

Experimental Methods

Henry May, Ph.D.

Upcoming Seminar:
July 13-16, 2021, Remote Seminar



Experimental Methods - Part II

Impact Analyses, Treatment Contrast, and Power



Henry May, Ph.D.
Statistical Horizons

Statistical Analyses for Single-Level Designs

Impact Analysis Options

- ▶ ANOVA
- ▶ ANCOVA
- ▶ Linear Regression
- ▶ Generalized Linear Models (e.g., Logistic Regression)



RCT Analysis – One-Way ANOVA

- ▶ A one-way Analysis of Variance is used to test for differences between J groups on I factor.
- ▶ The symbolic model for a one-way ANOVA is:

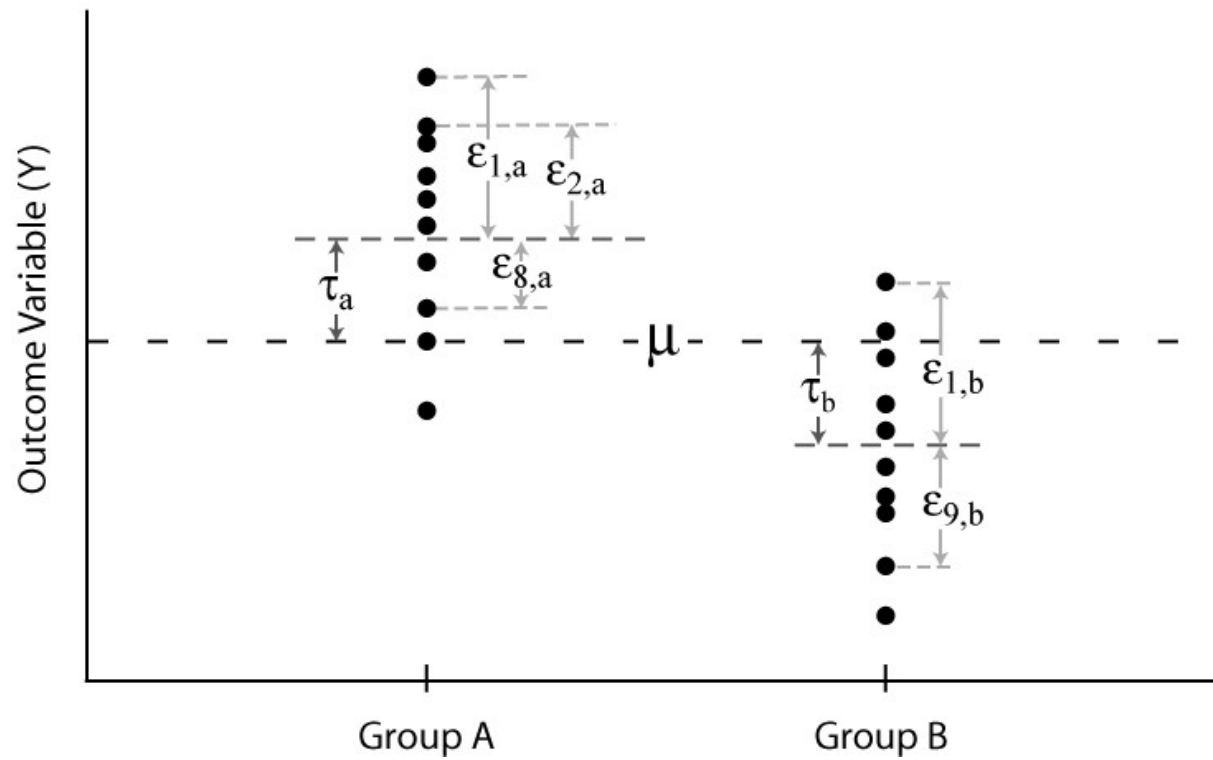
$$Y_{ij} = \mu + \tau_j + \varepsilon_{ij}$$

1. where the outcome Y for observation i in group j is equal to
2. the grand mean μ
3. plus an effect τ associated with being in group j
4. plus some error ε specific to observation i in group j

