

$$\text{Var}(Y) = 607.5$$

$$\text{SD}(Y) = 24.65$$

Generalized least squares fit by REML

```
summary(model0 <- gls(Taps ~ 1))
```

Coefficients:

	Value	Std.Error	t-value	p-value
(Intercept)	474	7.115	66.62	0

Residual standard error: 24.65

$$y_i = \beta + e_i$$

$$\bar{y} \quad \text{SE}(\bar{y}) = s/\sqrt{n} = 24.65/\sqrt{12} = 7.115$$

```
summary(modelA <- gls(Taps ~ StimulantF))
```

Coefficients:

	Value	Std.Error	t-value	p-value
(Intercept)	474	7.335	64.63	0.0000
StimulantF1	5	10.373	0.48	0.6413
StimulantF2	-12	10.373	-1.16	0.2771

Residual standard error: 25.41

$$\hat{\beta}_0 = \bar{y} \quad \text{se}(\hat{\beta}_0) = \frac{s}{\sqrt{n}} = \frac{25.41}{\sqrt{12}} = 7.335$$

```
summary(modelB <- gls(Taps ~ participantF))
```

Generalized least squares fit by REML

Coefficients:

	Value	Std.Error	t-value	p-value
(Intercept)	474	3.541	133.84	0.0000
participantF1	-17	6.134	-2.77	0.0242
participantF2	-15	6.134	-2.45	0.0402
participantF3	-4	6.134	-0.65	0.5326

Residual standard error: 12.27

$$\hat{\beta}_0 = \bar{y}$$

$$\hat{\beta}_1 = \beta_1 \text{ is below avg}$$

```
modelC <- lm(Taps ~ StimulantF + participantF, data = fingertapstudy)
```

Coefficients:

	Value	Std.Error	t-value	p-value
(Intercept)	474	2.147350	220.73721	0.0000
StimulantF1	5	3.036811	1.64646	0.1508
StimulantF2	-12	3.036811	-3.95151	0.0075
participantF1	-17	3.719319	-4.57073	0.0038
participantF2	-15	3.719319	-4.03300	0.0069
participantF3	-4	3.719319	-1.07547	0.3235

Residual standard error: 7.438638

5, -12 have not changed from model A because balanced design

but SEs ↓

$$7.4386/\sqrt{12} = 2.147$$

ANOVA table

	SS
treatment	
participant	
error	
total	

SS Total

conditional on participants

with block

```
modelD <- nlme::gls(Taps ~ 1,
  corr = corCompSymm(form = ~1 | participantF))
```

Correlation Structure: Compound symmetry

Formula: ~1 | participantF

Parameter estimate(s):

Rho

0.7877

Coefficients:

	Value	Std.Error	t-value	p-value
(Intercept)	474	12.34	38.43	0

Residual standard error: 26.63

```
modelE <- nlme::glg(Taps ~ 1 + StimulantF + participantF,
  corr = corCompSymm(form = ~1 | participantF))
```

Correlation Structure: Compound symmetry

Formula: ~1 | participantF

Parameter estimate(s): Rho 0

Coefficients:

	Value	Std.Error	t-value	p-value
(Intercept)	474	2.147	220.74	0.0000
StimulantF1	5	3.037	1.65	0.1508
StimulantF2	-12	3.037	-3.95	0.0075
participantF1	-17	3.719	-4.57	0.0038
participantF2	-15	3.719	-4.03	0.0069
participantF3	-4	3.719	-1.08	0.3235

Residual standard error: 7.439

```
modelF <- nlme::glg(Taps ~ 1 + StimulantF ,
  corr = corCompSymm(form = ~1 | participantF))
```

Correlation Structure: Compound symmetry

Formula: ~1 | participantF

Parameter estimate(s):

Rho

0.9143

Coefficients:

	Value	Std.Error	t-value	p-value
(Intercept)	474	12.336	38.43	0.0000
StimulantF1	5	3.037	1.65	0.1341
StimulantF2	-12	3.037	-3.95	0.0033

Residual standard error: 25.41

$$\hat{\rho} = ICC = 0.7877$$

$$12.34 = \frac{S}{\sqrt{N}} \sqrt{1 + (n-1)\hat{\rho}}$$

$$12.34 = \frac{26.63}{\sqrt{12}} \sqrt{1 + 2(0.7877)}$$

$$\hat{\sigma} = 474 = \bar{y}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

better $SE(\bar{y})$

$$S^2 = \hat{\sigma}^2$$

$$\begin{bmatrix} 709 & 358.5 \\ 358.5 & 209 \end{bmatrix}$$

$$\text{Cov}(Y_{11}, Y_{31})$$

$$= \text{Cov}(Y_{11}, Y_{21})$$

$$\frac{\text{Cov}(Y_{11}, Y_{21})}{SD(Y_{11}) SD(Y_{21})}$$

$$\text{Cor}(Y_{11}, Y_{21}) = \frac{358.5}{SD(Y_{11}) SD(Y_{21})}$$

$$\frac{358.5}{(26.63)(26.63)} \leftarrow 709$$

$$= .787 = \hat{\rho}$$