

final_project_419

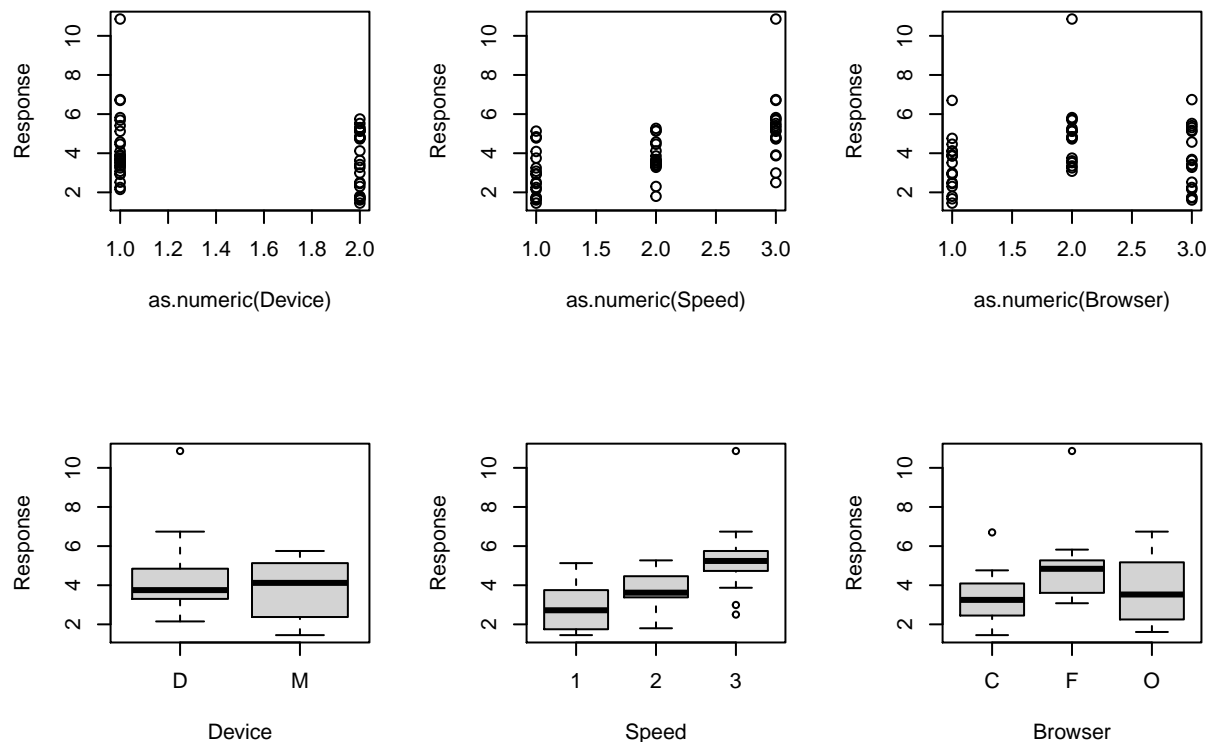
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11/24/2021

```
df = read.csv("df.csv")

df$Device = as.factor(df$Device)
df$Speed = as.factor(df$Speed)
df$Browser = as.factor(df$Browser)
new_df =
data.frame(Device = rep(df$Device,3),
Speed = rep(df$Speed,3),
Browser = rep(df$Browser,3),
Response = c(df$Replicate.1,df$Replicate.2,df$Replicate.3),replicate = as.factor(c(rep(1,18),rep(2,18),rep(3,18))))

par(mfrow=c(2,3))
plot(data= new_df, Response~ as.numeric(Device) + as.numeric(Speed)+as.numeric(Browser))
plot(data= new_df, Response~ (Device) + (Speed)+(Browser))
```



```
par(mfrow=c(1,1))
m1 <-lm(data=new_df, Response~Device + Speed + Browser +
        Device:Speed + Device:Browser + Speed:Browser +
        replicate)
summary(m1)
```

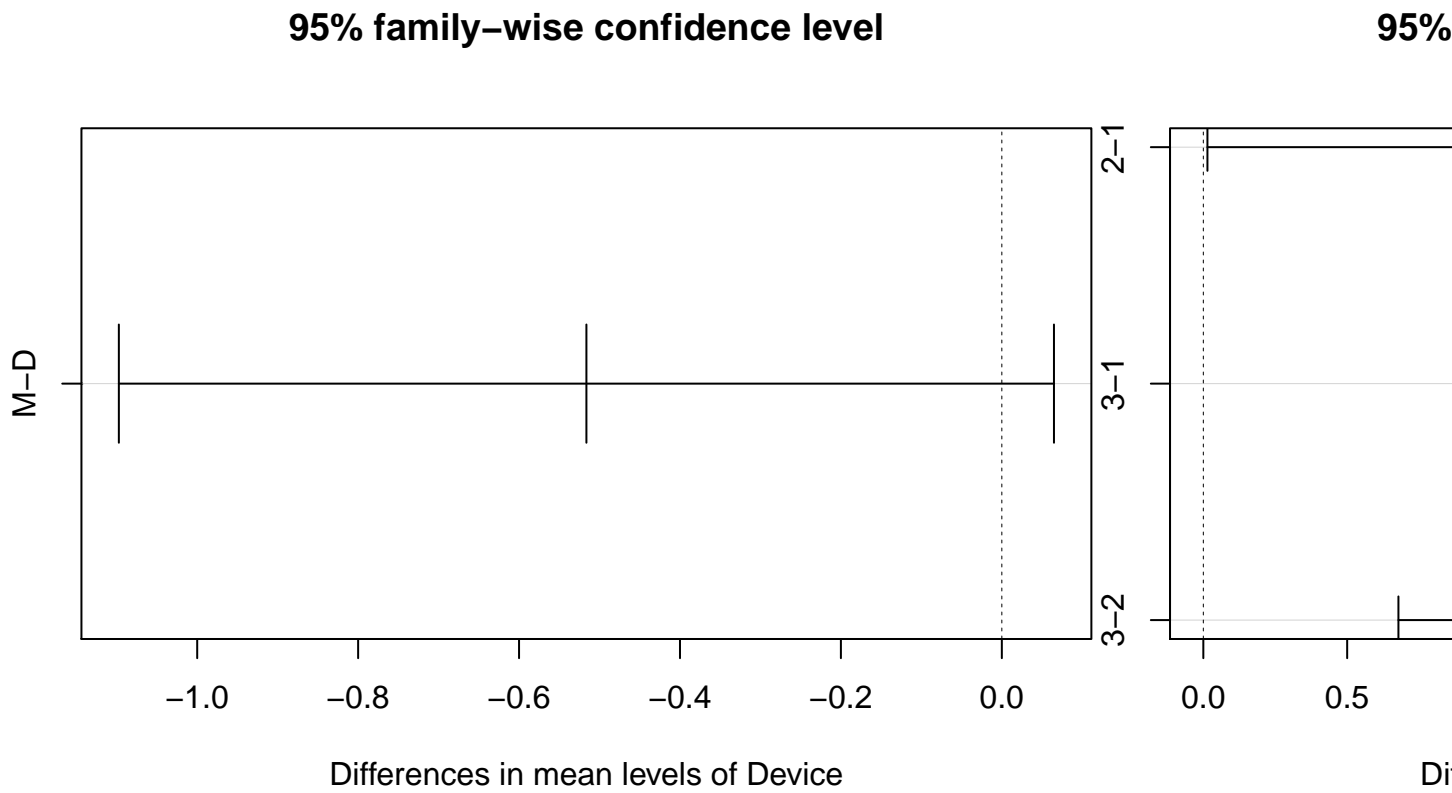
```
##
## Call:
## lm(formula = Response ~ Device + Speed + Browser + Device:Speed +
##      Device:Browser + Speed:Browser + replicate, data = new_df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.3974 -0.4870 -0.1892  0.4329  4.0217
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      3.3639     0.5741   5.859 8.88e-07 ***
