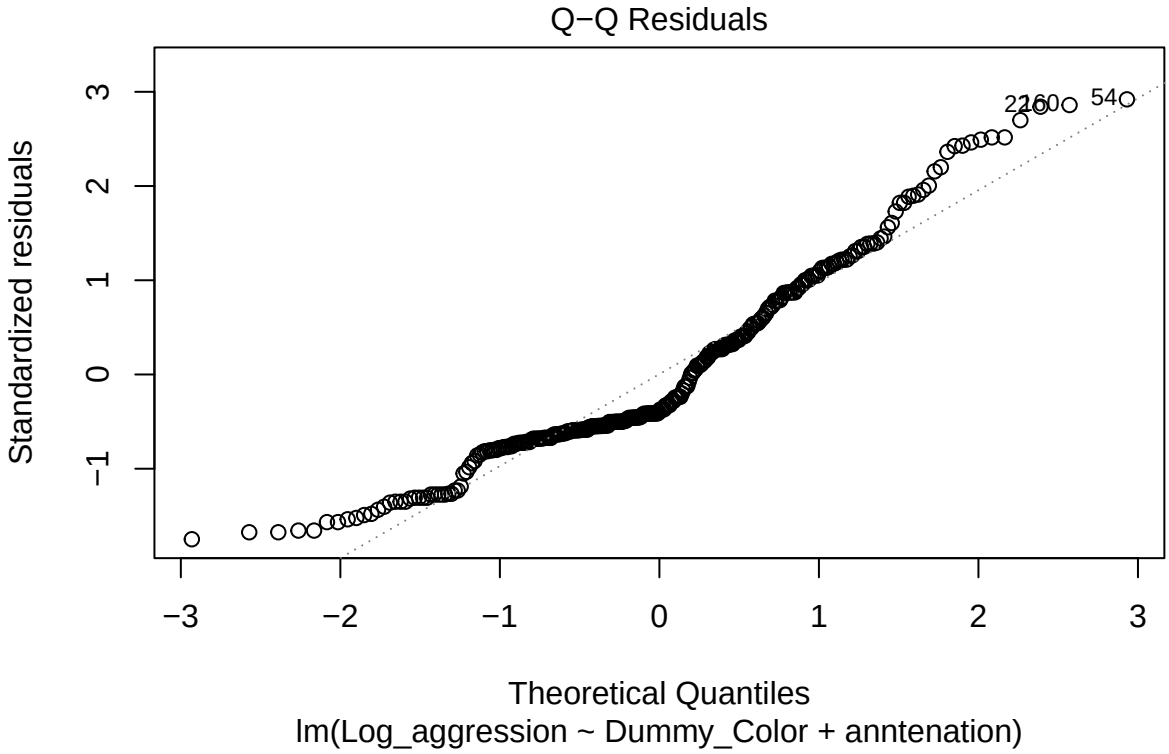
```
##
##  Shapiro-Wilk normality test
##
## data:  resid(agg_BF.model.BIC)
## W = 0.94043, p-value = 1.49e-09
```

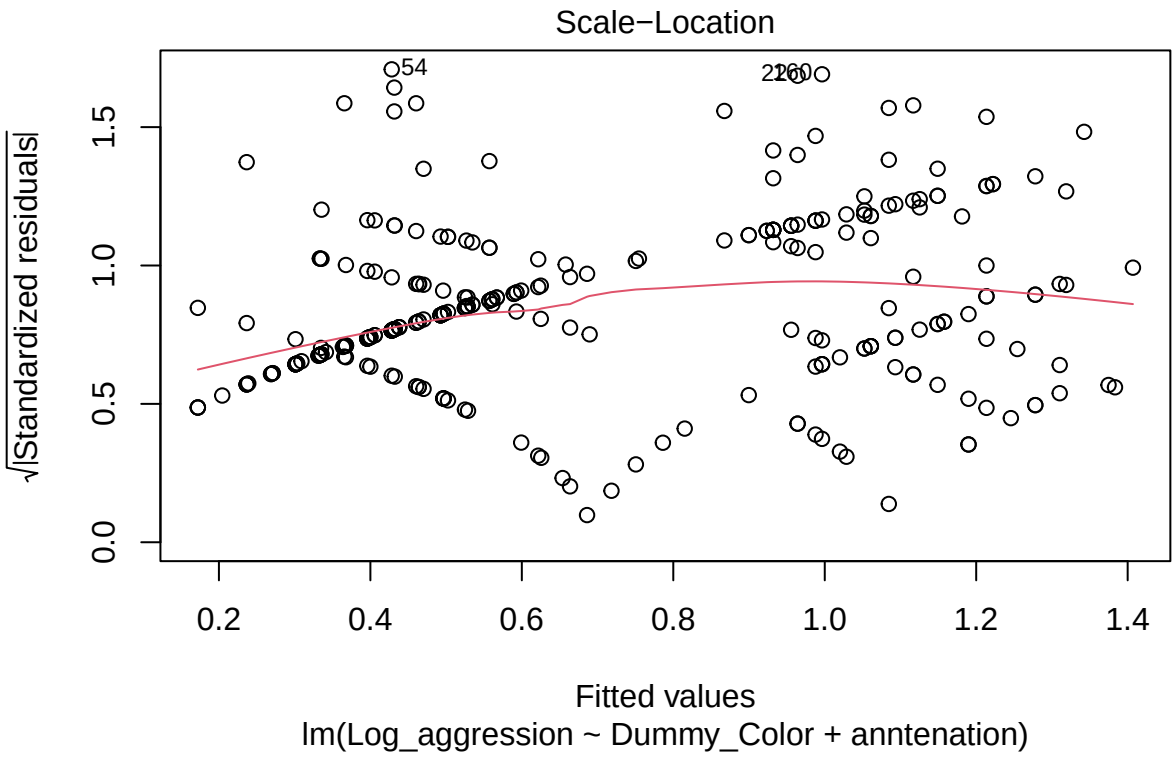
```
Group.agg = rep("Lower",nrow(wasp)) #Creates a vector that repeats "Lower" n times
Group.agg[wasp$Log_aggression < median(wasp$Log_aggression)] = "Upper" #Changing the appropriate values
Group.agg = as.factor(Group.agg) #Changes it to a factor, which R recognizes as a grouping variable.
