One-Way ANOVA

PSYC 2020-A01 / PSYC 6022-A01 | 2025-11-21 | Lab 14

Jessica Helmer

Outline

- Assignment 13 Review
- One-Way ANOVA

Learning objectives:

R: One-Way ANOVA

Housekeeping

Our very last lab!!

I will not have office hours 11/26 (institute holiday)

- Still happy to other schedule time if anyone has any questions or concerns

Extra Credit Opportunity: If class gets to 75% completion on CIOS, I will add 2pts (20% of a lab assignment!) to everyone's grade.

Assignment 13 Review

[placeholder for Assignment 13 review]

Analysis of Variance (ANOVA)

Method of understanding how categorical variables are related to an outcome of interest

Compares *between groups* to *within groups* variance

ANOVA: Partitioning Variance

Total Sum of Squared Errors: error term around the grand mean

$$SS_{total} = \sum(x_i - \bar{x})^2$$

If we have outcomes separated into different groups (e.g., control, treatment A, treatment B), can partition SS_{total} into *between groups sums of squares* SS_B and *within groups sums of squares* SS_W

$$SS_{total} = SS_B + SS_W$$

ANOVA: Partitioning Variance

Total Sum of Squares: aggregated error around the grand mean

$$SS_{total} = \sum_{j=1}^{J} \sum_{i=1}^{I} (x_{ij} - \bar{x})^2$$

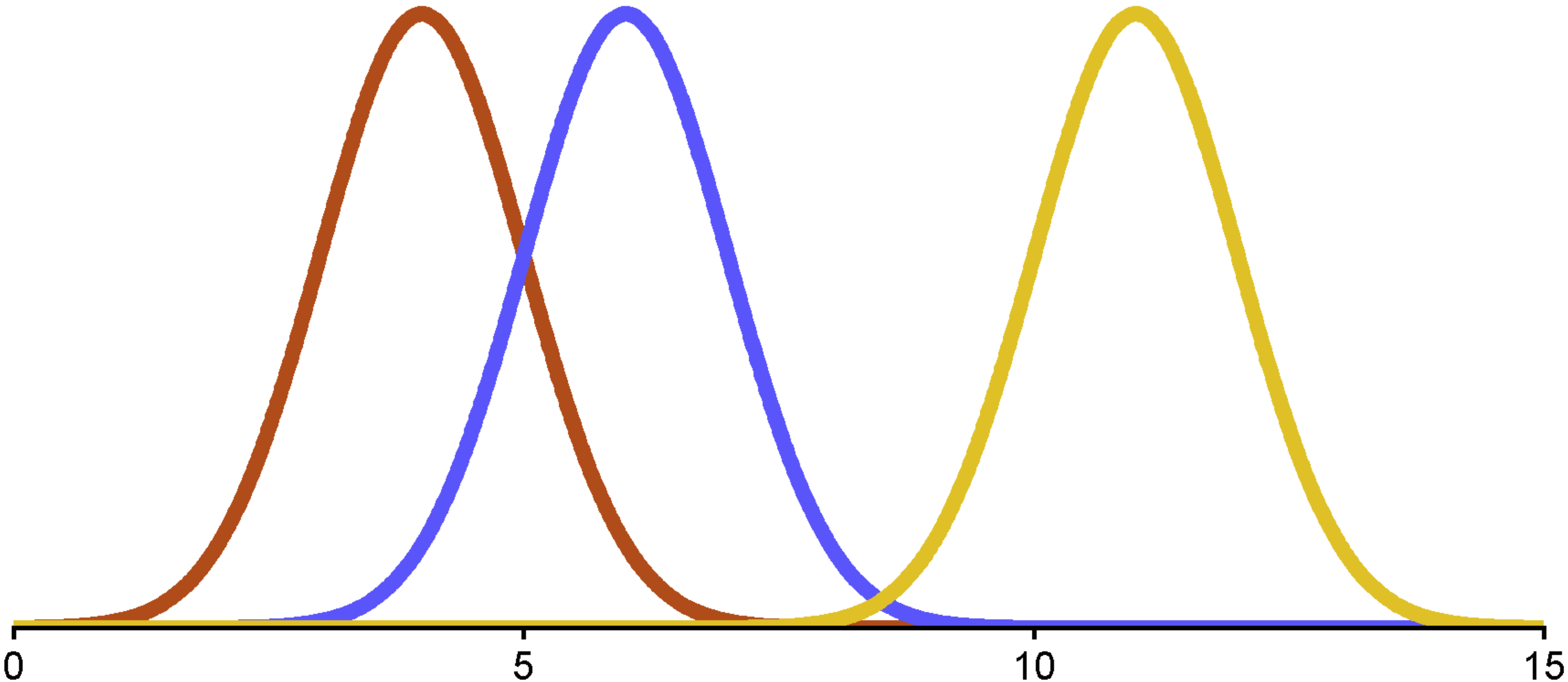
Between-Group Sum of Squares: error between the group mean and the grand mean