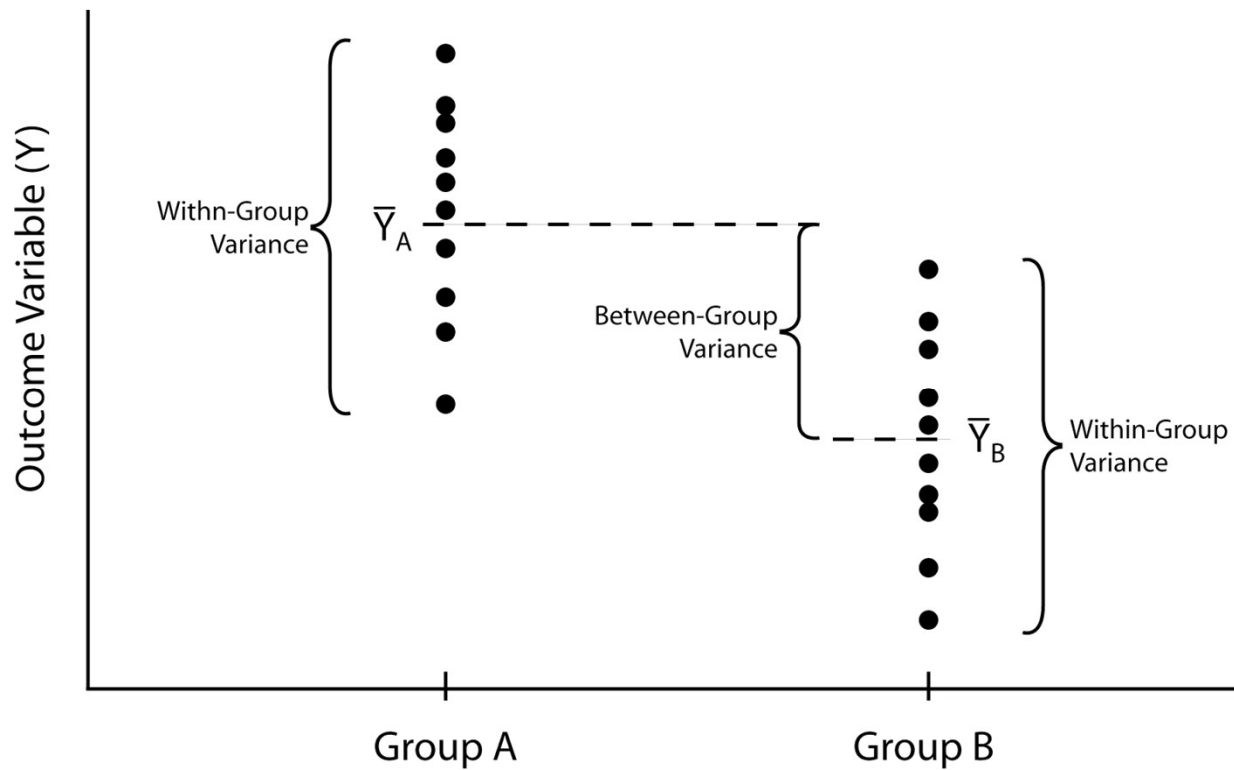
The ε_{ij} are assumed to be independent and identically distributed (iid) as $N(0, \sigma^2)$