fligner.test(agg_BF.model.BIC$residuals, Group.agg)
```

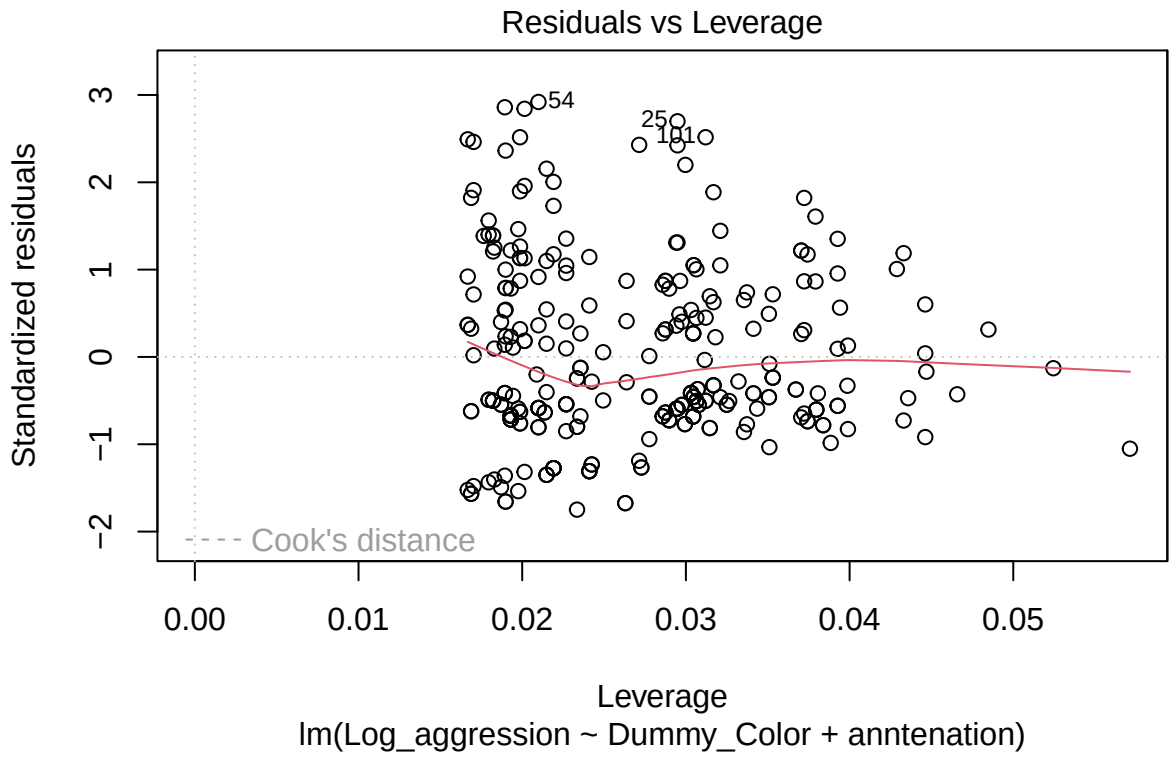
```
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  agg_BF.model.BIC$residuals and Group.agg
## Fligner-Killeen:med chi-squared = 58.732, df = 1, p-value = 1.807e-14
```

```
plot(agg_BF.model.BIC)
```




Q−Q Residuals
Standardized residuals
3
2
1
0
−1
−3
−2
−1
0
1
2
3
54
Theoretical Quantiles
lm(Log_aggression ~ Dummy_Color + anntenation)


Scale−Location
54
2260
√|Standardized residuals|
0.0
0.5
1.0
1.5
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Fitted values
lm(Log_aggression ~ Dummy_Color + anntenation)




```
lmer_model_agg <- lmer(Log_aggression ~ Dummy_Color + anntenation + (1|Wasp.ID), data = wasp)
lmer_model_agg
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: Log_aggression ~ Dummy_Color + anntenation + (1 | Wasp.ID)
