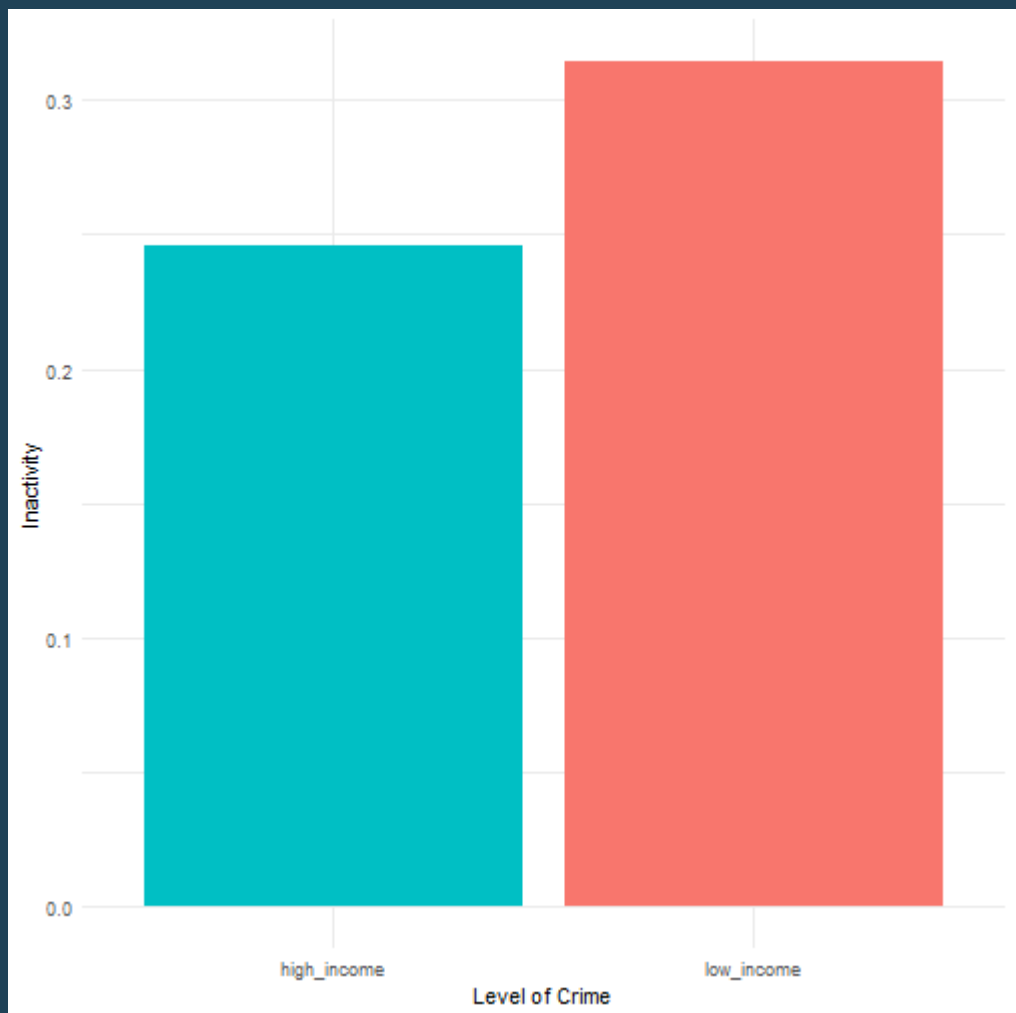# PSY 3307

Two-Way ANOVA cont.
