

## Analysis of Covariance (ANCOVA)

PSY 5102: Advanced Statistics for  
Psychological and Behavioral Research 2

---

---

---

---

---

---

---

---

### Goals

- ◉ When and Why do we use ANCOVA?
- ◉ Partitioning Variance
- ◉ Carrying out in SPSS
- ◉ Interpretation
  - Main Effects
  - Covariates

---

---

---

---

---

---

---

---

### When And Why Do We Use ANCOVA?

- ◉ To test for differences between group means when we know that an extraneous variable may have an impact on the outcome variable
- ◉ Used to control known extraneous variables

---

---

---

---

---

---

---

---

## Advantages of ANCOVA

- Reduces Error Variance
  - The error variance in the model can be reduced by explaining some of the unexplained variance
- Greater Experimental Control
  - By controlling known extraneous variables, we gain greater insight into the influence of the predictor variable(s)

---

---

---

---

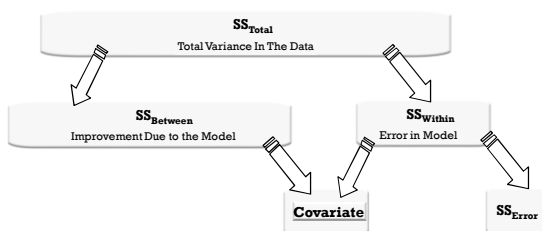
---

---

---

---

## Partitioning of Variance




---

---

---

---

---

---

---

---

## An Example

- Imagine that researchers wanted to test a new sexual stimulant drug called Viagra-2
- Three groups of men were given various doses of the drug and asked to report their sexual desire
  - There are several possible extraneous variables such as the sexual desire of their partners
- We can conduct the same study but measure the libido of their partners over the same time period following the dose of Viagra-2
  - DV = Participant's libido
  - IV = Dose of Viagra (Placebo, Low Dose, & High Dose)
  - Covariate = Partner's libido