##    Data: wasp
## REML criterion at convergence: 668.824
## Random effects:
##  Groups   Name        Std.Dev.
##  Wasp.ID  (Intercept) 0.2920
##  Residual             0.6798
## Number of obs: 296, groups:  Wasp.ID, 74
## Fixed Effects:
##           (Intercept)  Dummy_Colorgoldsilver       Dummy_Colorgreen
##              0.318735              0.527531              -0.009458
##        Dummy_Colorred      Dummy_Colorsilver       Dummy_Colorwhite
##              0.027020              0.584500              -0.046199
##     Dummy_Coloryellow            anntenation
##             -0.125362              0.032218
```

```
BIC(lmer_model_agg)
```

```
## [1] 725.7275
```

```
lm_model_exp <- lm(chambers_entered ~ Dummy_Color + Trial + weight + Log_aggression + seconds_moving + b
lm_model_exp
```

```
##
## Call:
## lm(formula = chambers_entered ~ Dummy_Color + Trial + weight +
##     Log_aggression + seconds_moving + bodily_contact_time + anntenation,
##     data = wasp)
##
## Coefficients:
##           (Intercept)  Dummy_Colorgoldsilver       Dummy_Colorgreen
##              2.587045              0.054953              0.127885
##        Dummy_Colorred      Dummy_Colorsilver       Dummy_Colorwhite
##              0.112001              0.222856             -0.474804
##     Dummy_Coloryellow                 Trial                weight
##             -0.240149             -0.041701             -3.678774
##        Log_aggression         seconds_moving    bodily_contact_time
##             -0.070734              0.015302              0.000194
##           anntenation
##             -0.042012
```

```
lm_empty_exp <- lm(chambers_entered ~ 1, data = wasp)