## DeviceM          -1.0159     0.6419  -1.583  0.12176
## Speed2             0.6572     0.7031   0.935  0.35584
## Speed3             2.1439     0.7031   3.049  0.00417 **
## BrowserF           0.7206     0.7031   1.025  0.31194
## Browser0          -1.0228     0.7031  -1.455  0.15399
## replicate2        -0.3222     0.3516  -0.917  0.36516
## replicate3        -0.4806     0.3516  -1.367  0.17968
## DeviceM:Speed2     0.1922     0.7031   0.273  0.78604
## DeviceM:Speed3    -1.2211     0.7031  -1.737  0.09054 .
## DeviceM:BrowserF   1.6589     0.7031   2.359  0.02355 *
## DeviceM:Browser0   0.8689     0.7031   1.236  0.22413
## Speed2:BrowserF   -0.5517     0.8611  -0.641  0.52562
## Speed3:BrowserF    0.6100     0.8611   0.708  0.48305
## Speed2:Browser0    0.9067     0.8611   1.053  0.29905
## Speed3:Browser0    2.0117     0.8611   2.336  0.02487 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.055 on 38 degrees of freedom
## Multiple R-squared:  0.7089, Adjusted R-squared:  0.594
## F-statistic:  6.17 on 15 and 38 DF, p-value: 2.781e-06
```

```
anova(m1)
```