---

---

---

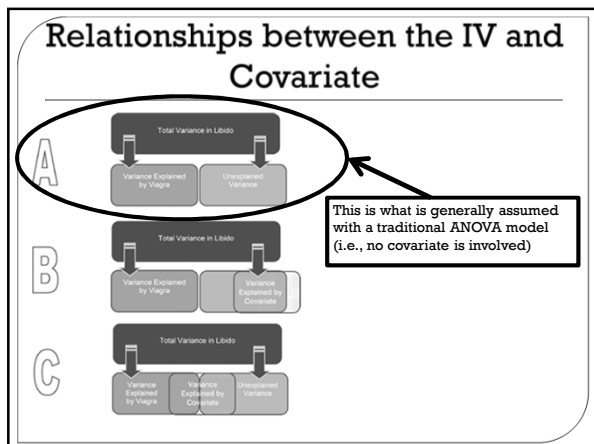
---

---

---

---

---




---

---

---

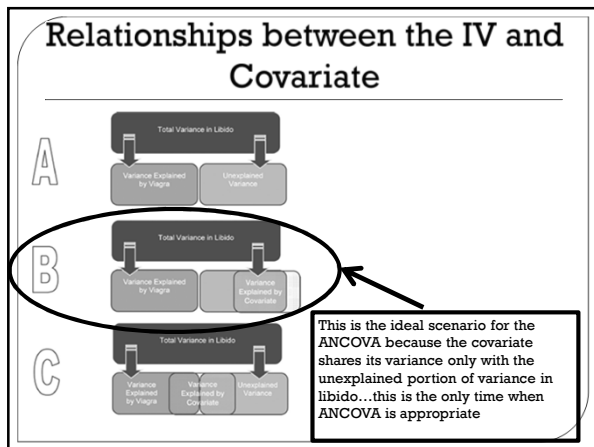
---

---

---

---

---




---

---

---

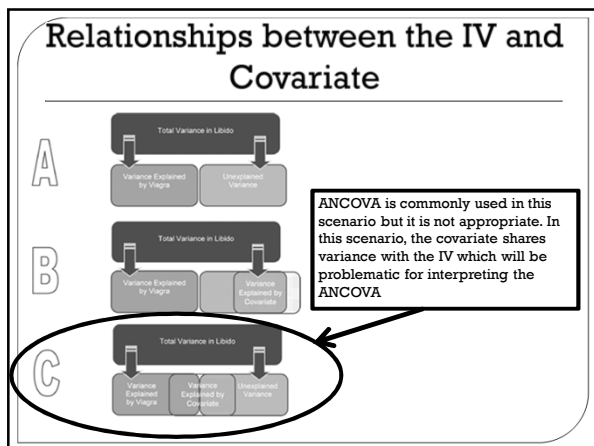
---

---

---

---

---




---

---

---

---

---

---

---

---

Dose	Participant's Libido	Partner's Libido
Placebo	3	4
	2	1
	5	5
	2	1
	2	2
	7	7
	2	4
	4	5
Low Dose	7	5
	5	3
	3	1
	4	2
	4	2
	7	6
High Dose	5	4
	4	2
	9	1
	2	3
	6	5
	3	4
	4	3
	4	3
	4	2
	6	0
4	1	
6	3	
2	0	
8	1	
5	0	

Dose	Participant's Libido	Partner's Libido
Placebo	3.22 (1.79)	3.44 (2.07)
Low Dose	4.88 (1.46)	3.12 (1.73)
High Dose	4.85 (2.12)	2.00 (1.63)

---

---

---

---

---

---

---

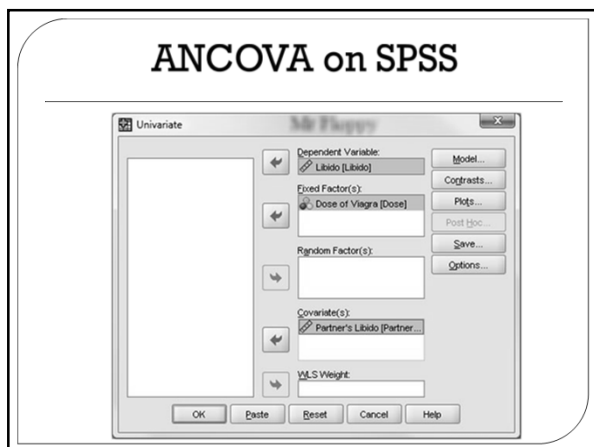
---

---

---

---

---




---

---

---

---

---

---

---

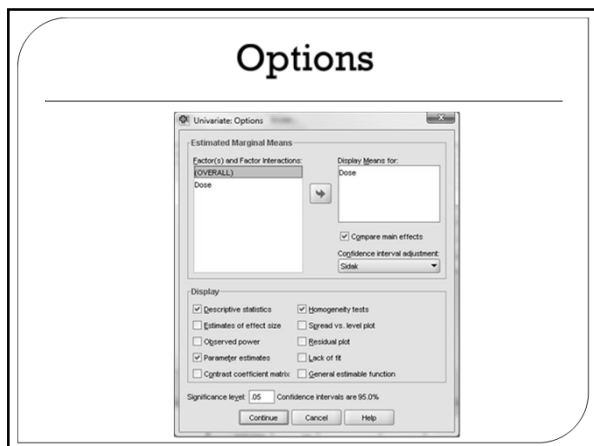
---

---

---

---

---




---

---

---

---

---

---

---

---

---

---

---

---

## Results Without the Covariate

Tests of Between-Subjects Effects

Dependent Variable: Libido

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	16.844 <sup>a</sup>	2	8.422	2.416	.108
Intercept	535.184	1	535.184	153.522	.000
DOSE	16.844	2	8.422	2.416	.108
Error	94.123	27	3.486		
Total	683.000	30			
Corrected Total	110.967	29			

a. R Squared = .152 (Adjusted R Squared = .089)

Without the partner's libido as a covariate, the dose of Viagra-2 does not have a significant effect on the sexual desire of the participants

---

---

---

---

---

---

---

---

---

---

---

---

## Output

Levene's Test of Equality of Error Variances

Dependent Variable: Libido

F	df1	df2	Sig.
5.525	2	27	.010

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.  
a. Design: Intercept-PARTNER-DOSE

Tests of Between-Subjects Effects

Dependent Variable: Libido

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	34.750 <sup>a</sup>	3	11.583	3.952	.019
Intercept	12.171	1	12.171	4.152	.052
PARTNER	17.906	1	17.906	6.109	.020
DOSE	28.337	2	14.169	4.833	.016
Error	76.216	26	2.931		
Total	683.000	30			
Corrected Total	110.967	29			

a. R Squared = .313 (Adjusted R Squared = .234)

---

---

---

---

---

---

---

---

---

---

---

---

## Output

Levene's Test of Equality of Error Variances

Dependent Variable: Libido

F	df1	df2	Sig.
5.525	2	27	.010

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.  
a. Design: Intercept-PARTNER-DOSE

