Multivariate Analysis of Variance (MANOVA)

PSY 5102: Advanced Statistics for Psychological and Behavioral Research 2

Goals

- When and why do we use MANOVA?
- Issues for MANOVA analysis
- Theory behind MANOVA:
  - MANOVA Test Statistics

When And Why Do We Use MANOVA?

- To test for differences between groups when we have several outcome variables
- Much better than multiple ANOVAs
  - Controls familywise error rate (Type I error)
  - Takes account of relationships between outcome variables which can improve our understanding of group differences
  - Other ANOVAs are "univariate" tests

Issues in MANOVA

- Selecting outcome variables
  - The outcome variables should fit together on a conceptual basis (e.g., behavioral and cognitive symptoms of depression)
  - Researchers should include fewer than 10 outcome variables unless the sample size is large
- Test statistics (Choice of four)
- Power
  - Power depends on correlations between outcome variables and expected direction of effects (i.e., best power when outcome variables are somewhat different but the group differences are in the same direction for each outcome)

MANOVA: An Example

- Efficacy of psychotherapy for obsessive compulsive disorder (OCD)
- Three Groups:
  - Cognitive Behavior Therapy (CBT)
  - Behavior Therapy (BT)
  - No Treatment (NT)
- Two Outcome Variables:
  - Obsession-related behaviors
  - Obsession-related thoughts

Descriptive Statistics

Descriptive Statistics

	group	Mean	Std. Deviation	N
Number of obsession-related thoughts	CBT	13.40	1.90	10
	BT	15.20	2.10	10
	No Treatment Control	15.00	2.36	10
	Total	14.53	2.21	30
Number of obsession-related behaviours	CBT	4.90	1.20	10
	BT	3.70	1.77	10
	No Treatment Control	5.00	1.05	10
	Total	4.53	1.46	30

If We Did Separate ANOVAs…

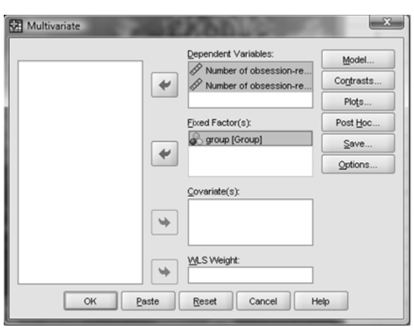
ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Number of obsession-related behaviours	Between Groups	10.467	2	5.233	2.771	.080
	Within Groups	51.000	27	1.889		
	Total	61.467	29			
Number of obsession-related thoughts	Between Groups	19.467	2	9.733	2.154	.136
	Within Groups	122.000	27	4.519		
	Total	141.467	29			

Which Test Statistic?

- MANOVA offers four slightly different test statistics
  - Pillai-Bartlett Trace
  - Hotellings's T^2
  - Wilk's Lambda
  - Roy's Largest Root
- Issues to Consider
  - Power (Roy's Largest Root is often best)
  - Robustness (Pillai-Bartlett is most robust when sample sizes are equal)
  - Equality of Sample Sizes (Pillai-Bartlett may have trouble when sample sizes are unequal)

Doing MANOVA



MANOVA Options

Main Output

Multivariate Tests[c]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.983	745.230[a]	2.000	26.000	.000
	Wilks' Lambda	.017	745.230[a]	2.000	26.000	.000
	Hotelling's Trace	57.325	745.230[a]	2.000	26.000	.000
	Roy's Largest Root	57.325	745.230[a]	2.000	26.000	.000
Group	Pillai's Trace	.318	2.557	4.000	54.000	.049
	Wilks' Lambda	.699	2.555[a]	4.000	52.000	.050
	Hotelling's Trace	.407	2.546	4.000	50.000	.051
	Roy's Largest Root	.335	4.520[b]	2.000	27.000	.020

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

c. Design: Intercept + Group

Pillai-Bartlett Trace is significant

Main Output

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Hotelling's Trace is NOT significant

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Roy's Largest Root is significant

Follow-up ANOVAs

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Number of obsession-related behaviours	10.467[a]	2	5.233	2.771	.080
	Number of obsession-related thoughts	19.467[b]	2	9.733	2.154	.136
Intercept	Number of obsession-related behaviours	616.533	1	616.533	326.400	.000
	Number of obsession-related thoughts	6336.533	1	6336.533	1402.348	.000
Group	Number of obsession-related behaviours	10.467	2	5.233	2.771	.080
	Number of obsession-related thoughts	19.467	2	9.733	2.154	[illegible]
Error	Number of obsession-related behaviours	51.000	27	1.889		
	Number of obsession-related thoughts	122.000	27	4.519		
Total	Number of obsession-related behaviours	678.000	30			
	Number of obsession-related thoughts	6478.000	30			
Corrected Total	Number of obsession-related behaviours	61.467	29			
	Number of obsession-related thoughts	141.467	29			

a. R Squared = .170 (Adjusted R Squared = .109)

b. R Squared = .138 (Adjusted R Squared = .074)

A simple one-way ANOVA does not find a significant difference between the groups for obsession-related behaviors

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For this example, we found a significant multivariate effect but no univariate differences for either outcome variable. The reason is most likely the correlation between the outcome variables which gives the MANOVA better power than one-way ANOVA