$$SS_B = \sum_{j=1}^{J} n_j (\bar{x_j} - \bar{x})^2$$

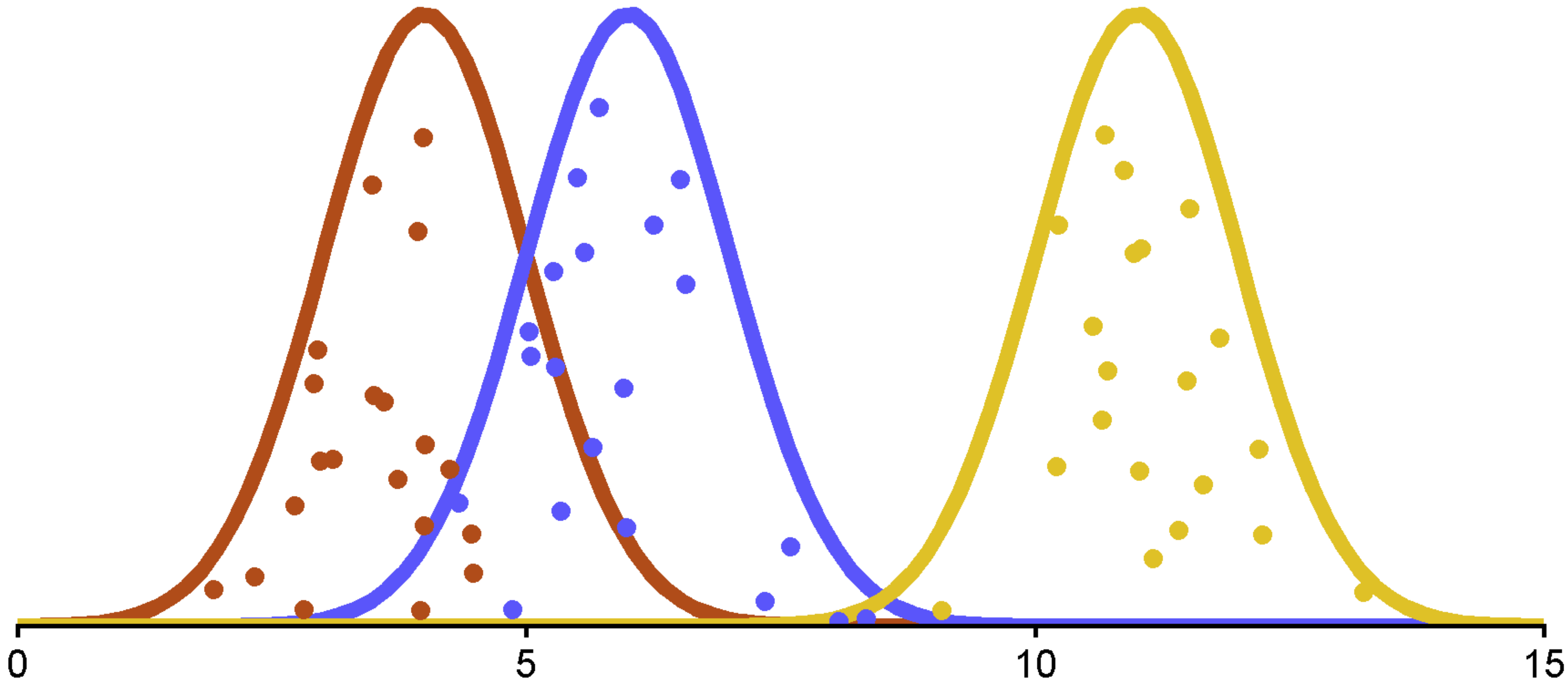
Within-Group Sum of Squares: error between observations and their group mean