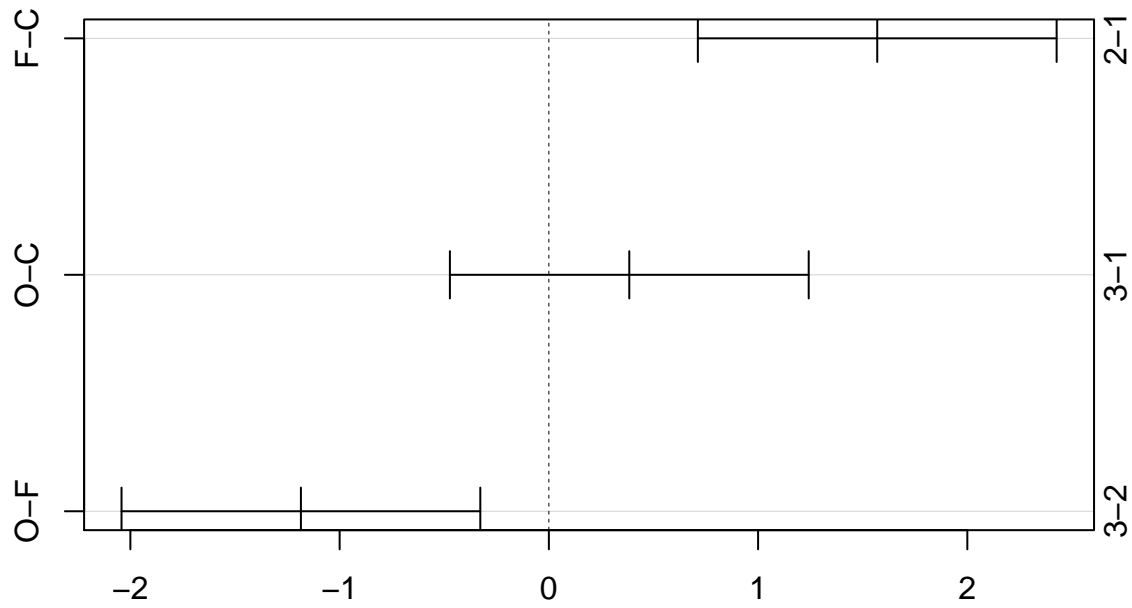
```
## Analysis of Variance Table
##
## Response: Response
##              Df Sum Sq Mean Sq F value    Pr(>F)
## Device         1  3.599   3.5986   3.2351 0.0800236 .
## Speed          2 53.475  26.7374  24.0366 1.792e-07 ***
## Browser        2 24.091  12.0455  10.8288 0.0001898 ***
## replicate      2   2.159   1.0795   0.9704 0.3881055
## Device:Speed    2   5.288   2.6442   2.3771 0.1064872
## Device:Browser  2   6.196   3.0982   2.7853 0.0743397 .
## Speed:Browser   4   8.140   2.0351   1.8295 0.1432653
```

```
## Residuals      38 42.270  1.1124
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

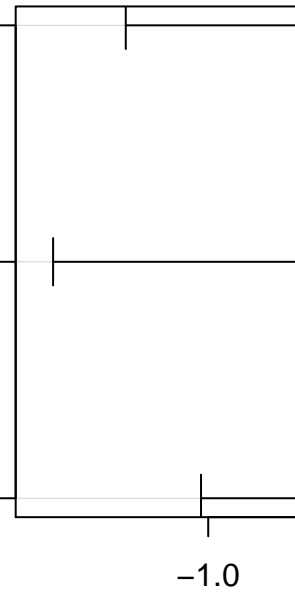
```
plot(TukeyHSD(aov(m1)))
```



95% family-wise confidence level

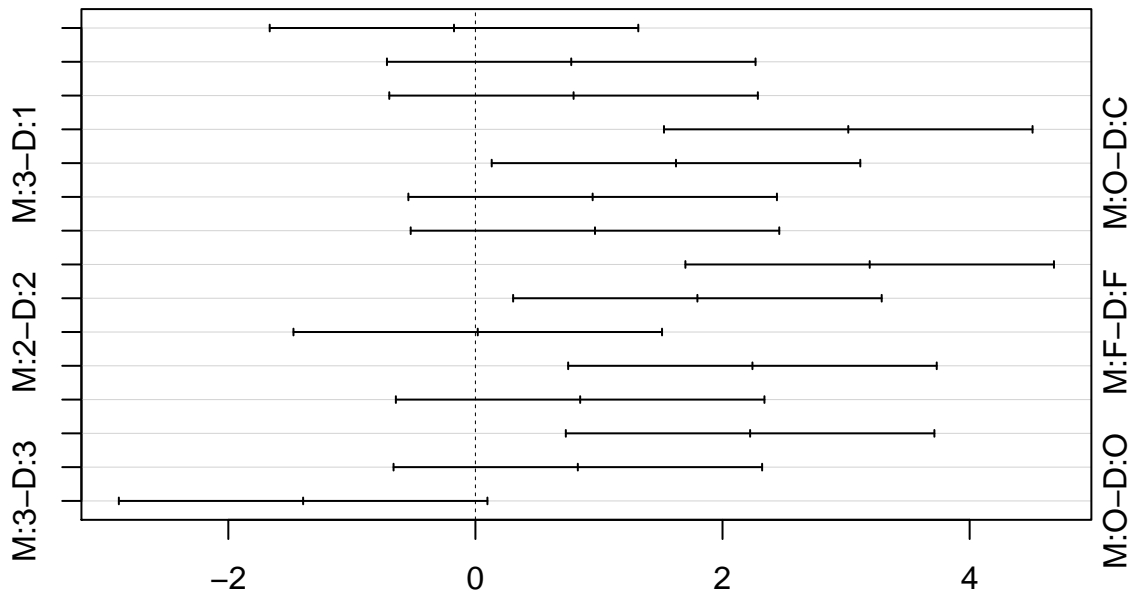


95%

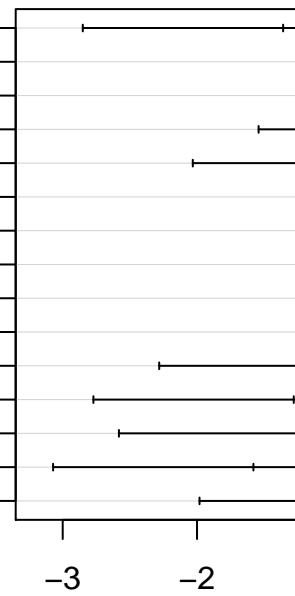


Differences in mean levels of Browser
95% family-wise confidence level

Differences in mean levels of Browser
95%

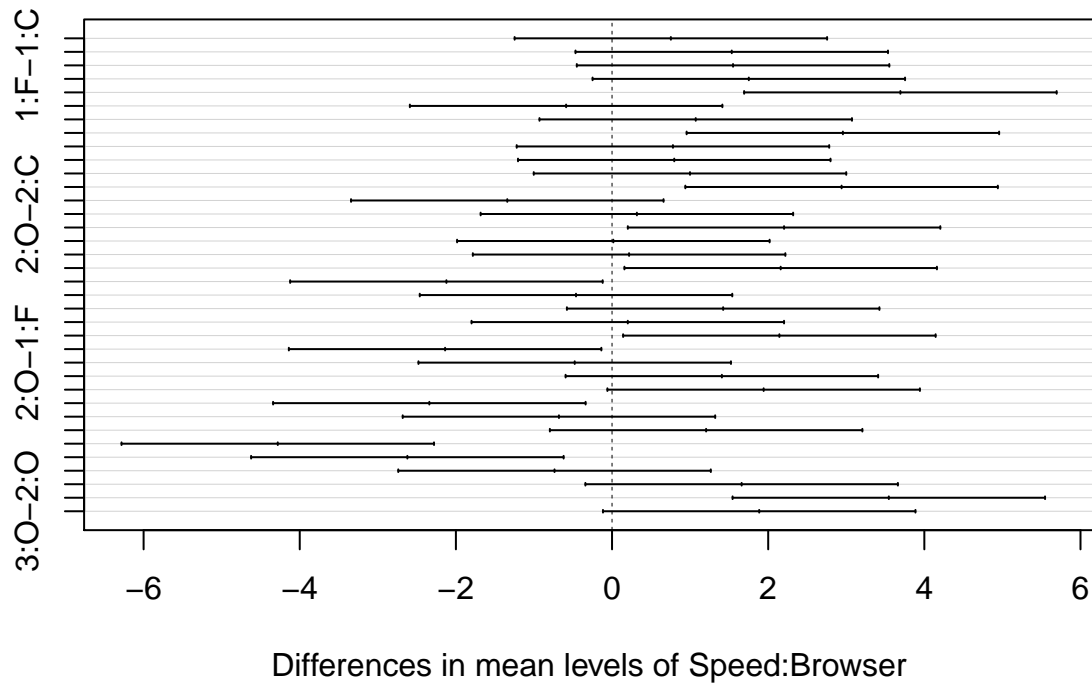


Differences in mean levels of Device:Speed



Differences in mean levels of Device:Speed

95% family-wise confidence level



```
TukeyHSD(aov(m1))
```

```