```

```
exp_backward.model.BIC = stepAIC(lm_model_exp,  scope = list(lower = lm_empty_exp, upper= lm_model_exp)
exp_forward.model.BIC = stepAIC(lm_empty_exp,  scope = list(lower = lm_empty_exp, upper= lm_model_exp),
```

```
## Start:  AIC=679.19
## chambers_entered ~ 1
##
##                       Df Sum of Sq     RSS    AIC
## + seconds_moving       1   2106.82  773.61 295.75
## <none>                              2880.43 679.19
## + bodily_contact_time  1     52.04 2828.39 679.48
## + Trial                1     51.10 2829.33 679.58
## + Log_aggression       1     32.80 2847.63 681.49
## + anntenation          1      1.43 2879.00 684.73
## + weight               1      0.93 2879.50 684.78
## + Dummy_Color          6     45.26 2835.17 708.64
##
## Step:  AIC=295.75
## chambers_entered ~ seconds_moving
##
##                       Df Sum of Sq    RSS    AIC
## <none>                              773.61 295.75
## + anntenation          1    7.0960 766.51 298.71
## + weight               1    2.1437 771.46 300.62
## + bodily_contact_time  1    0.3268 773.28 301.31
## + Log_aggression       1    0.3235 773.28 301.32
## + Trial                1    0.0004 773.60 301.44
## + Dummy_Color          6   10.1387 763.47 325.99
```

```
exp_FB.model.BIC = stepAIC(lm_empty_exp,  scope = list(lower = lm_empty_exp, upper= lm_model_exp), k = l
exp_BF.model.BIC = stepAIC(lm_model_exp,  scope = list(lower = lm_empty_exp, upper= lm_model_exp), k = l
```

```
BIC(exp_backward.model.BIC)
```

```
## [1] 1141.451
```

```
BIC(exp_forward.model.BIC)
```

```
## [1] 1141.451
```

```
BIC(exp_BF.model.BIC)
```

```
## [1] 1141.451
```