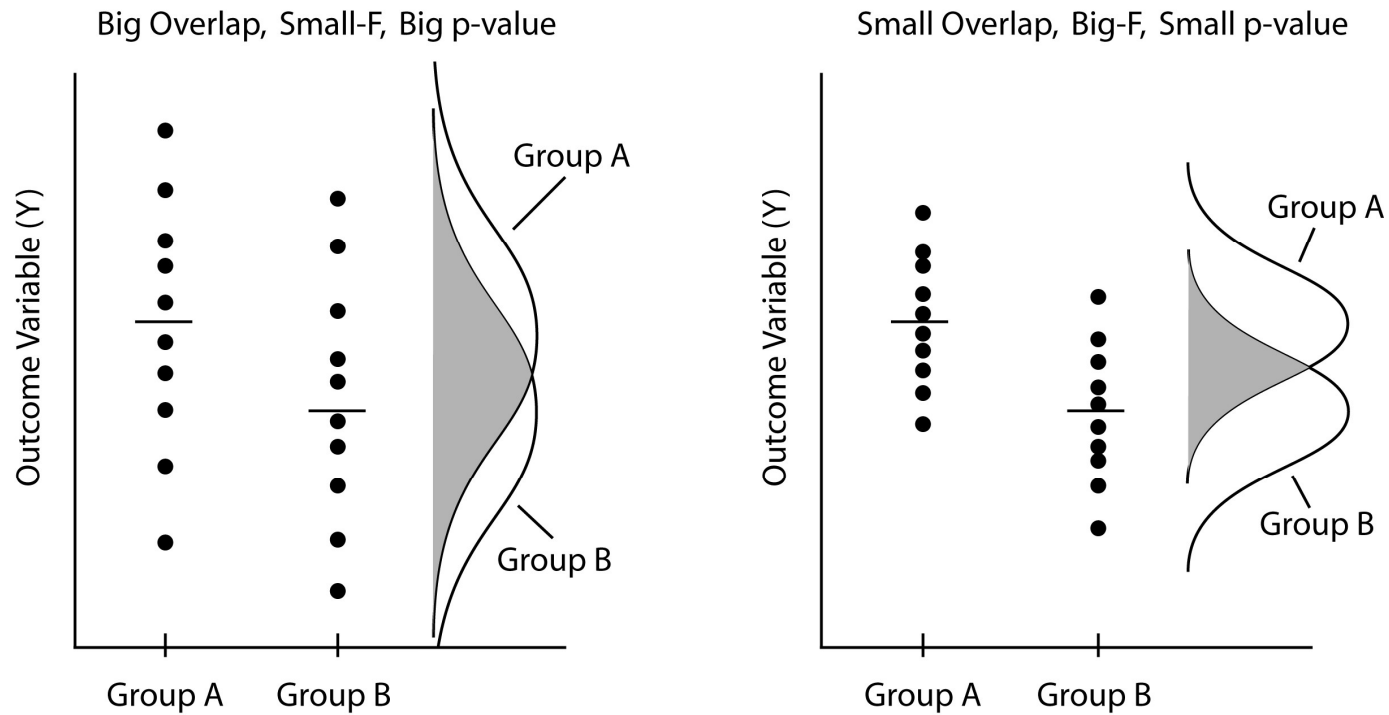
RCT Analysis – One-Way ANOVA



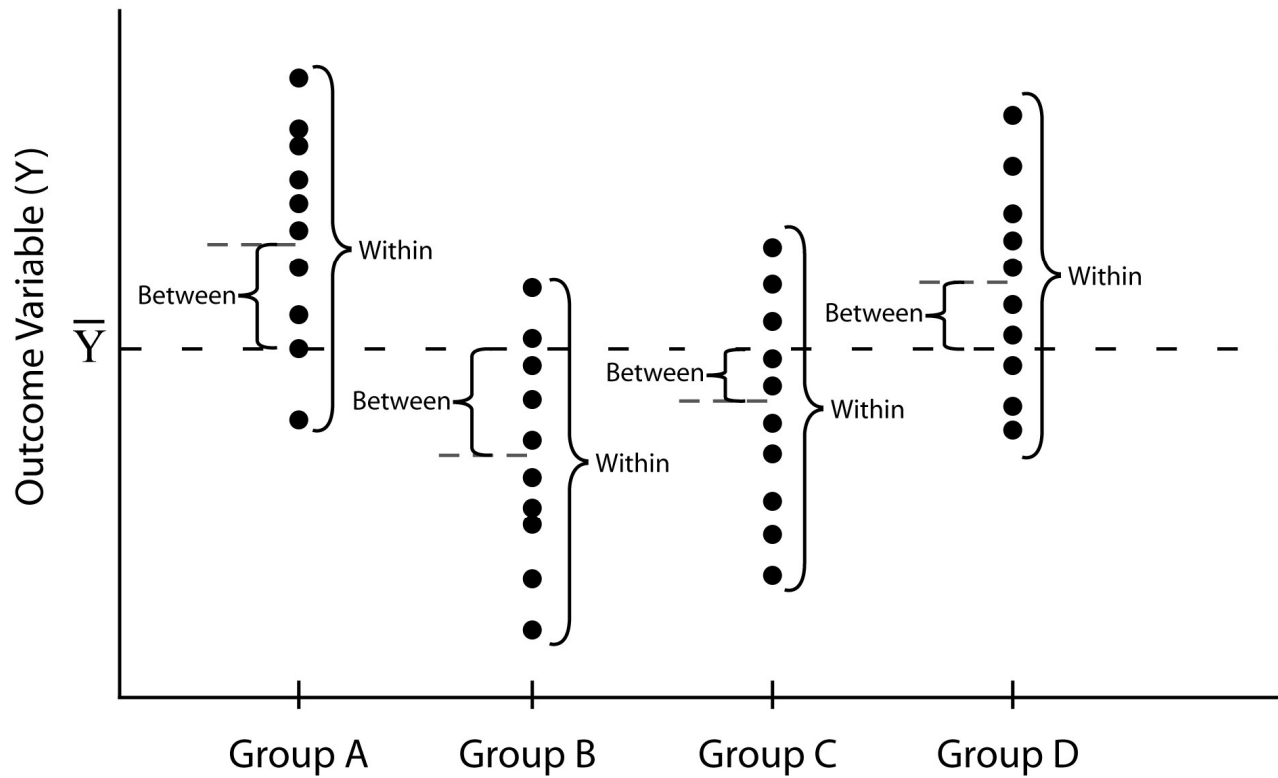
RCT Analysis – One-Way ANOVA



RCT Analysis – One-Way ANOVA



RCT Analysis – One-Way ANOVA



RCT Analysis – One-Way ANCOVA

- ▶ A one-way analysis of covariance is used