## Tukey multiple comparisons of means
## 95% family-wise confidence level
##
## Fit: aov(formula = m1)
##
## $Device
##      diff      lwr      upr    p adj
## M-D -0.5162963 -1.097397 0.06480432 0.0800236
##
## $Speed
##      diff      lwr      upr    p adj
## 2-1 0.8716667 0.01426817 1.729065 0.0456058
## 3-1 2.4072222 1.54982372 3.264621 0.0000001
## 3-2 1.5355556 0.67815705 2.392954 0.0002703
##
## $Browser
##      diff      lwr      upr    p adj
## F-C 1.5694444 0.7120459 2.4268429 0.0002019
## O-C 0.3844444 -0.4729541 1.2418429 0.5238794
## O-F -1.1850000 -2.0423985 -0.3276015 0.0048219
##
## $replicate
##      diff      lwr      upr    p adj
## 2-1 -0.3222222 -1.179621 0.5351763 0.6333224
## 3-1 -0.4805556 -1.337954 0.3768429 0.3680928
## 3-2 -0.1583333 -1.015732 0.6990652 0.8945354
```

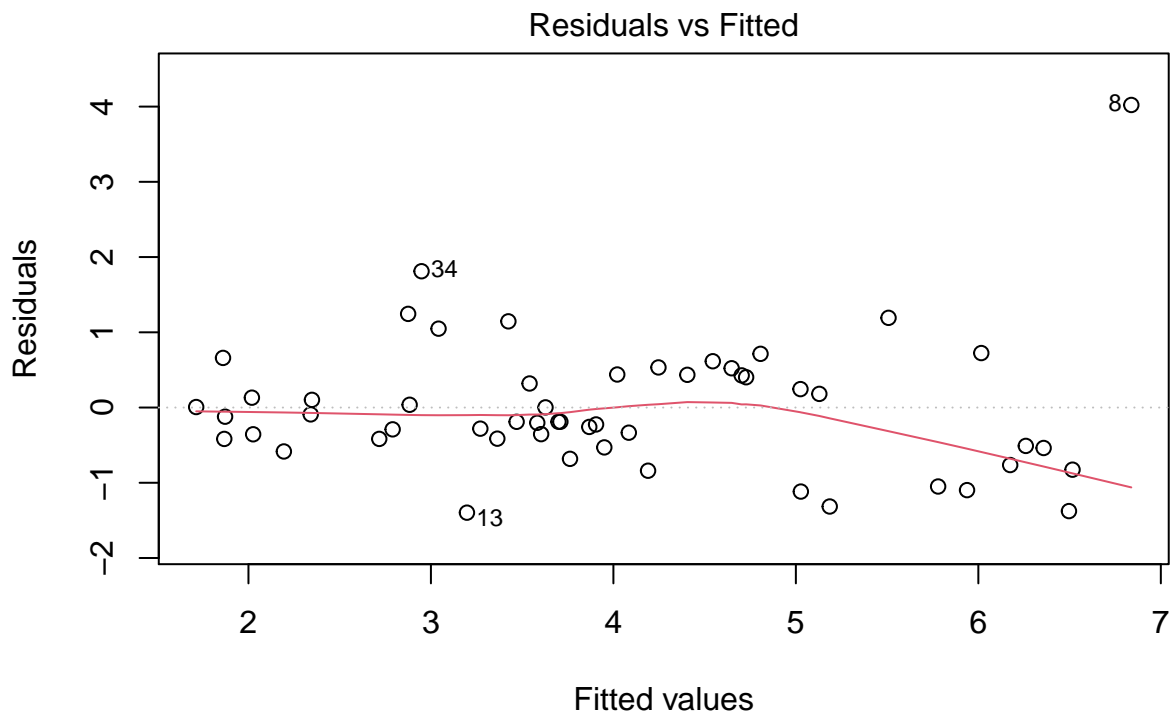
```

##
## $'Device:Speed'
##          diff          lwr          upr          p adj
## M:1-D:1 -0.17333333 -1.6648626 1.31819589 0.9992647
## D:2-D:1  0.77555556 -0.7159737 2.26708478 0.6289095
## M:2-D:1  0.79444444 -0.6970848 2.28597367 0.6049174
## D:3-D:1  3.01777778  1.5262486 4.50930701 0.0000065
## M:3-D:1  1.62333333  0.1318041 3.11486256 0.0260895
## D:2-M:1  0.94888889 -0.5426403 2.44041812 0.4128114
## M:2-M:1  0.96777778 -0.5237514 2.45930701 