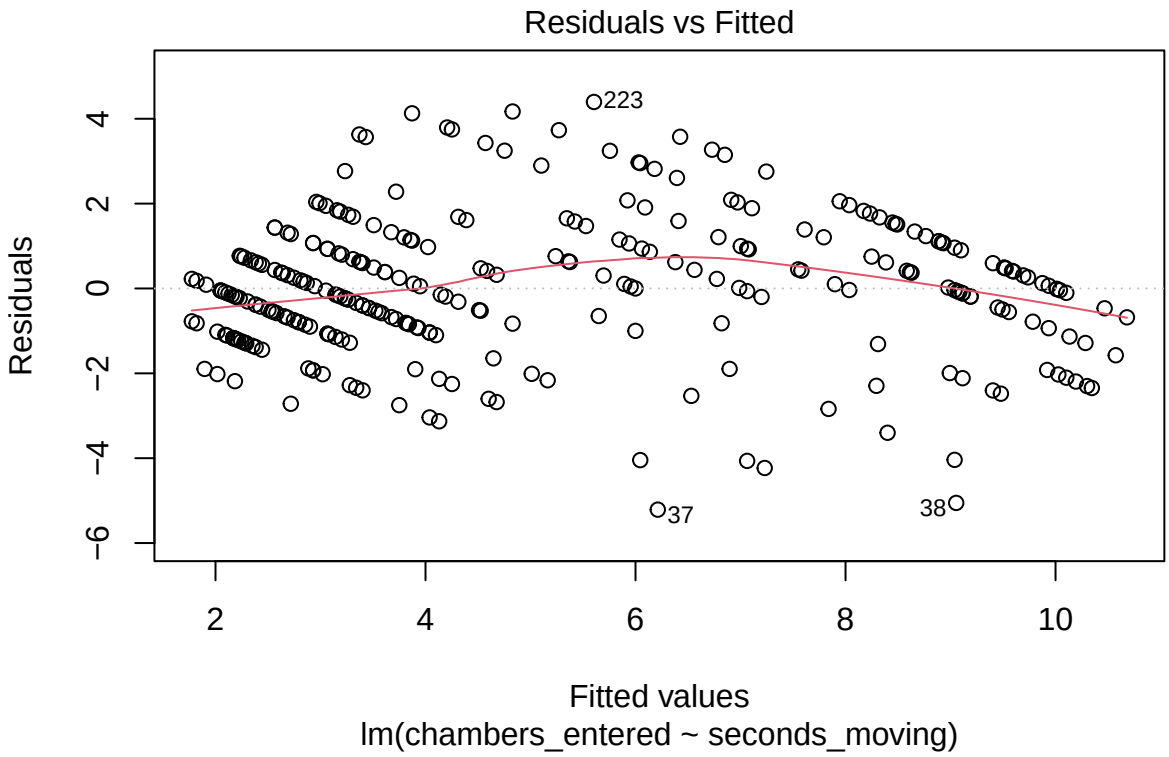
```
BIC(exp_FB.model.BIC)
```

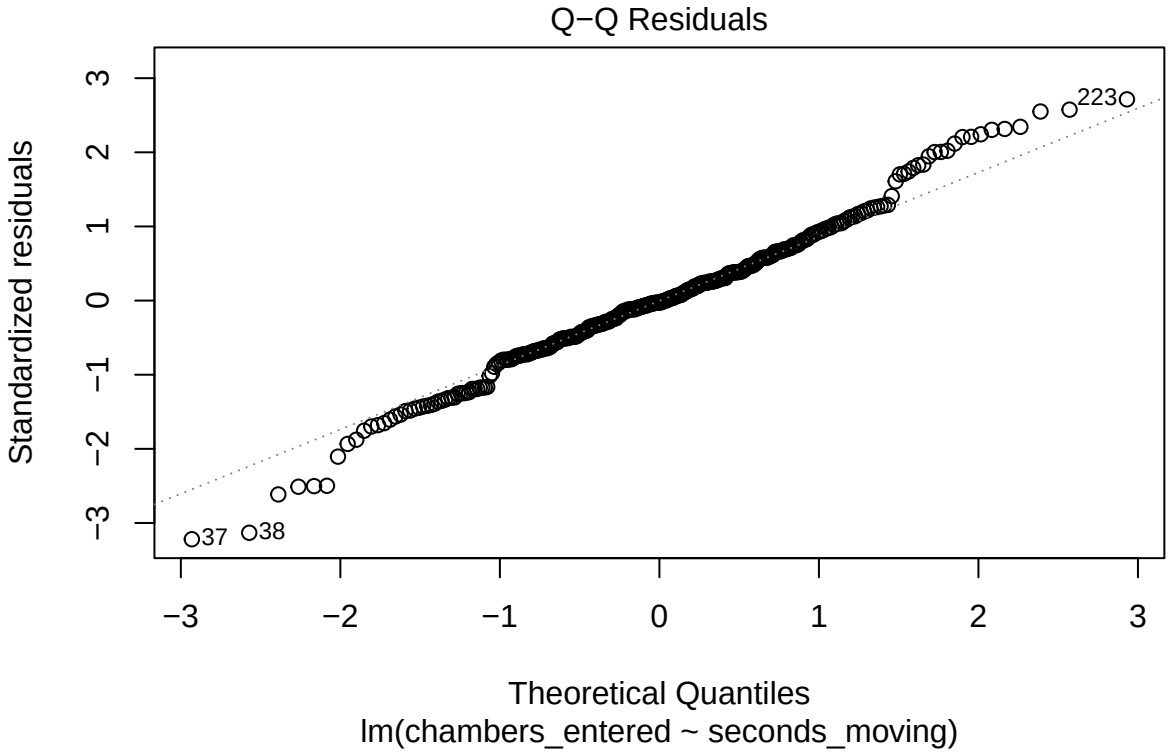
```
## [1] 1141.451
```

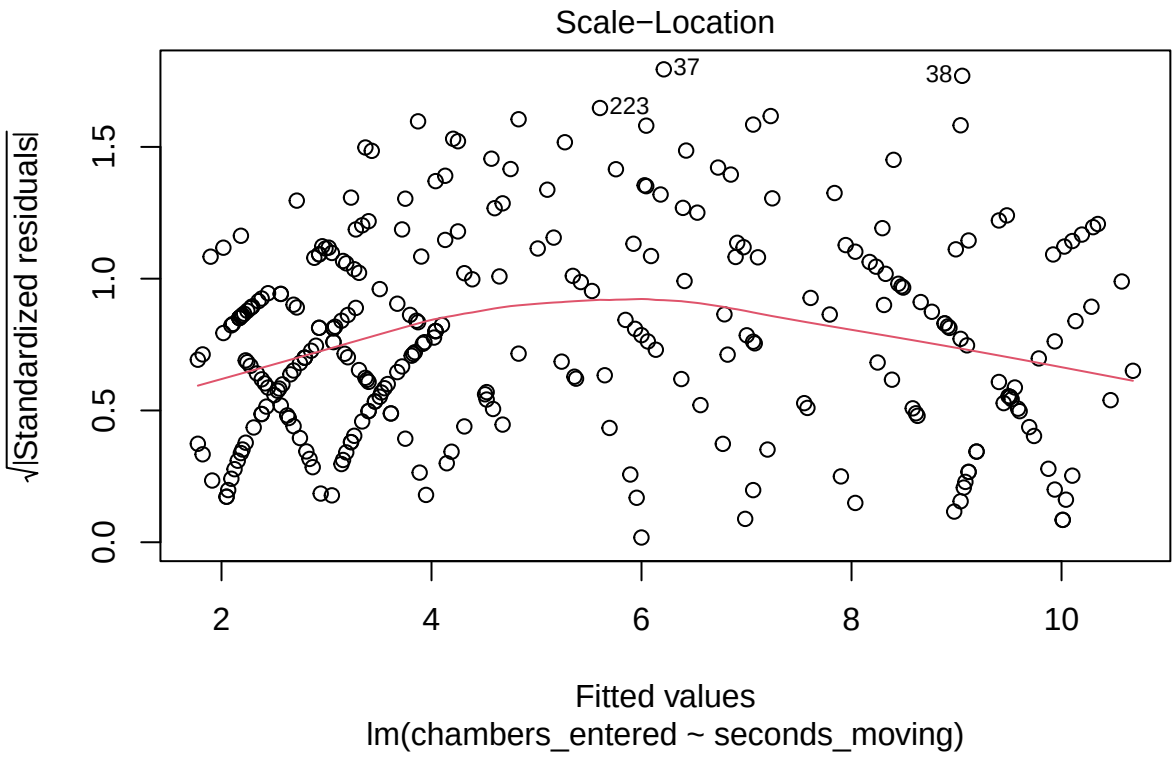
```
exp_BF.model.BIC
```

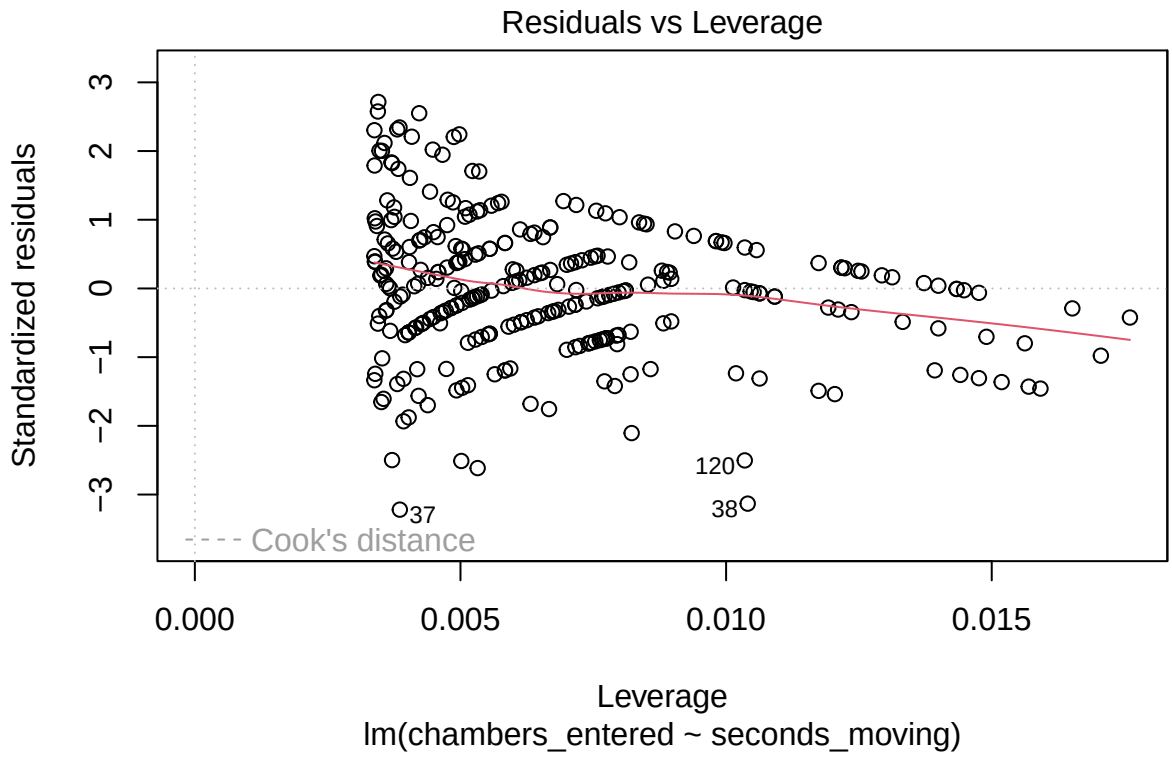
```
##
## Call:
## lm(formula = chambers_entered ~ seconds_moving, data = wasp)
##
## Coefficients:
##    (Intercept)  seconds_moving
##         1.6986          0.0152
```

```
plot(exp_BF.model.BIC)
```


Residuals vs Fitted
Residuals
Fitted values
lm(chambers_entered ~ seconds_moving)
223
37
38
−6
−4
−2
0
2
4
2
4
6
8
10


Q−Q Residuals
Standardized residuals
−3
−2
−1
0
1
2
3
37
38
223
Theoretical Quantiles
lm(chambers_entered ~ seconds_moving)


Scale−Location
37
38
223
√|Standardized residuals|
0.0
0.5
1.0
1.5
2
4
6
8
10
Fitted values
lm(chambers_entered ~ seconds_moving)




```
shapiro.test(resid(exp_BF.model.BIC))
```

```
##
##  Shapiro-Wilk normality test
##
## data:  resid(exp_BF.model.BIC)
## W = 0.98843, p-value = 0.01837
```

```
Group.exp = rep("Lower",nrow(wasp)) #Creates a vector that repeats "Lower" n times
Group.exp[wasp$chambers_entered < median(wasp$chambers_entered)] = "Upper" #Changing the appropriate va
Group.exp = as.factor(Group.exp) #Changes it to a factor, which R recognizes as a grouping variable.
fligner.test(exp_BF.model.BIC$residuals, Group.exp)
```

```
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  exp_BF.model.BIC$residuals and Group.exp
## Fligner-Killeen:med chi-squared = 9.9773, df = 1, p-value = 0.001585
```

##LMER MODEL NOT BETTER.

```
lmer_model_exp <- lmer(chambers_entered ~ seconds_moving + (1|Wasp.ID), data = wasp)
BIC(lmer_model_exp)
```

```
## [1] 1142.717
```