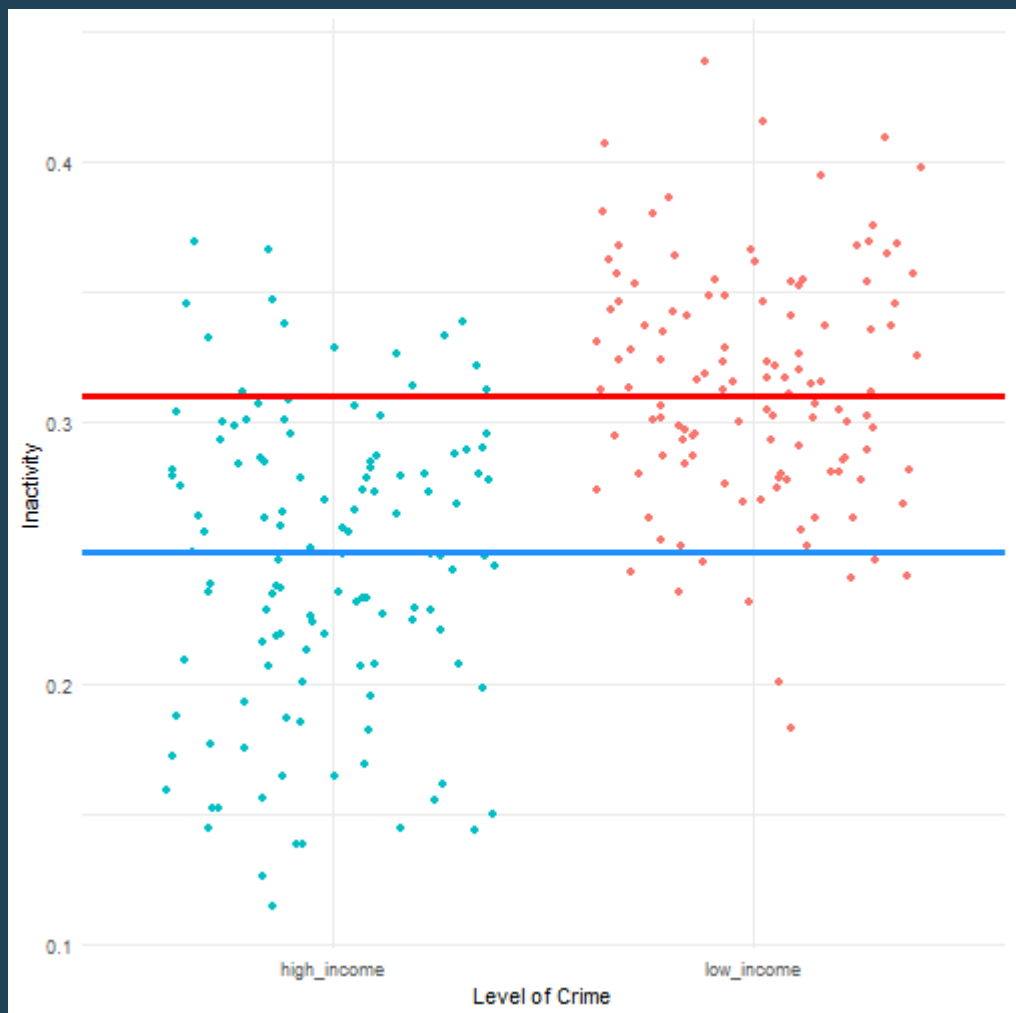
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Agenda

- Go over two-way ANOVA
- Answer any questions about the exam
- Conduct a two-way ANOVA together for upcoming problem set & SPSS assignment

```
##                Df Sum Sq Mean Sq F value              Pr(>F)
## income_split   1 0.2868 0.28685   107.2 <0.0000000000000002 ***
## Residuals    241 0.6446 0.00267
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##    Tukey multiple comparisons of means
##       95% family-wise confidence level
##
## Fit: aov(formula = inactivity ~ income_split, data = data)
##
## $income_split
##                                 diff           lwr           upr p adj
## high_income-low_income -0.06871562 -0.08178622 -0.05564503      0