0.3909805
## D:3-M:1  3.19111111  1.6995819 4.68264034 0.0000022
## M:3-M:1  1.79666667  0.3051374 3.28819589 0.0104657
## M:2-D:2  0.01888889 -1.4726403 1.51041812 1.0000000
## D:3-D:2  2.24222222  0.7506930 3.73375145 0.0008055
## M:3-D:2  0.84777778 -0.6437514 2.33930701 0.5369632
## D:3-M:2  2.22333333  0.7318041 3.71486256 0.0009022
## M:3-M:2  0.82888889 -0.6626403 2.32041812 0.5609896
## M:3-D:3 -1.39444444 -2.8859737 0.09708478 0.0784428
##
## $'Device:Browser'
##          diff          lwr          upr          p adj
## M:C-D:C -1.3588889 -2.8504181 0.13264034 0.0918831
## D:F-D:C  0.7400000 -0.7515292 2.23152923 0.6734902
## M:F-D:C  1.0400000 -0.4515292 2.53152923 0.3130668
## D:O-D:C -0.0500000 -1.5415292 1.44152923 0.9999984
## M:O-D:C -0.5400000 -2.0315292 0.95152923 0.8838625
## D:F-M:C  2.0988889  0.6073597 3.59041812 0.0018874
## M:F-M:C  2.3988889  0.9073597 3.89041812 0.0003112
## D:O-M:C  1.3088889 -0.1826403 2.80041812 0.1140135
## M:O-M:C  0.8188889 -0.6726403 2.31041812 0.5737428
## M:F-D:F  0.3000000 -1.1915292 1.79152923 0.9901548
## D:O-D:F -0.7900000 -2.2815292 0.70152923 0.6105744
## M:O-D:F -1.2800000 -2.7715292 0.21152923 0.1286806
## D:O-M:F -1.0900000 -2.5815292 0.40152923 0.2649608