```
lm_model_act <- lm(seconds_moving ~ Dummy_Color + Trial + weight + bodily_contact_time + Log_aggression
lm_model_act
```

```
##
## Call:
## lm(formula = seconds_moving ~ Dummy_Color + Trial + weight +
##     bodily_contact_time + Log_aggression + anntenation + chambers_entered,
##     data = wasp)
##
## Coefficients:
##           (Intercept)  Dummy_Colorgoldsilver       Dummy_Colorgreen
##             -73.74424               -3.63268                1.86132
##        Dummy_Colorred      Dummy_Colorsilver       Dummy_Colorwhite
##             -16.70804              -13.08140               30.69797
##     Dummy_Coloryellow                  Trial                weight
##               5.65166                9.62748              201.88969
##   bodily_contact_time         Log_aggression            anntenation
##              -0.06383               10.59644                1.62328
##      chambers_entered
##              47.16311
```

```
lm_empty_act <- lm(seconds_moving ~ 1, data = wasp)
```

```
act_backward.model.BIC = stepAIC(lm_model_act,  scope = list(lower = lm_empty_act, upper= lm_model_act)
act_forward.model.BIC = stepAIC(lm_empty_act,  scope = list(lower = lm_empty_act, upper= lm_model_act),
```

```
## Start:  AIC=3065.1
## seconds_moving ~ 1
##
##                        Df Sum of Sq     RSS    AIC
## + chambers_entered      1   6672074 2449921 2681.7
## + bodily_contact_time   1    261884 8860110 3062.2
## + Trial                 1    222460 8899534 3063.5
## <none>                               9121994 3065.1
## + Log_aggression        1    171337 8950657 3065.2
## + anntenation           1      9303 9112691 3070.5