$$SS_W = \sum_{j=1}^{J} \sum_{i=1}^{I} (x_{ij} - \bar{x_j})^2$$

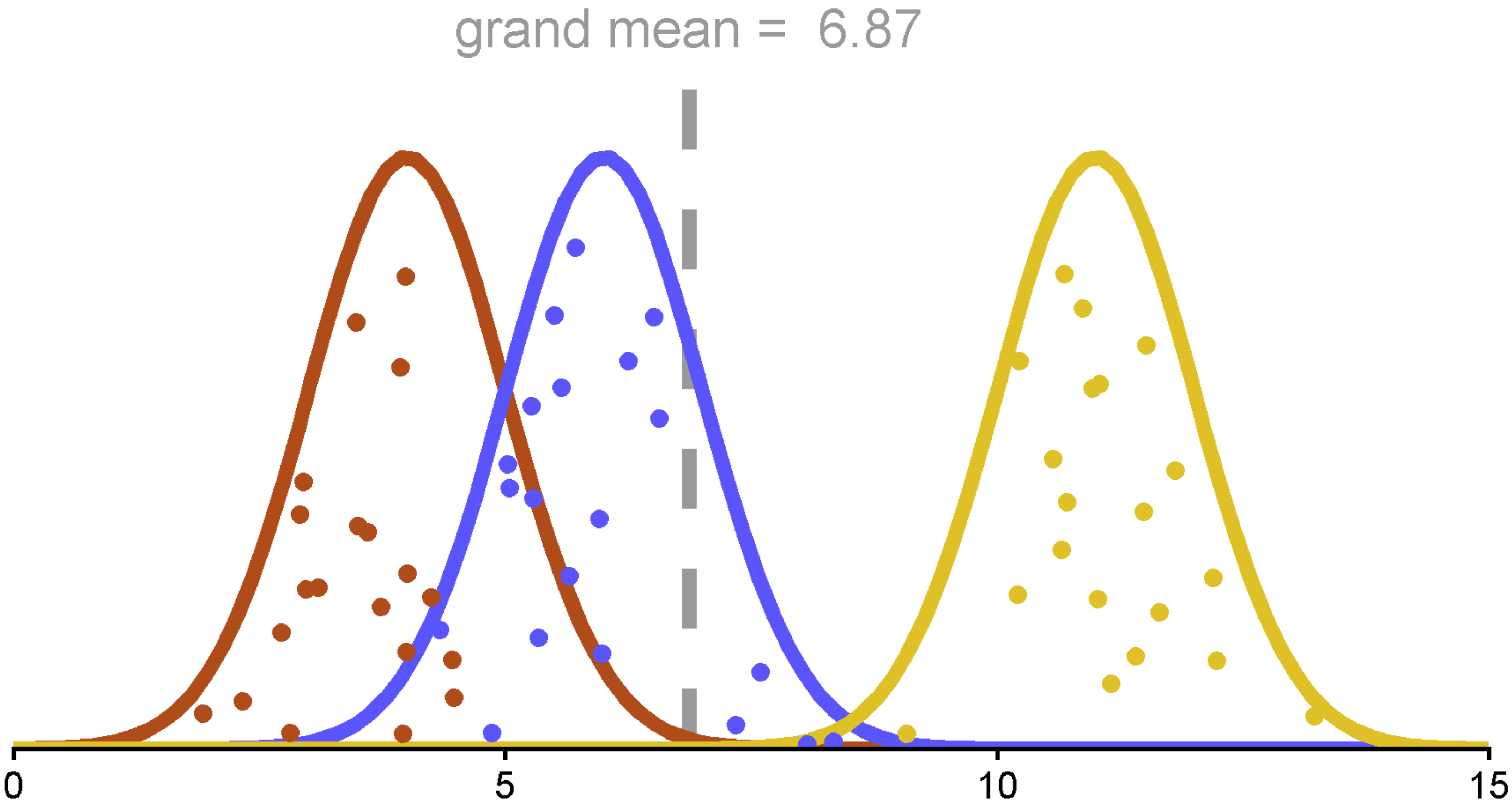