## M:O-M:F -1.5800000 -3.0715292 -0.08847077 0.0324596
## M:O-D:O -0.4900000 -1.9815292 1.00152923 0.9197318
##
## $'Speed:Browser'
##          diff          lwr          upr          p adj
## 2:C-1:C  0.75333333 -1.24791208 2.7545787 0.9426732
## 3:C-1:C  1.53333333 -0.46791208 3.5345787 0.2556438
## 1:F-1:C  1.55000000 -0.45124541 3.5512454 0.2434023
## 2:F-1:C  1.75166667 -0.24957874 3.7529121 0.1269457
## 3:F-1:C  3.69333333  1.69208792 5.6945787 0.0000153
## 1:O-1:C -0.58833333 -2.58957874 1.4129121 0.9868047
## 2:O-1:C  1.07166667 -0.92957874 3.0729121 0.7066823
## 3:O-1:C  2.95666667  0.95542126 4.9579121 0.0006401
## 3:C-2:C  0.78000000 -1.22124541 2.7812454 0.9308163
## 1:F-2:C  0.79666667 -1.20457874 2.7979121 0.9226410
## 2:F-2:C  0.99833333 -1.00291208 2.9995787 0.7773467
## 3:F-2:C  2.94000000  0.93875459 4.9412454 0.0006951
## 1:O-2:C -1.34166667 -3.34291208 0.6595787 0.4240101
## 2:O-2:C  0.31833333 -1.68291208 2.3195787 0.9998224
## 3:O-2:C  2.20333333  0.20208792 4.2045787 0.0216776

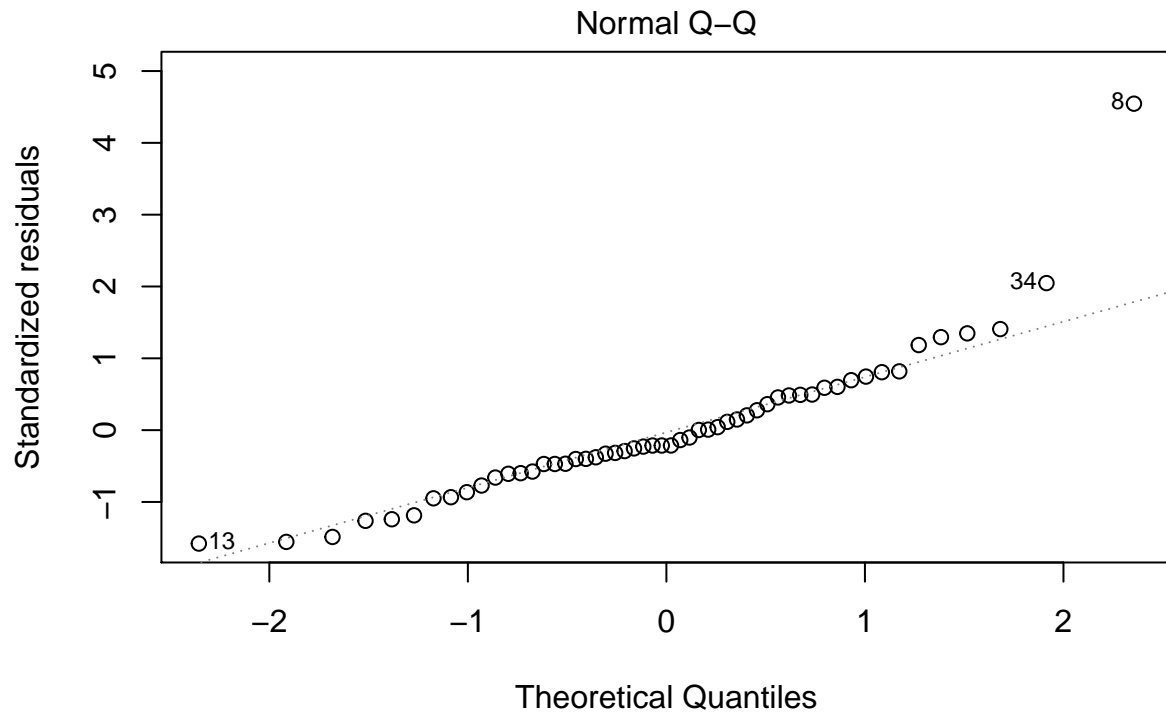
```

```