to test for differences between J groups on I factor, after controlling for a continuous covariate (e.g., pretest score).
- ▶ The symbolic model for a one-way ANCOVA is:

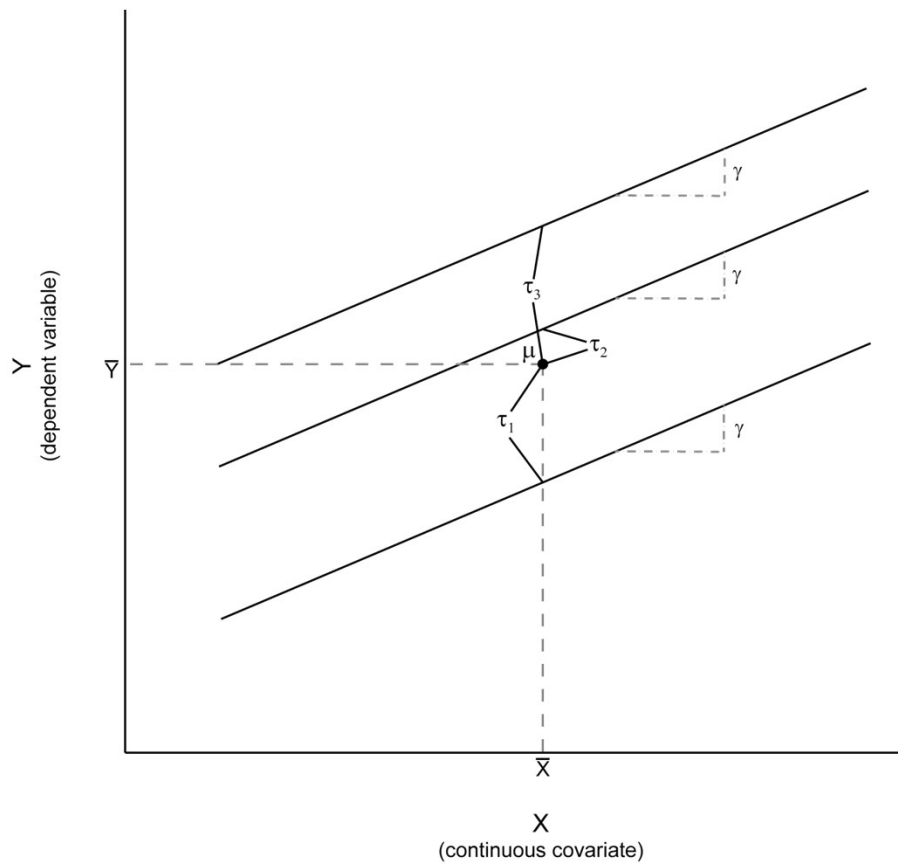
$$Y_{ij} = \mu + \tau_j + \gamma(X_{ij} - \bar{X}) + \varepsilon_{ij}$$

