

## Unbalanced ANOVA Report

Outcome: G3

Primary factor: studytime

Secondary factor: school

Minimum group n: 35

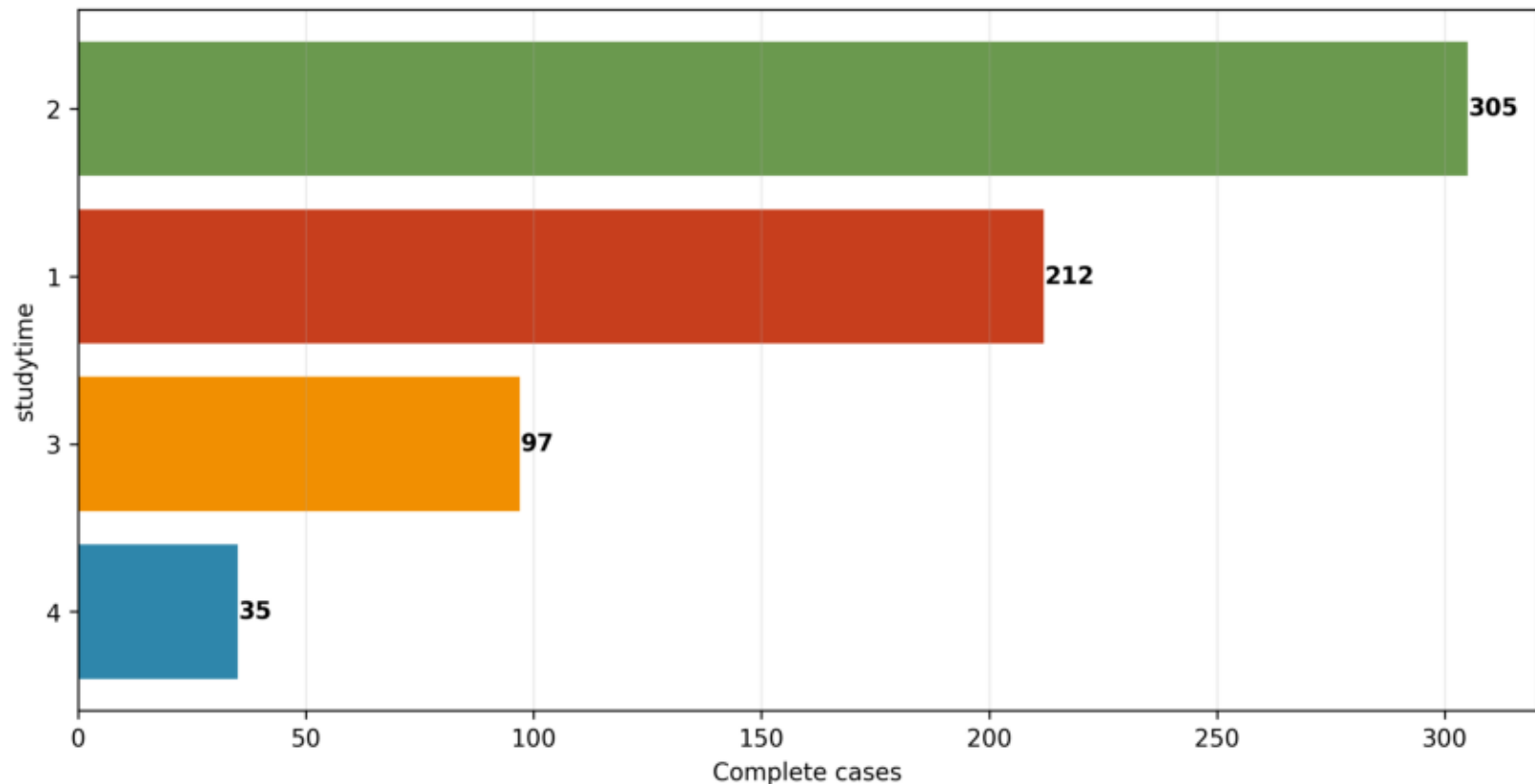
Maximum group n: 305

Imbalance ratio max/min: 8.714

Type I, Type II, and Type III ANOVA tables are saved in CSV output.  
Use Type II/III carefully when group sizes are unequal.