## 1:F-3:C 0.01666667 -1.98457874 2.0179121 1.0000000
## 2:F-3:C 0.21833333 -1.78291208 2.2195787 0.9999900
## 3:F-3:C 2.16000000 0.15875459 4.1612454 0.0260686
## 1:0-3:C -2.12166667 -4.12291208 -0.1204213 0.0306190
## 2:0-3:C -0.46166667 -2.46291208 1.5395787 0.9973799
## 3:0-3:C 1.42333333 -0.57791208 3.4245787 0.3464456
## 2:F-1:F 0.20166667 -1.79957874 2.2029121 0.9999946
## 3:F-1:F 2.14333333 0.14208792 4.1445787 0.0279649
## 1:0-1:F -2.13833333 -4.13957874 -0.1370879 0.0285580
## 2:0-1:F -0.47833333 -2.47957874 1.5229121 0.9966526
## 3:0-1:F 1.40666667 -0.59457874 3.4079121 0.3616376
## 3:F-2:F 1.94166667 -0.05957874 3.9429121 0.0631492
## 1:0-2:F -2.34000000 -4.34124541 -0.3387546 0.0119191
## 2:0-2:F -0.68000000 -2.68124541 1.3212454 0.9679680
## 3:0-2:F 1.20500000 -0.79624541 3.2062454 0.5664822
## 1:0-3:F -4.28166667 -6.28291208 -2.2804213 0.0000008
## 2:0-3:F -2.62166667 -4.62291208 -0.6204213 0.0032546
## 3:0-3:F -0.73666667 -2.73791208 1.2645787 0.9493382
## 2:0-1:0 1.66000000 -0.34124541 3.6612454 0.1728194
## 3:0-1:0 3.54500000 1.54375459 5.5462454 0.0000328
## 3:0-2:0 1.88500000 -0.11624541 3.8862454 0.0783697
```

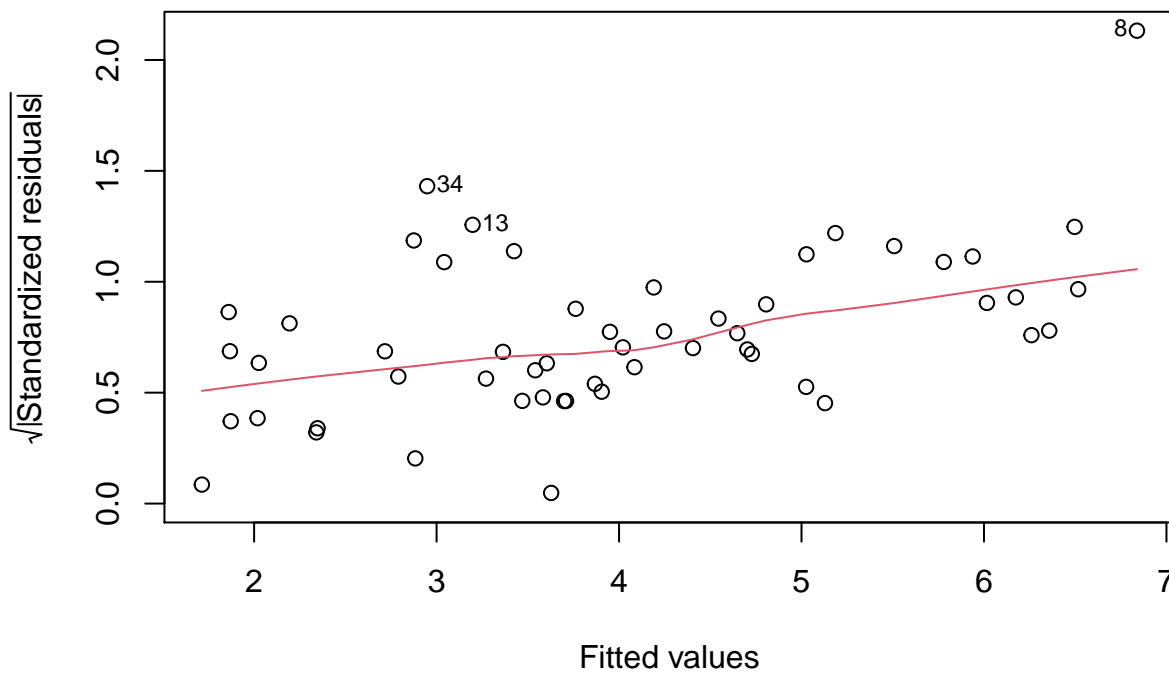
```
plot(m1)
```



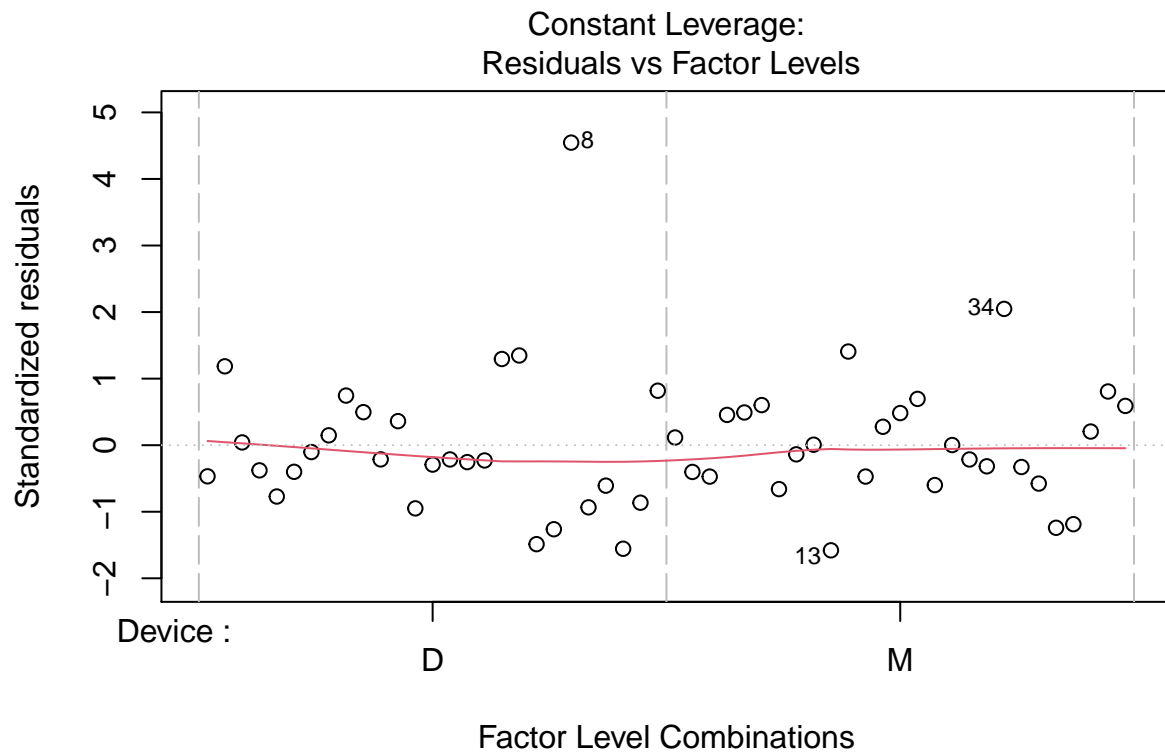
lm(Response ~ Device + Speed + Browser + Device:Speed + Device:Browser + Sp .



lm(Response ~ Device + Speed + Browser + Device:Speed + Device:Browser + Sp .