##
##   Descriptive statistics by group
## group: low_income
##     vars   n mean   sd median trimmed  mad  min  max range skew kurtosis se
## X1     1 121 0.31 0.05   0.31    0.31 0.05 0.18 0.44  0.26 0.01     0.09  0
## ----------------------------------------------------------------
## group: high_income
##     vars   n mean   sd median trimmed  mad  min  max range  skew kurtosis
## X1     1 122 0.25 0.06   0.25    0.25 0.06 0.11 0.37  0.26 -0.22    -0.68 0.
```

```
## 
## Call:
## lm(formula = inactivity ~ income_split, data = data)
## 
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.13159 -0.03331  0.00241  0.03741  0.12369
## 
## Coefficients:
##                            Estimate Std. Error t value           Pr(>|t|)
## (Intercept)                0.314306   0.004702   66.85 <0.0000000000000002 **
## income_splithigh_income   -0.068716   0.006635  -10.36 <0.0000000000000002 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.05172 on 241 degrees of freedom
## Multiple R-squared:  0.308,    Adjusted R-squared:  0.3051
## F-statistic: 107.2 on 1 and 241 DF,  p-value: < 0.00000000000000022
```
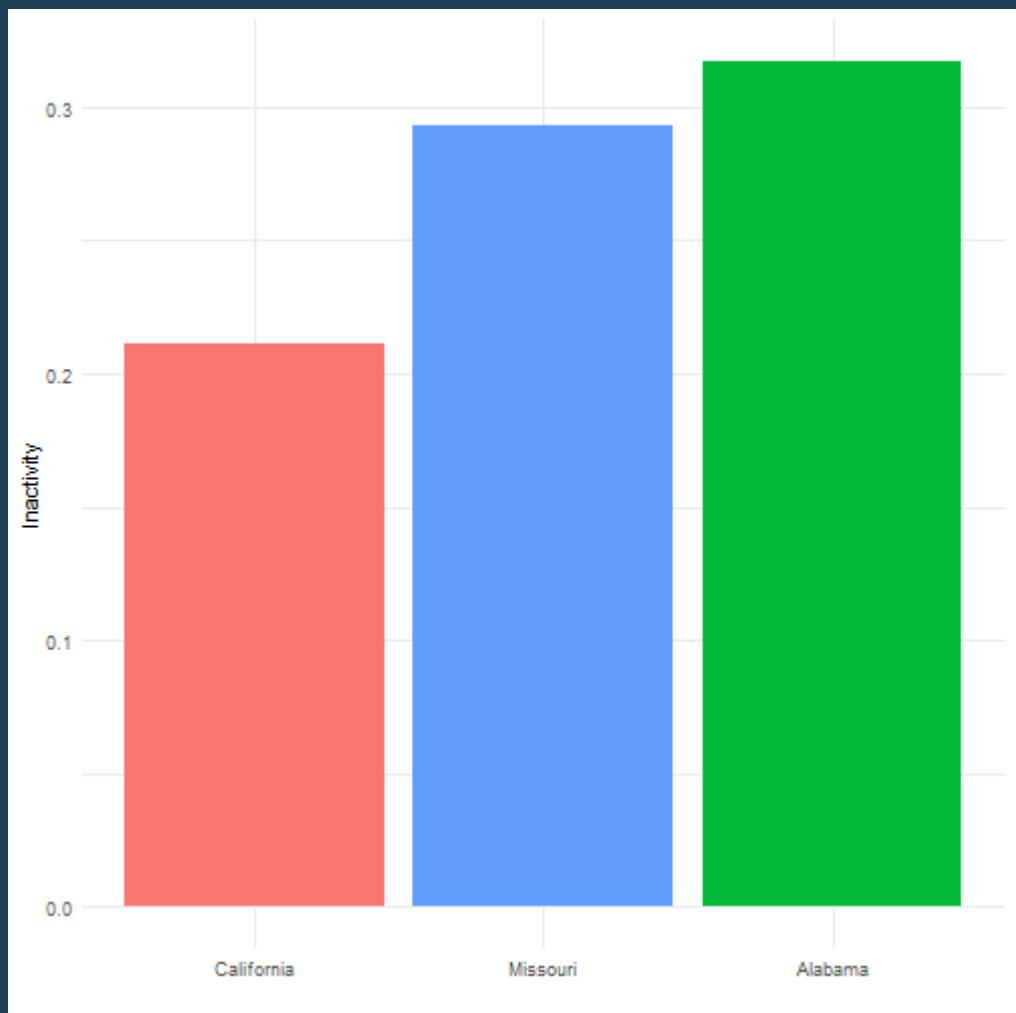
```
##                  Df Sum Sq Mean Sq F value             Pr(>F)
## state            2 0.3894 0.19469    86.2 <0.0000000000000002 ***
## Residuals      240 0.5421 0.00226
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##     Tukey multiple comparisons of means
##       95% family-wise confidence level
##
## Fit: aov(formula = inactivity ~ state, data = data)
##
## $state
##                            diff         lwr          upr     p adj
## Alabama-California   0.10560120  0.08566023  0.125542160 0.0000000
## Missouri-California  0.08127513  0.06335304  0.099197226 0.0000000
## Missouri-Alabama    -0.02432606 -0.04144395 -0.007208176 0.0026782


##
##  Descriptive statistics by group
## group: California
##    vars  n mean   sd median trimmed  mad  min  max range skew kurtosis    se
## X1    1 59 0.21 0.06   0.21    0.21 0.06 0.11 0.37  0.26 0.52    -0.25 0.01
## -------------------------------------------------------------
## group: Alabama
##    vars  n mean   sd median trimmed  mad  min  