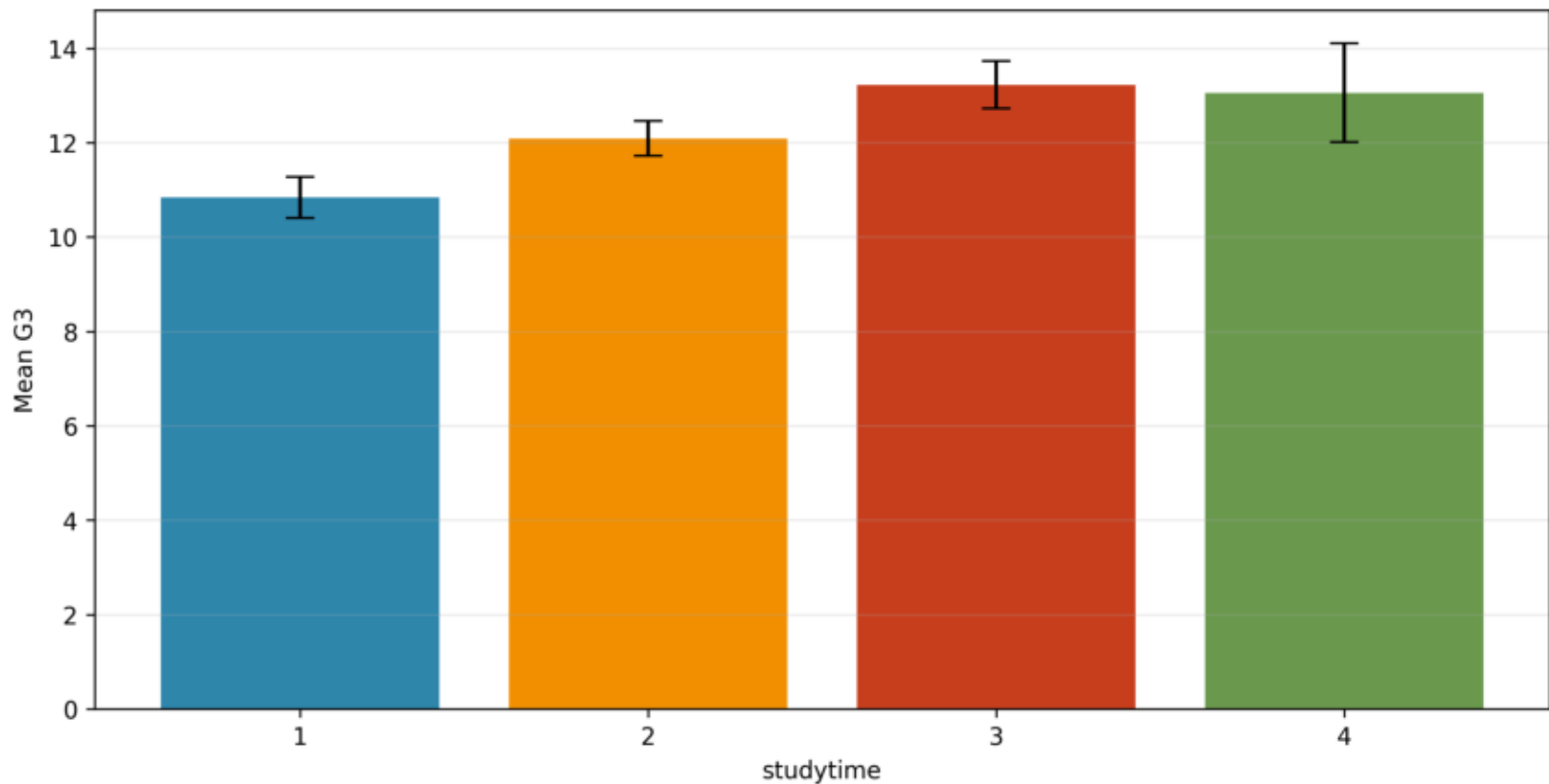
# Unbalanced ANOVA: Group Sizes

Unequal group sizes are the reason this analysis is treated as unbalanced.