ANOVA: Partitioning Variance



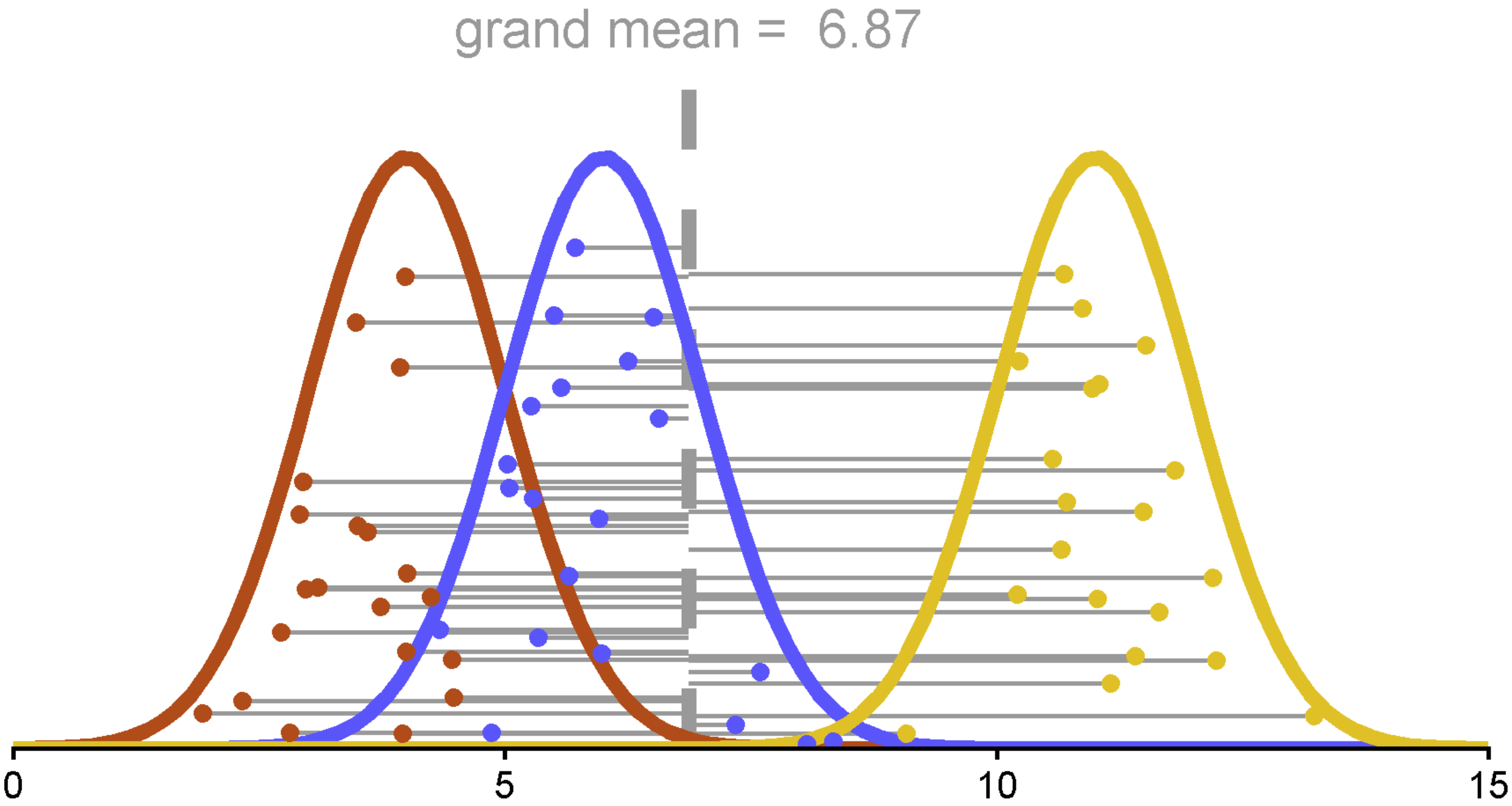