1. where the outcome Y for observation i in group j is equal to
2. the grand mean μ
3. plus an effect τ associated with being in group j
4. plus a regression slope γ multiplied by observation i 's deviation from the mean on the covariate X
5. plus some error ε specific to observation i in group j

The ε_{ij} are assumed to be independent and identically distributed (iid) as $N(0, \sigma^2)$, and γ is assumed to be the same for all groups.

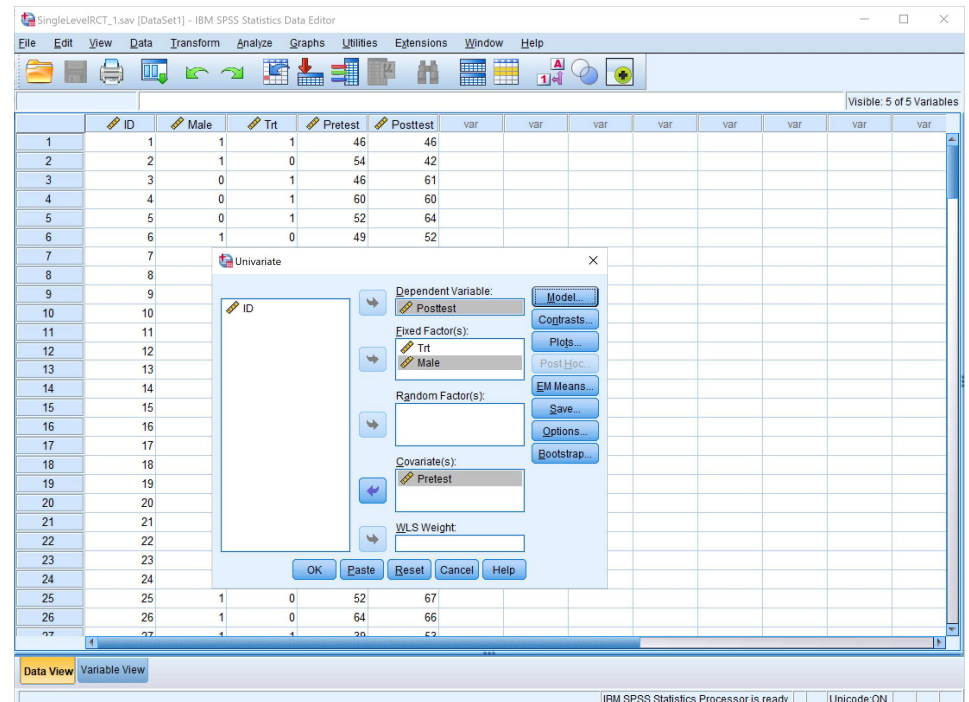


RCT Analysis – One-Way ANCOVA



ANOVA / ANCOVA in SPSS

1. Analyze → General Linear Model → Univariate
2. Select posttest outcome as dependent variable.
3. Select treatment indicator as fixed factor.
4. Include any blocking variables as fixed factors.
5. Include any pretest measures as covariates.
6. Use the “Model” button to include only main effects (and interactions, if planned).
7. Use “EM Means” button to request means for TRT/CTRL groups.