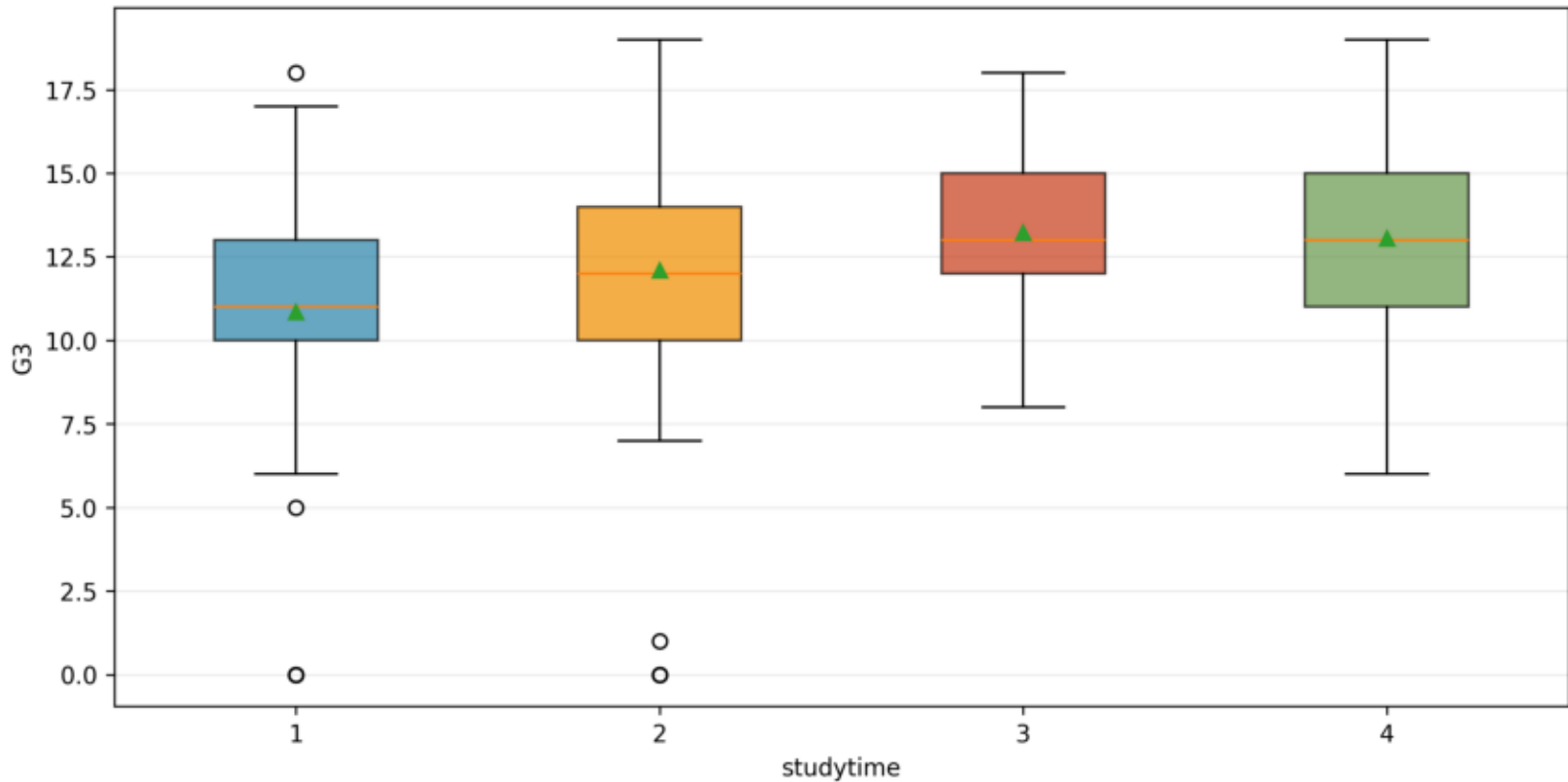
# Mean G3 by studytime

Bars show means with 95% confidence intervals despite unequal group sizes.