max range  skew kurtosis    s
## X1    1 68 0.32 0.04   0.32    0.32 0.04 0.18 0.41  0.22 -0.63     0.31 0.0
## -------------------------------------------------------------
## group: Missouri
##    vars   n mean   sd median trimmed  mad min  max range skew kurtosis se
## X1    1 116 0.29 0.04   0.29    0.29 0.04 0.2 0.44  0.24  0.6     0.62  0
```
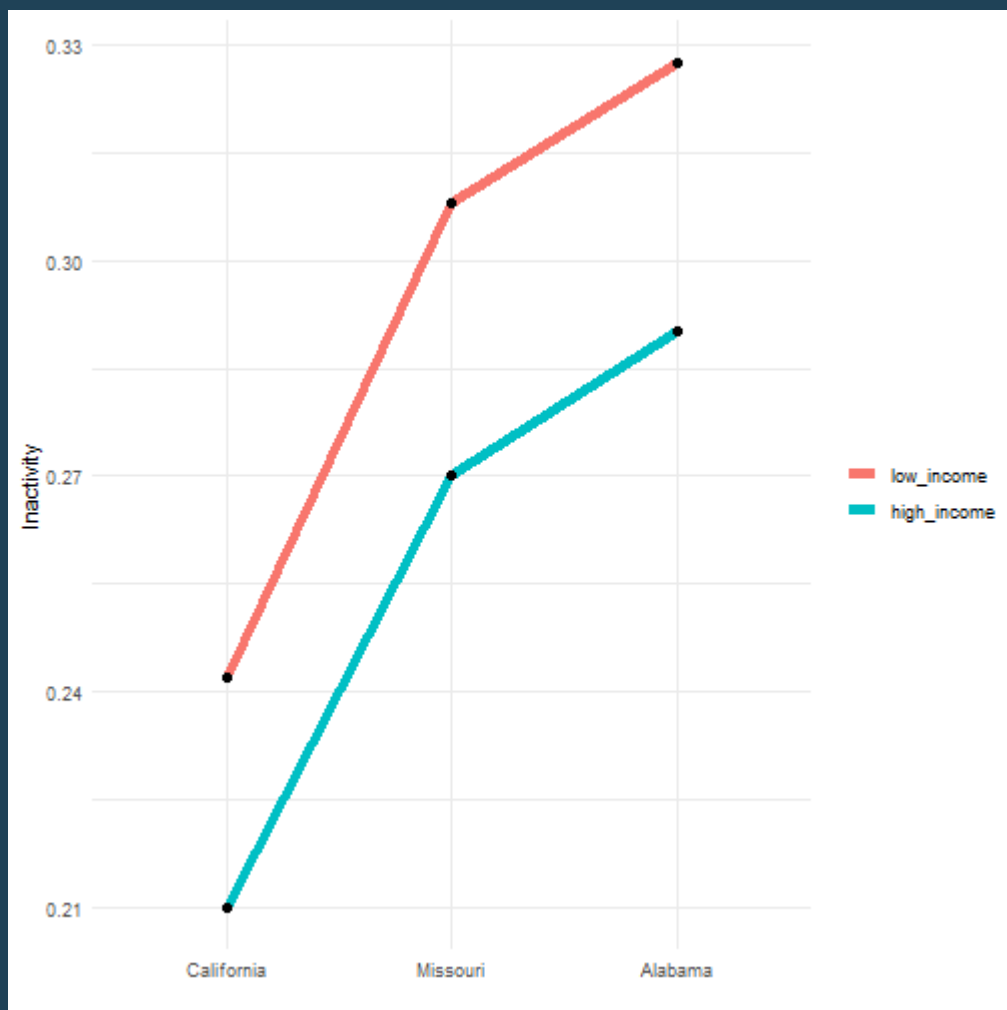
```
## lm(formula = inactivity ~ state, data = data)
##               coef.est coef.se
## (Intercept)   0.21     0.01
## stateAlabama  0.11     0.01
## stateMissouri 0.08     0.01
## ---
## n = 243, k = 3
## residual sd = 0.05, R-Squared = 0.42
```

```
##                       Df Sum Sq Mean Sq F value                   Pr(>F)
## state                  2 0.3894 0.19469   96.15 < 0.0000000000000002 ***
## income_split           1 0.0621 0.06209   30.67          0.0000000812 ***
## state:income_split     2 0.0001 0.00004    0.02                  0.98
## Residuals            237 0.4799 0.00202
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##                             diff          lwr          upr                     p
## Alabama-California   0.10560120   0.08671883   0.124483563 0.0000000000000285
## Missouri-California  0.08127513   0.06430446   0.098245803 0.0000000000000391
## Missouri-Alabama    -0.02432606  -0.04053522  -0.008116906 0.0013959002717003
```

```
##                                 diff        lwr       upr         p adj
## high_income-low_income -0.02736152 -0.03873504 -0.015988 0.000003699046
```

```
##                                                           diff          lwr
## Alabama:low_income-California:low_income            0.08553061  0.008635365
## Missouri:low_income-California:low_income           0.06605797 -0.010191629
## California:high_income-California:low_income       -0.03217857 -0.108796051
## Alabama:high_income-California:low_income           0.04805263 -0.032268609
## Missouri:high_income-California:low_income          0.02823404 -0.048755536
## Missouri:low_income-Alabama:low_income             -0.01947264 -0.043625854
## California:high_income-Alabama:low_income          -0.11770918 -0.142999781