Scale-Location

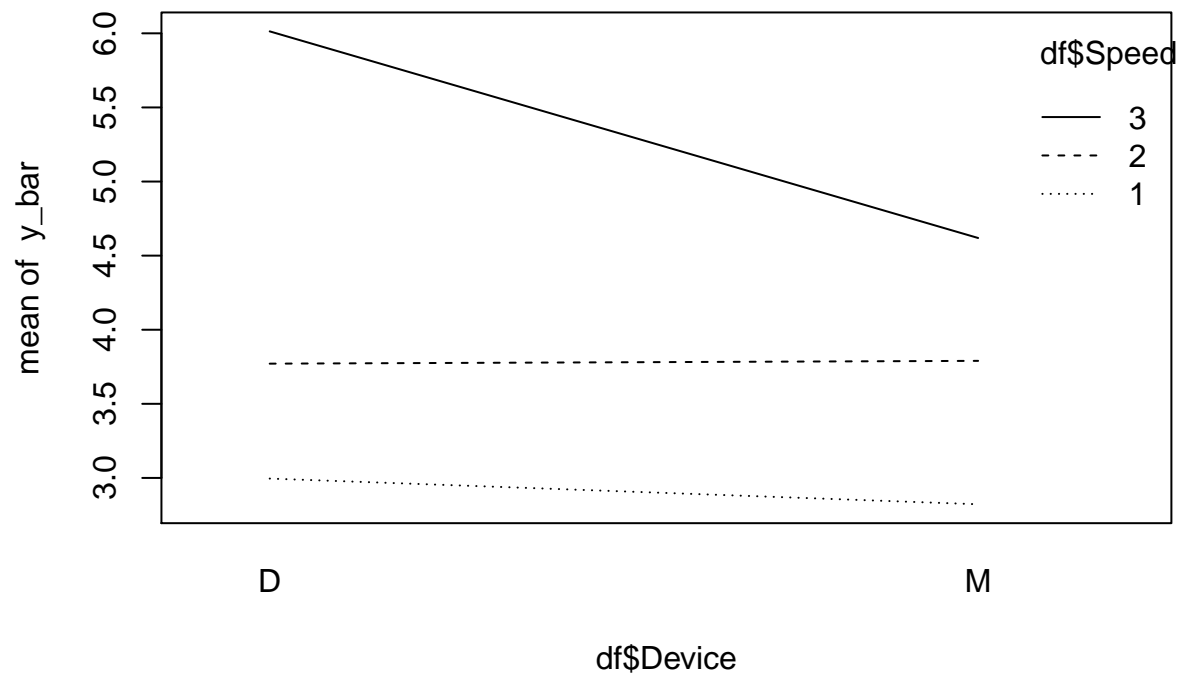


lm(Response ~ Device + Speed + Browser + Device:Speed + Device:Browser + Sp .

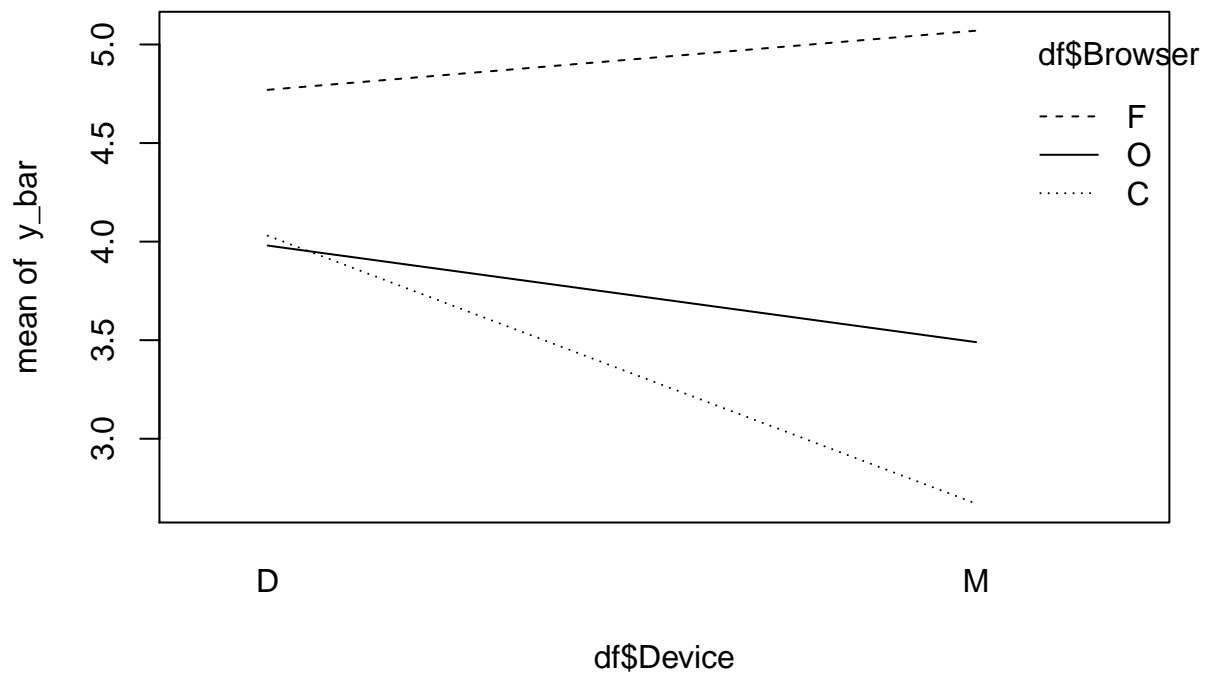


```
y_bar = (df$Replicate.1 + df$Replicate.2 + df$Replicate.3)/3
```

```
interaction.plot(df$Device, df$Speed, y_bar)
```



```
interaction.plot(df$Device, df$Browser, y_bar)
```



```
interaction.plot(df$Browser, df$Speed, y_bar)
```