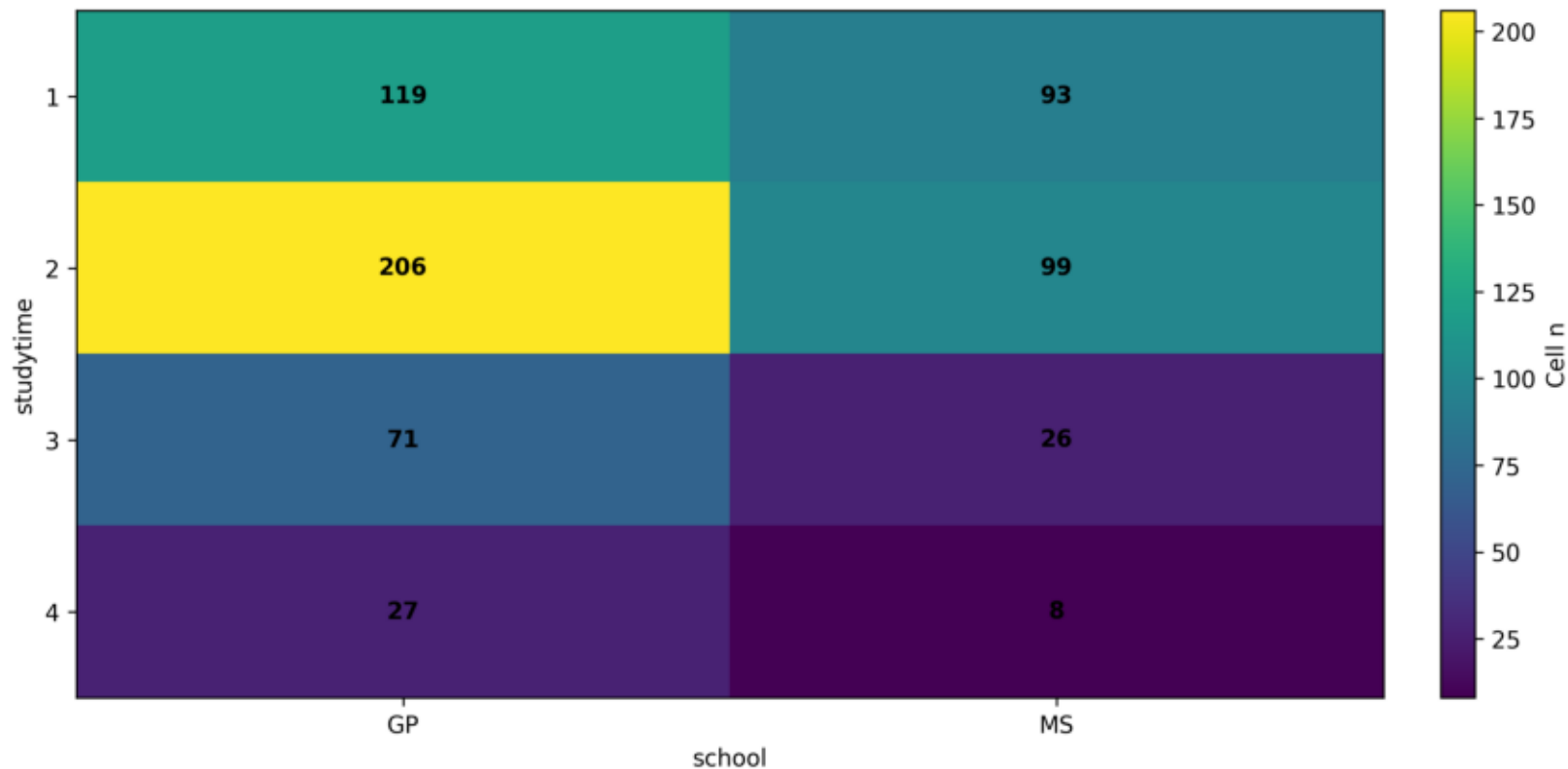
# Distribution of G3 by studytime

Boxplots show spread, median, mean marker, and possible outliers for unequal groups.