## + weight                1      1092 9120902 3070.8
## + Dummy_Color           6    120978 9001017 3095.3
##
## Step:  AIC=2681.66
## seconds_moving ~ chambers_entered
##
##                        Df Sum of Sq     RSS    AIC
## <none>                               2449921 2681.7
## + bodily_contact_time   1   27577.3 2422343 2684.0
## + anntenation           1   23741.8 2426179 2684.5
## + Log_aggression        1   19342.8 2430578 2685.0
## + Trial                 1   16581.3 2433339 2685.3
## + weight                1    6296.7 2443624 2686.6
## + Dummy_Color           6   26088.0 2423833 2712.6
```

```
act_FB.model.BIC = stepAIC(lm_empty_act,  scope = list(lower = lm_empty_act, upper= lm_model_act), k = l
act_BF.model.BIC = stepAIC(lm_model_act,  scope = list(lower = lm_empty_act, upper= lm_model_act), k = l
```

```
BIC(act_backward.model.BIC)
```

```
## [1] 3527.36
```

```
BIC(act_forward.model.BIC)
```

```
## [1] 3527.36
```

```
BIC(act_BF.model.BIC)
```

```
## [1] 3527.36
```

```
BIC(act_FB.model.BIC)
```

```
## [1] 3527.36
```

```
act_BF.model.BIC
```

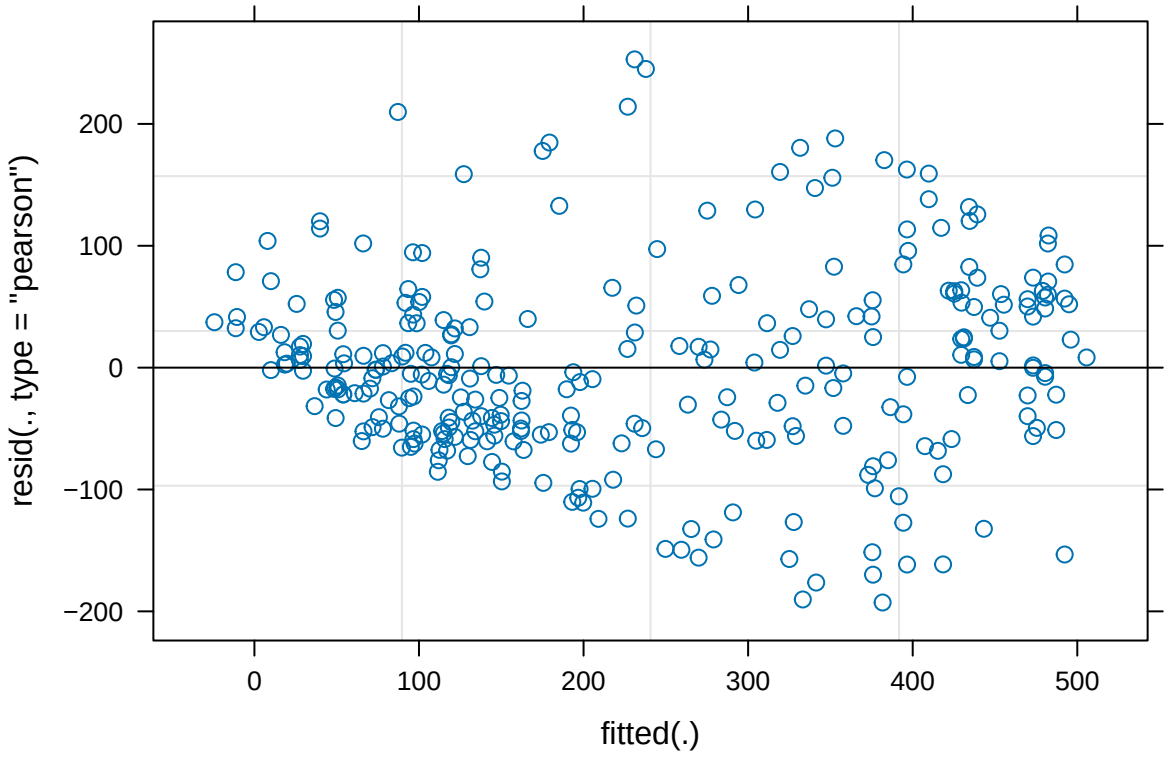
```
##
## Call:
## lm(formula = seconds_moving ~ chambers_entered, data = wasp)
##
## Coefficients:
##       (Intercept)  chambers_entered
##             -19.77             48.13
```

```
lmer_model_act <- lmer(seconds_moving ~ chambers_entered + (1|Wasp.ID), data = wasp)
```

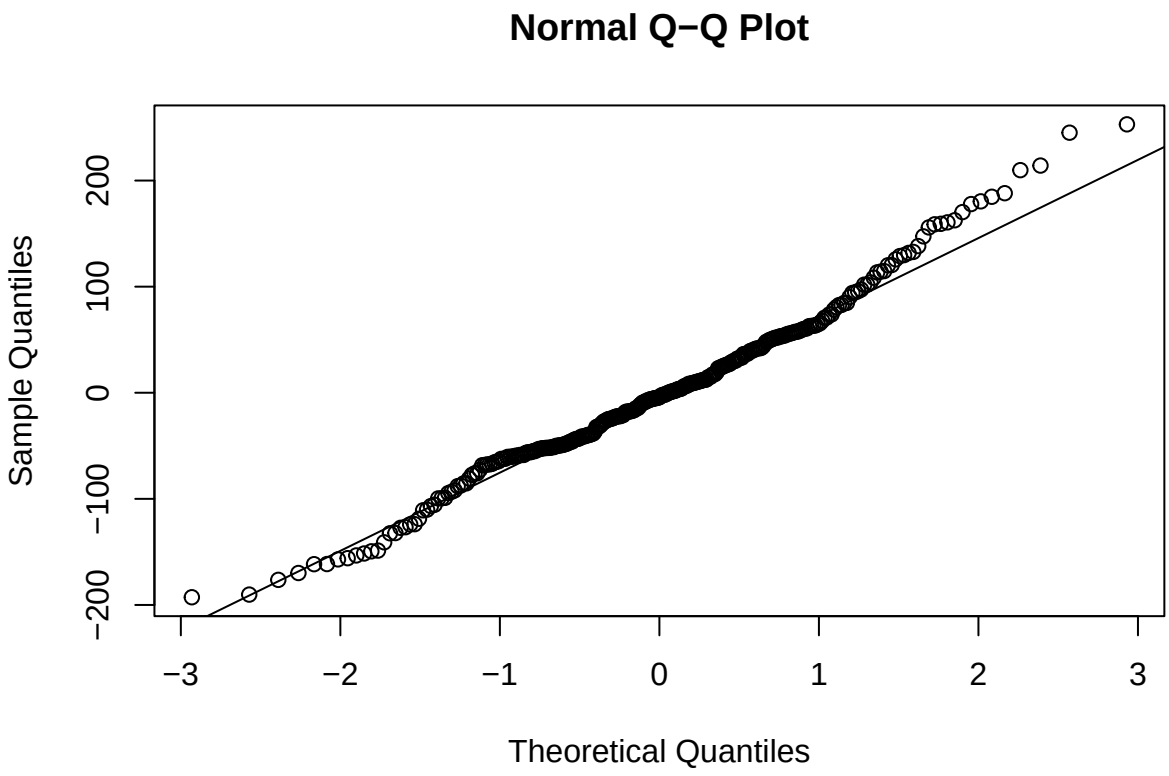
```
BIC(lmer_model_act)
```

```
## [1] 3513.757
```

```
plot(lmer_model_act)
```




```
qqnorm(resid(lmer_model_act))
qqline(resid(lmer_model_act))
```




```
shapiro.test(resid(act_BF.model.BIC))
```

```