ANOVA / ANCOVA in SPSS

Tests of Between-Subjects Effects

Dependent Variable: Posttest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10102.56 ^a	3	3367.521	57.485	.000
Intercept	2634.861	1	2634.861	44.978	.000
Male	57.574	1	57.574	.983	.323
Trt	721.169	1	721.169	12.311	.001
Pretest	7732.428	1	7732.428	131.996	.000
Error	11481.832	196	58.581		
Total	561241.00	200			
Corrected Total	21584.395	199			

a. R Squared = .468 (Adjusted R Squared = .460)

Estimated Marginal Means

2. Trt

Dependent Variable: Posttest

Trt	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
0	49.985 ^a	1.086	47.844	52.126
1	54.664 ^a	.768	53.150	56.179

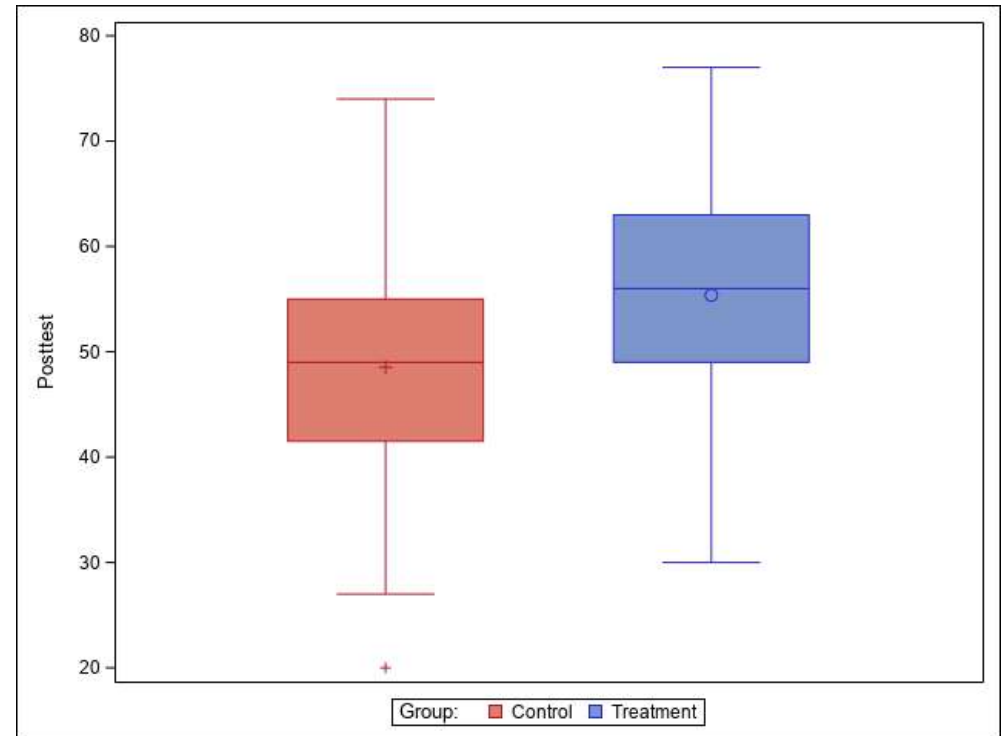
a. Covariates appearing in the model are evaluated at the following values: Pretest = 49.92.



ANOVA / ANCOVA in SAS

```
proc glm data=SingleLevelRCT_1;
  class Male(ref='0') Trt(ref='0');
  model Posttest = Pretest Male Trt;
  lsmeans Trt / stderr cl;
run;

proc format;
  value condition 0='Control'
                1='Treatment';
proc sgplot data=SingleLevelRCT_1;
  vbox Posttest / group=Trt
                grouporder=ascending;
  format Trt condition.;
run;
```



ANOVA / ANCOVA in SAS

The GLM Procedure


Dependent Variable: Posttest

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	10102.56313	3367.52104	57.49	<.0001
Error	196	11481.83187	58.58077		
Corrected Total	199	21584.39500			

R-Square	Coeff Var	Root MSE	Posttest Mean
0.468049	14.73445	7.653808	51.94500

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Pretest	1	7732.428127	7732.428127	132.00	<.0001
Male	1	57.573948	57.573948	0.98	0.3227
Trt	1	721.169113	721.169113	12.31	0.0006

Trt	Posttest LSMEAN	95% Confidence Limits	
1	54.664354	53.150062	56.178645
0	49.984777	47.843560	52.125994