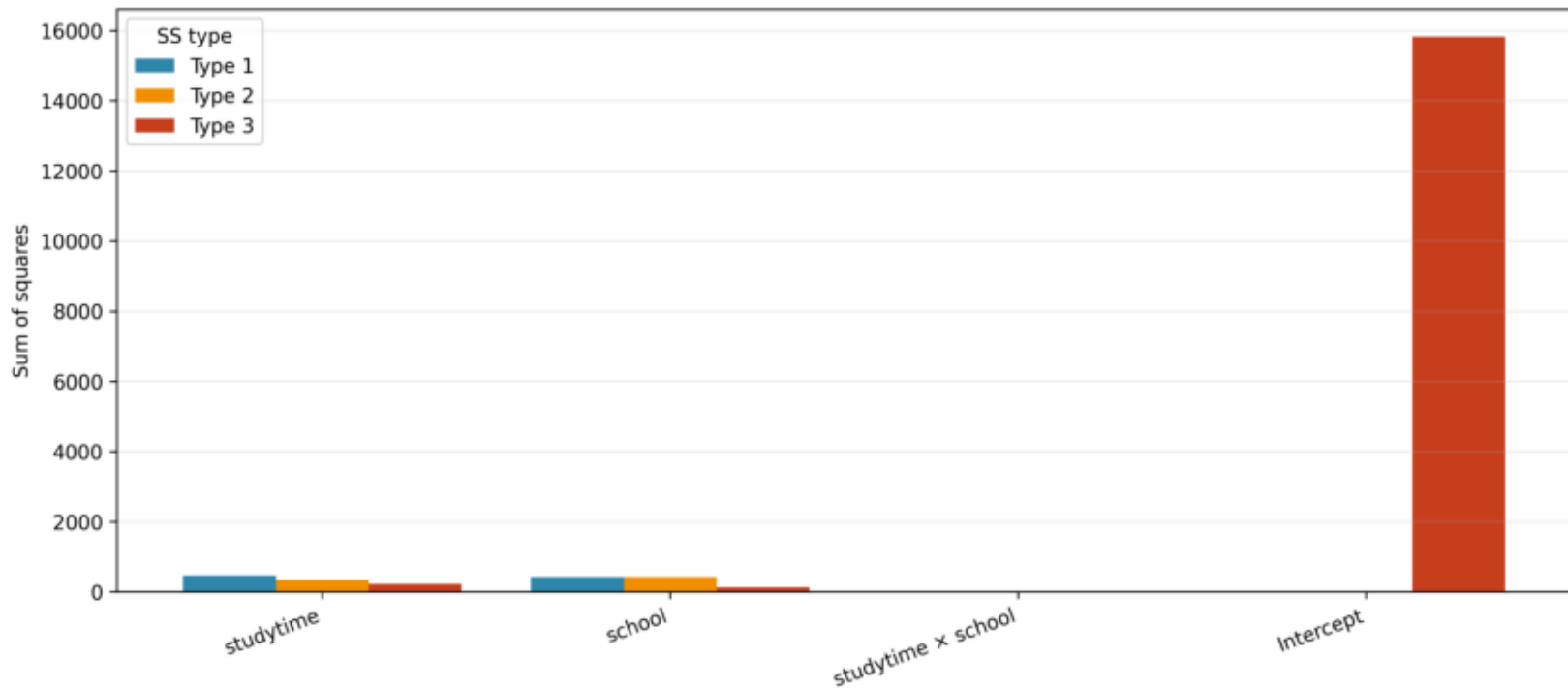
# Unbalanced ANOVA: Cell Size Heatmap

The heatmap shows which factor combinations have more or fewer observations.