## Alabama:high_income-Alabama:low_income             -0.03747798 -0.072419043
## Missouri:high_income-Alabama:low_income            -0.05729657 -0.083692997
## California:high_income-Missouri:low_income         -0.09823654 -0.121490289
## Alabama:high_income-Missouri:low_income            -0.01800534 -0.051501612
## Missouri:high_income-Missouri:low_income           -0.03782393 -0.062275795
## Alabama:high_income-California:high_income          0.08023120  0.045905747
## Missouri:high_income-California:high_income         0.06041261  0.034836641
## Missouri:high_income-Alabama:high_income           -0.01981859 -0.054966760
##                                                           upr
## Alabama:low_income-California:low_income            0.162425860
## Missouri:low_income-California:low_income           0.142307571
## California:high_income-California:low_income        0.044438908
## Alabama:high_income-California:low_income           0.128373872
## Missouri:high_income-California:low_income          0.105223621
## Missouri:low_income-Alabama:low_income              0.004680572
## California:high_income-Alabama:low_income          -0.092418586
## Alabama:high_income-Alabama:low_income             -0.002536918
## Missouri:high_income-Alabama:low_income            -0.030900143
## California:high_income-Missouri:low_income         -0.074982795
## Alabama:high_income-Missouri:low_income             0.015490933
```

```
## lm(formula = inactivity ~ state * income_split, data = data)
##                                      coef.est coef.se
## (Intercept)                             0.24     0.03
## stateAlabama                            0.09     0.03
## stateMissouri                           0.07     0.03
## income_splithigh_income                -0.03     0.03
## stateAlabama:income_splithigh_income   -0.01     0.03
## stateMissouri:income_splithigh_income  -0.01     0.03
## ---
## n = 243, k = 6
## residual sd = 0.04, R-Squared = 0.48
```

Recap on Main Effects & Interaction

- We have three F tests

  - one for the first IV on DV
  - second for the second IV on DV
  - third the interaction on DV

- Interpret the interaction first

  - then the main effects