ANOVA / ANCOVA in R

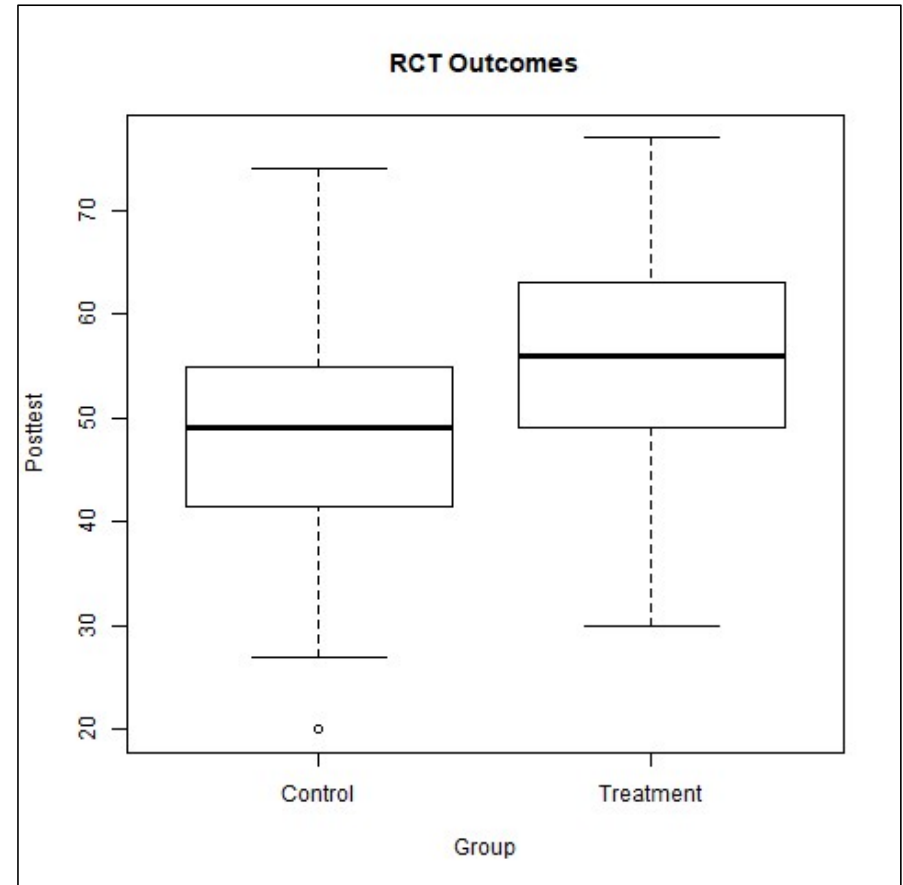
```
library(car)
library(ggplot2)
library(psych)
library(lsmmeans)
```

```
SingleLevelRCT_I <- read.csv("SingleLevelRCT_I.csv")
```

```
Anova(aov(Posttest ~ Pretest + Male + Trt,
SingleLevelRCT_I), type=3);
```

```
lsmmeans(aov(Posttest ~ Pretest + Male + Trt,
SingleLevelRCT_I), "Trt")
```

```
boxplot(Posttest ~ Trt, data = SingleLevelRCT_I,
xlab = "Group", ylab = "Posttest", main = "RCT Outcomes",
names=c("Control", "Treatment"))
```



ANOVA / ANCOVA in R

```
> Anova(aov(Posttest ~ Pretest + Male + Trt, SingleLevelRCT_1), type=3);  
Anova Table (Type III tests)
```

```
Response: Posttest
```

	Sum Sq	Df	F value	Pr(>F)	
(Intercept)	1810.9	1	30.9134	8.749e-08	***
Pretest	7732.4	1	131.9960	< 2.2e-16	***
Male	57.6	1	0.9828	0.3227276	
Trt	721.2	1	12.3107	0.0005586	***
Residuals	11481.8	196			

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
> lsmeans(aov(Posttest ~ Pretest + Male + Trt, SingleLevelRCT_1), "Trt")
```

Trt	lsmean	SE	df	lower.CL	upper.CL
0	50.0	1.086	196	47.8	52.1
1	54.7	0.768	196	53.2	56.2

```
Results are averaged over the levels of: Male
```

```
Confidence level used: 0.95
```