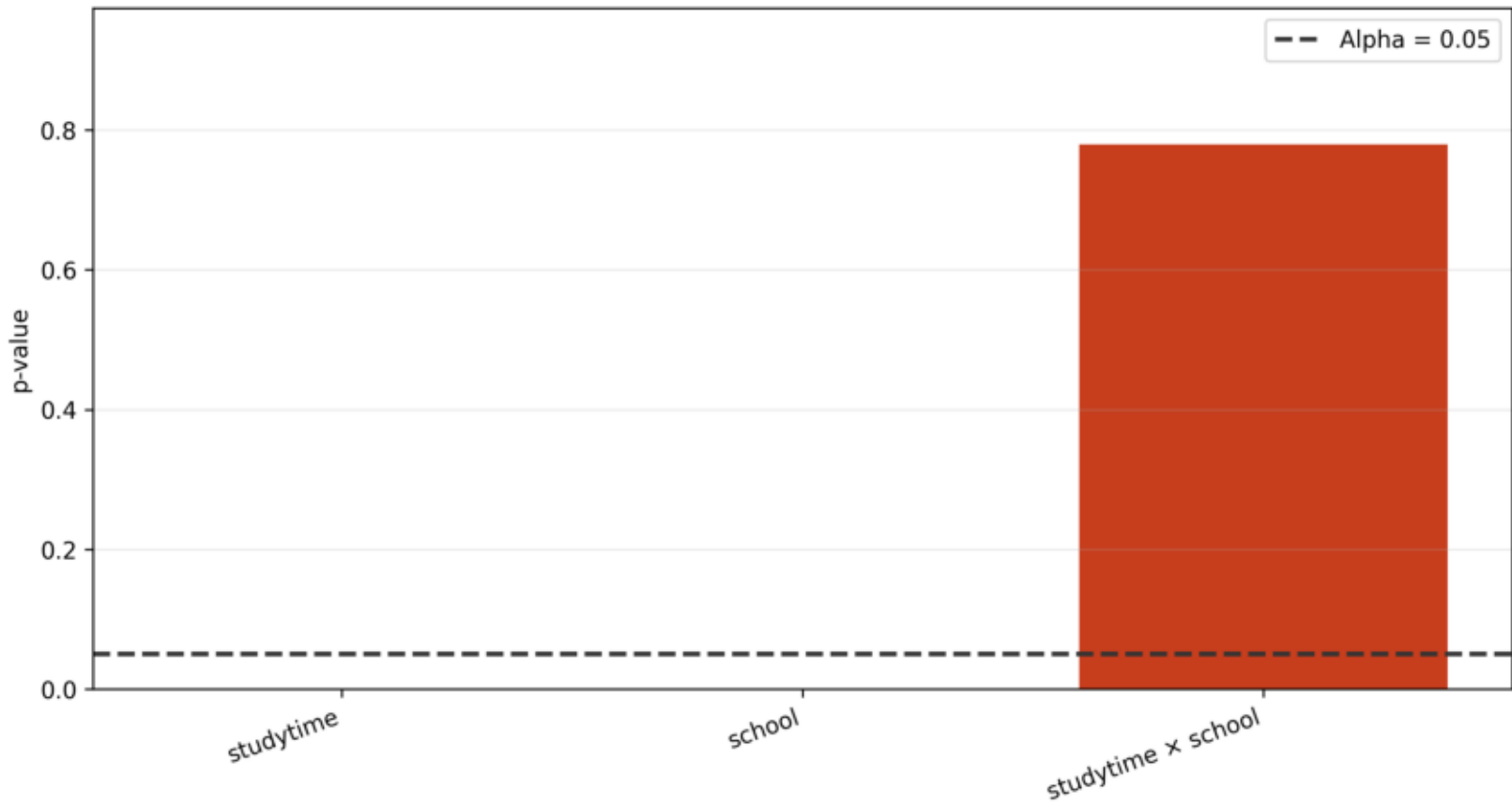
# Type I, II, and III Sum-of-Squares Comparison

Unbalanced designs can change interpretation depending on the SS type.