ANOVA: Partitioning Variance



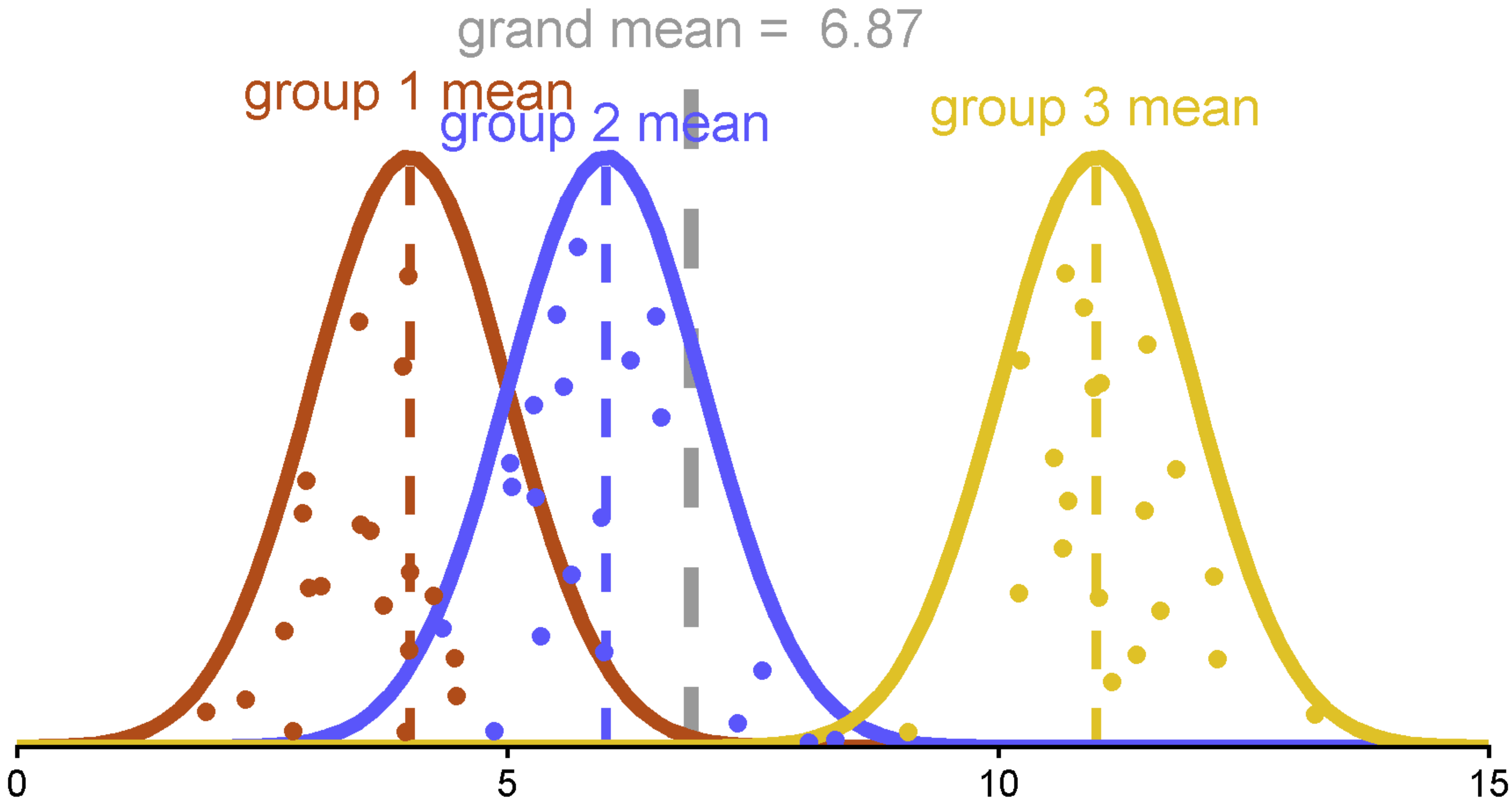
ANOVA: Partitioning Variance