##
##  Shapiro-Wilk normality test
##
## data:  resid(act_BF.model.BIC)
## W = 0.98133, p-value = 0.0006617
```

```
#install.packages("MPV")
#install.packages("leaps")
library(MPV)
library(leaps)
library(MASS)
#install.packages("lmerTest")
```

```
#lmerTest::step(lmer_model_affilitation_full)
```

```
lmer_model_affilitation
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: bodily_contact_time ~ Trial + seconds_moving + (1 | Wasp.ID)
##    Data: wasp
## REML criterion at convergence: 3870.311
## Random effects:
```

```
##  Groups   Name        Std.Dev.
##  Wasp.ID  (Intercept) 104.3
##  Residual             149.0
## Number of obs: 296, groups:  Wasp.ID, 74
## Fixed Effects:
##    (Intercept)           Trial  seconds_moving
##       148.0218         24.6667         -0.1134
```

```
lmer_model_act
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: seconds_moving ~ chambers_entered + (1 | Wasp.ID)
##    Data: wasp
## REML criterion at convergence: 3490.996
## Random effects:
##  Groups   Name        Std.Dev.
##  Wasp.ID  (Intercept) 38.11
##  Residual             83.06
## Number of obs: 296, groups:  Wasp.ID, 74
## Fixed Effects:
##      (Intercept)  chambers_entered
##           -18.81             47.95
```

```
lmer_model_ant
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: anntenation ~ Log_aggression + (1 | Wasp.ID)
##    Data: wasp
## REML criterion at convergence: 1532.576
## Random effects:
##  Groups   Name        Std.Dev.
##  Wasp.ID  (Intercept) 2.073
##  Residual             2.785
## Number of obs: 296, groups:  Wasp.ID, 74
## Fixed Effects:
##    (Intercept)  Log_aggression
##         5.1067          0.7655
```