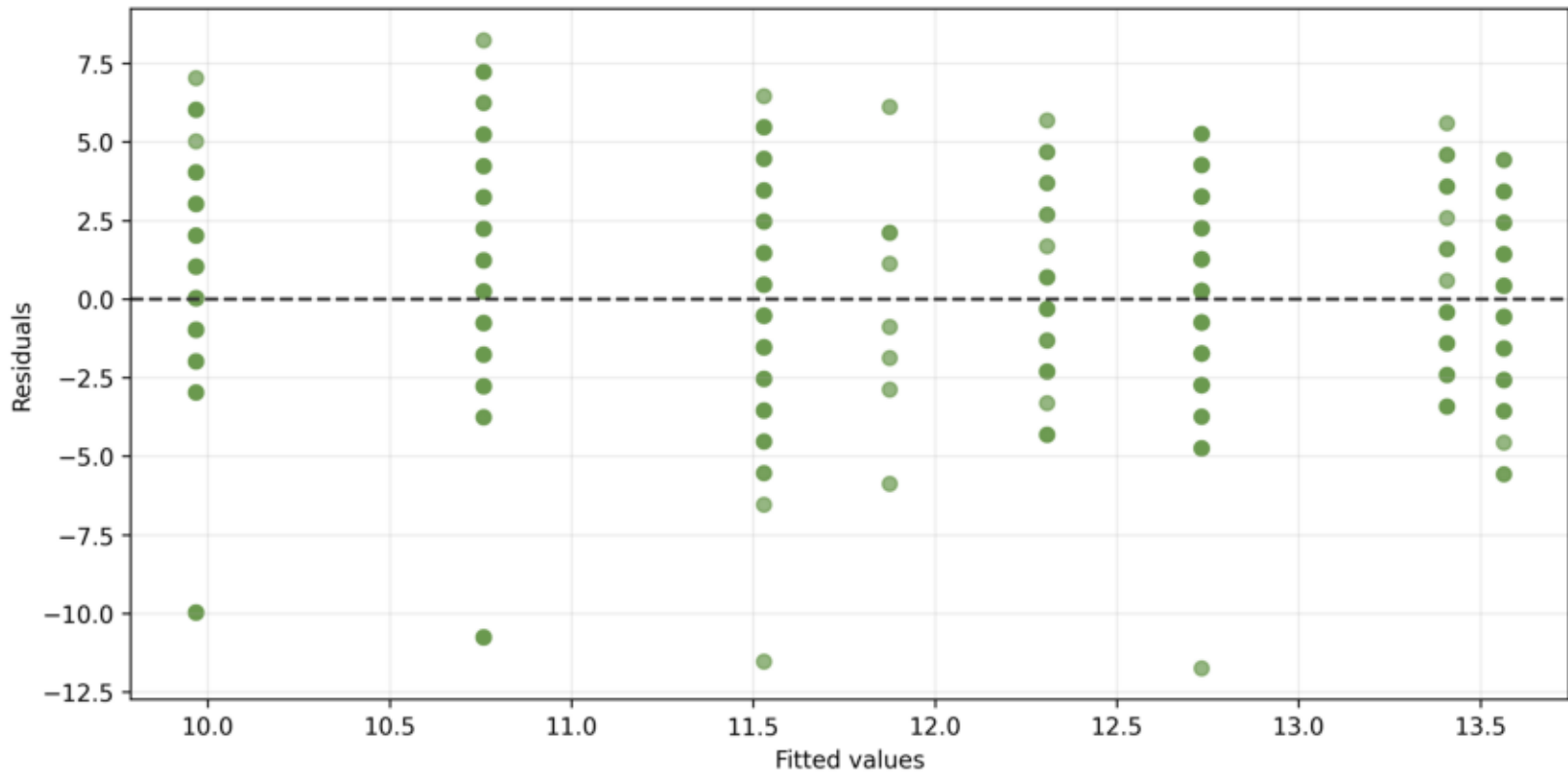
# Unbalanced ANOVA: Effect p-values

Effects below alpha are statistically significant at the selected threshold.



# Residuals vs Fitted Values

A random pattern around zero supports ANOVA model interpretation.



# Unbalanced ANOVA Result Summary

Group-size imbalance ratio max/min = 8.71.

| Effect             | df | F      | p         | Partial eta <sup>2</sup> | Label      | Decision          |
|--------------------|----|--------|-----------|--------------------------|------------|-------------------|
| studytime          | 3  | 12.43  | 6.557e-08 | 0.05498                  | Small      | Reject H0         |
| school             | 1  | 46.2   | 2.445e-11 | 0.06723                  | Medium     | Reject H0         |
| studytime x school | 3  | 0.3636 | 0.7793    | 0.001699                 | Very small | Fail to reject H0 |