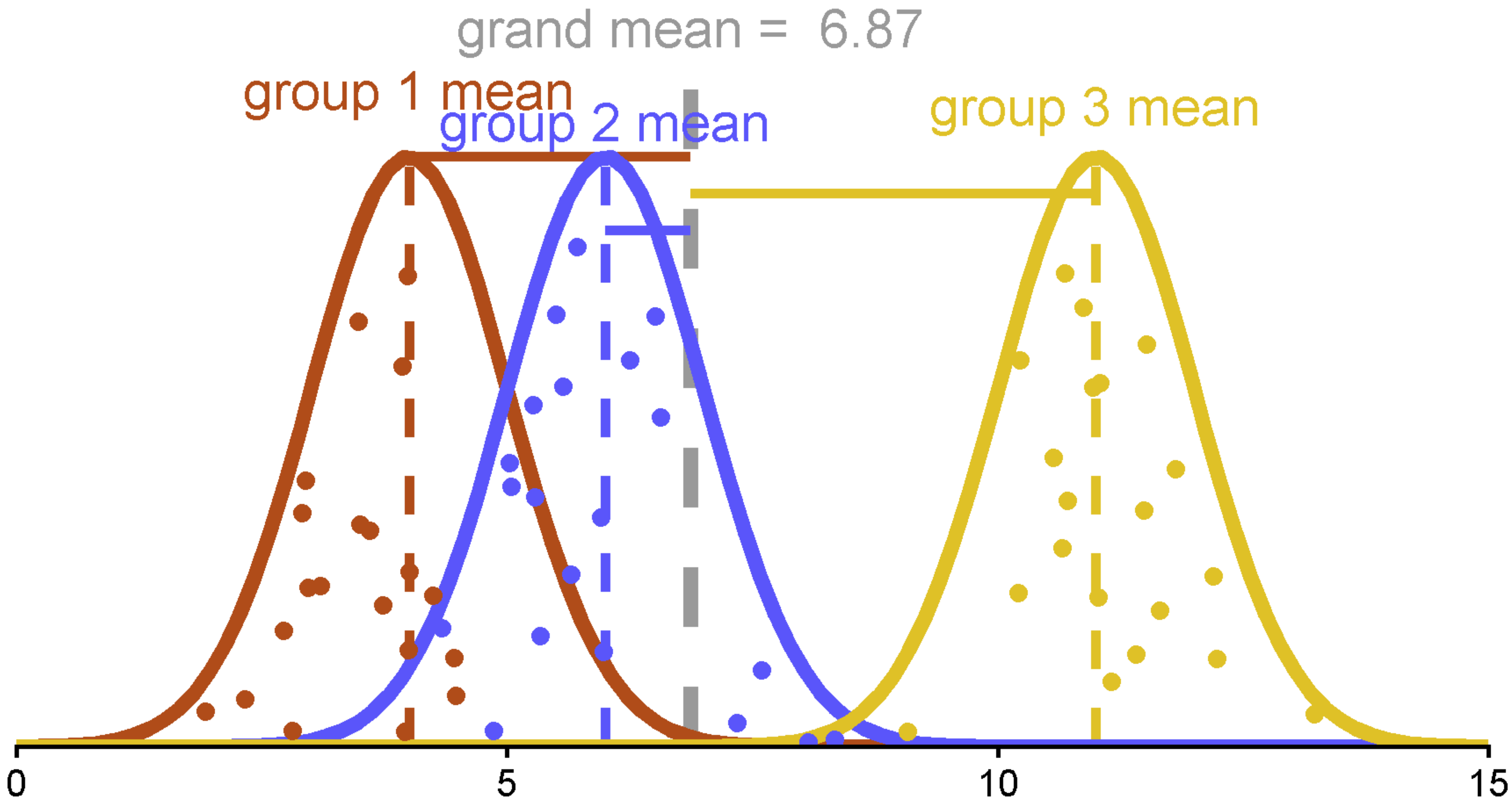
ANOVA: Partitioning Variance: SS_{error}