Tests of Between-Subjects Effects

Dependent Variable: Libido

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	34.750 <sup>a</sup>	3	11.583	3.952	.019
Intercept	12.171	1	12.171	4.152	.052
PARTNER	17.906	1	17.906	6.109	.020
DOSE	28.337	2	14.169	4.833	.016
Error	76.216	26	2.931		
Total	683.000	30			
Corrected Total	110.967	29			

a. R Squared = .313 (Adjusted R Squared = .234)

---

---

---

---

---

---

---

---

---

---

---

---

### Output

**Levene's Test of Equality of Error Variances**

Dependent Variable: Libido

F	df1	df2	Sig.
5.525	2	27	.010

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.  
a. Design: Intercept-PARTNER-DOSE

**Tests of Between-Subjects Effects**

Dependent Variable: Libido

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	34.750 <sup>a</sup>	3	11.583	3.952	.019
Intercept	12.171	1	12.171	4.152	.052
PARTNER	17.906	1	17.906	6.109	.020
DOSE	28.337	2	14.169	4.833	.016
Error	76.216	26	2.931		
Total	693.600	30			
Corrected Total	110.967	29			

a. R Squared = .313 (Adjusted R Squared = .234)

This shows that the dose of Viagra-2 has an impact on the sexual desire of the participants when the libido of the partner is included as a covariate

---

---

---

---

---

---

---

---

---

---

---

---

### Output

**Levene's Test of Equality of Error Variances**

Dependent Variable: Libido

F	df1	df2	Sig.
5.525	2	27	.010

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.  
a. Design: Intercept-PARTNER-DOSE

**Tests of Between-Subjects Effects**

Dependent Variable: Libido

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	34.750 <sup>a</sup>	3	11.583	3.952	.019
Intercept	12.171	1	12.171	4.152	.052
PARTNER	17.906	1	17.906	6.109	.020
DOSE	28.337	2	14.169	4.833	.016
Error	76.216	26	2.931		
Total	693.600	30			
Corrected Total	110.967	29			

a. R Squared = .313 (Adjusted R Squared = .234)

The covariate has an impact on the result of the analysis because its inclusion reduces the variance that is unexplained (i.e., error variance)

---

---

---

---

---

---

---

---

---

---

---

---

### Output

**Estimates**

Dependent Variable: Libido

Dose of Viagra	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Placebo	2.926 <sup>a</sup>	.596	1.701	4.152
Low Dose	4.712 <sup>a</sup>	.621	3.436	5.989
High Dose	5.151 <sup>a</sup>	.593	4.118	6.184

a. Covariates appearing in the model are evaluated at the following values:  
Partner's Libido = 2.73

**Pairwise Comparisons**

Dependent Variable: Libido

(i) Dose of Viagra	(j) Dose of Viagra	Mean Difference (i-j)	Std. Error	Sig. <sup>*</sup>	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
Placebo	Low Dose	-1.786	.849	.030	-3.363	-.209
	High Dose	-2.225 <sup>*</sup>	.803	.030	-3.273	-.177
Low Dose	Placebo	1.786	.849	.030	.209	3.363
	High Dose	-.439	.811	.932	-2.509	1.631
High Dose	Placebo	2.225 <sup>*</sup>	.803	.030	1.177	4.273
	Low Dose	.439	.811	.932	-1.831	2.509

Based on estimated marginal means.  
a. Adjustment for multiple comparisons: Sidak.  
\*. The mean difference is significant at the .05 level.

Participants in the high dose group report higher levels of sexual desire than those in the placebo group...but participants in the low dose group do not differ from those in either the placebo group or the high dose group

---

---

---

---

---

---

---

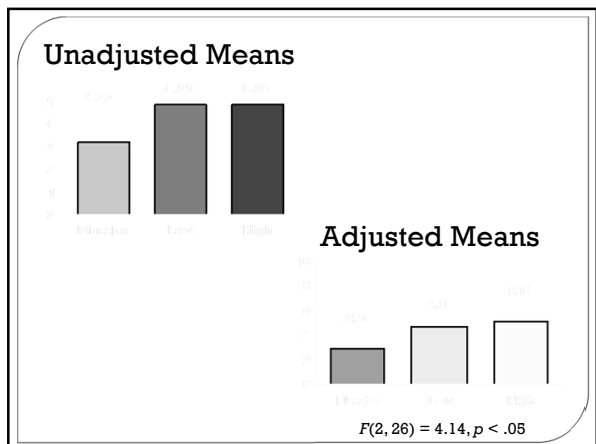
---

---

---

---

---



---

---

---

---

---

---

---

---