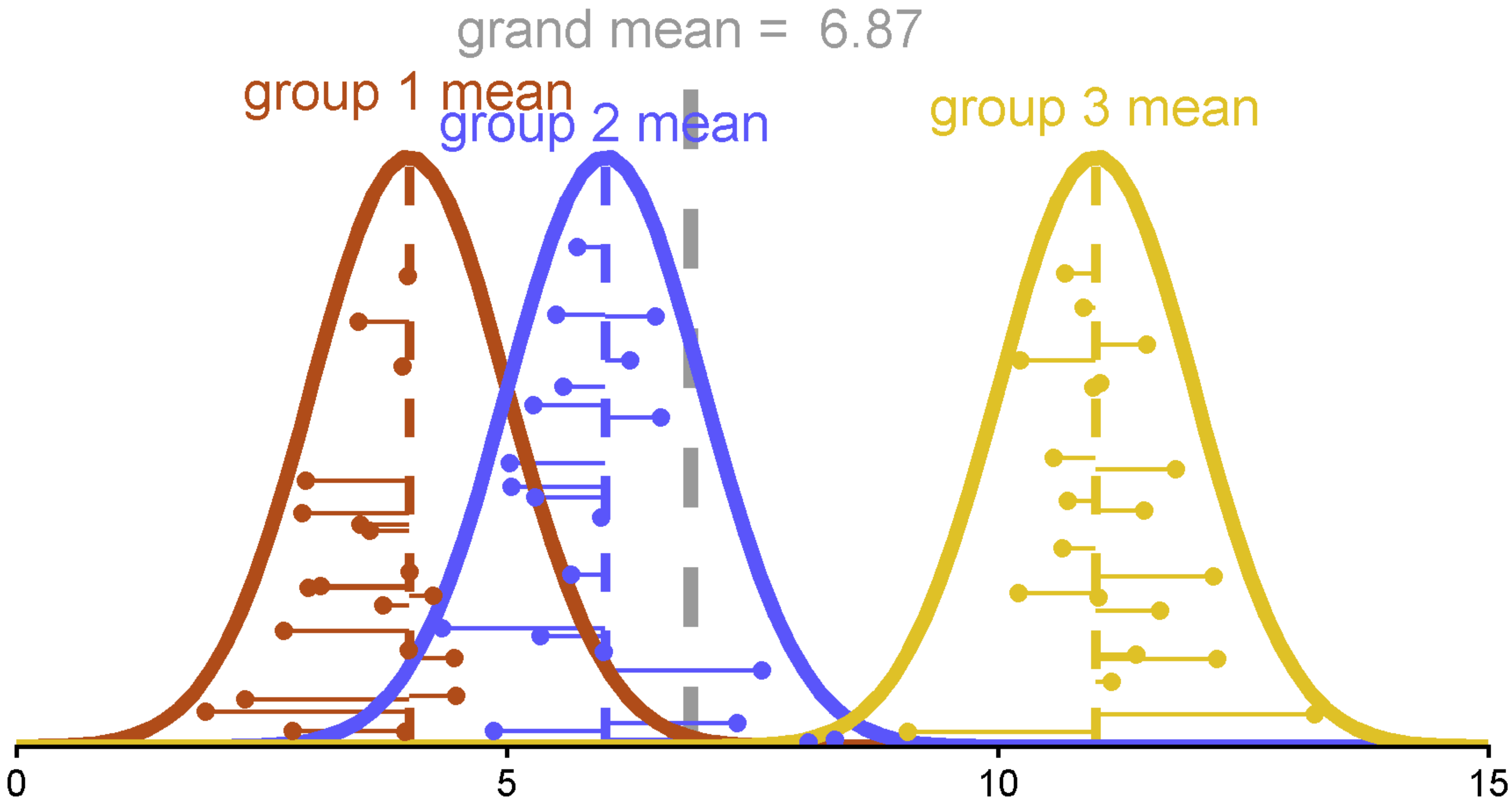
ANOVA: Partitioning Variance



ANOVA: Partitioning Variance: SS_B



ANOVA: Partitioning Variance: SS_W



ANOVA: Partitioning Variance

Ratio of SS_B to SS_W

If $SS_B >> SS_W$, good model. Easy to predict differences based on groups.

If $SS_B \approx SS_W$, less good model. Not easy to predict differences based on groups.

$$F \propto \frac{\text{between-group variance}}{\text{within-group variance}}$$

ANOVA: F

Mean Square Between

$ MS_B = = $

Mean Square Within

$ MS_W = = $

$$F = \frac{MS_B}{MS_W}$$

ANOVA: Hypotheses

$H_0\colon \sigma_B^2 = 0$

$H_1\colon \sigma_B^2 \neq 0$

Equivalent to:

$H_0\colon \mu_1 = \mu_2 = \ldots = \mu_J$

H_1: not H_0

ANOVA: R function

`aov(y ~ grouping_var, data = data)`

- `y` = outcome
- `grouping_var` = name of grouping variable
- `data` = dataframe that includes `grouping_var` and `y`

`summary(model)`

AVOVA: Example

```r
library(palmerpenguins)

summary(penguins |> select(species, flipper_length_mm))
```

```
      species    flipper_length_mm
 Adelie   :152   Min.   :172.0
 Chinstrap: 68   1st Qu.:190.0
 Gentoo   :124   Median :197.0
                 Mean   :200.9
                 3rd Qu.:213.0
                 Max.   :231.0
                 NA's   :2
```

Does flipper length vary by penguin species?

```r
flipper_model <- aov(flipper_length_mm ~ species, data = penguins)
summary(flipper_model)
```

```
             Df Sum Sq Mean Sq F value Pr(>F)
species       2  52473   26237   594.8 <2e-16 ***
Residuals   339  14953      44
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
2 observations deleted due to missingness
```

Huge F-statistic!

We reject the null in favor of the alternative that there is significant variation between penguin species in flipper length

Assignment 14