Other Analytic Designs

Psy 420

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Latin Square Designs

- In a basic latin square (LS) design a researcher has a single variable of interest in a design and you want to control for other nuisance variables.
- To analyze the variable of interest while controlling for the other variables in a fully crossed ANOVA would be prohibitively large.

Latin Square Designs

- In these designs only the main effects are of interest
- The interaction(s) are confounded with the tests of the main effects and the error term

Latin Square Designs

- Typically applied to repeated measures designs (to control for carryover, testing, etc.)
- Can be used with between groups variables (typically used to control for unavoidable nuisance variables like time of day, different instruments, etc.)

Latin Square Designs

- Basic latin square design

	b_1	b_2	b_3	b_4
a_1	c_1	c_2	c_3	c_4
a_2	c_2	c_4	c_1	c_3
a_3	c_3	c_1	c_4	c_2
a_4	c_4	c_3	c_2	c_1

Latin Square Designs

- Limited view into the interactions

c1

	b_1	b_2	b_3	b_4
a_1	X			
a_2			X	
a_3		X		
a_4				X

c2

	b_1	b_2	b_3	b_4
a_1		X		
a_2	X			
a_3				X
a_4			X	

c3

	b_1	b_2	b_3	b_4
a_1			X	
a_2				X
a_3	X			
a_4		X		

c4

	b_1	b_2	b_3	b_4
a_1				X
a_2		X		
a_3			X	
a_4	X			

Latin Square Designs

- Other Types
  - Latin Square with replications
  - Crossover Designs – special name for a 2 level LS design
  - Greco-latin square design
    - Another nuisance variable is incorporated
    - 2 latin square designs superimposed
  - Incomplete Block Designs
    - When a complete latin square is not possible
    - Time constraints, limited number of subjects, etc.

Screening/Incomplete Designs

- Screening designs are analytical models that allow researchers to test for the effects of many variables while only using a few subjects
- Applicable to pilot-testing and limited subject pools (e.g. expense, time, etc.)

Screening/Incomplete Designs

- Resolution in Screening/Incomplete designs
  - Resolution refers to what aspects (factors) of a screening design are testable
  - Low resolution refers to designs in which only main effects can be tested
  - High resolution refers to designs in which main effects and two-way interactions can be tested

Screening/Incomplete Designs

Resolution	Description	When To Use
III	Main effects are independent of each other but are aliased with interations	You are willing to assume that all interactions are negligible and will base future research only on screened main effects
IV	Main effects are independent of each other and independent of two-way interactions, but some two-way interactions are aliased with others	You are willing to assume that all third- and higher-order effects are negligible. You are unable to determine ahead of time which two-way interactions are negligible and which are worth testing.
V	Main effects and two-way interactions are independent of each other	You are willing to assume that all third- and higher-order effects are negligible. You want to test all main effects and two-way interactions.

Screening/Incomplete Designs

- 2-level Fractional Factorial Designs
  - Typically indicated by a 2 raised to the number of IVs (e.g. 2^5 with five IVs)
  - Fractional Factorial designs can be tested with less "runs" by simply reducing the number of cells tested in the design and reducing the number of replications
  - Reduced fractional models are indicated by subtracting some value, q, from the factorial (e.g. 2^{k-q})

Screening/Incomplete Designs

- A 2^5 fractional factorial with replication

			a_1		a_2	
			b_1	b_2	b_1	b_2
c_1	d_1	e_1	s_1	s_{17}	s_{33}	s_{49}
			s_2	s_{18}	s_{34}	s_{50}
		e_2	s_3	s_{19}	s_{35}	s_{51}
			s_4	s_{20}	s_{36}	s_{52}
	d_2	e_1	s_5	s_{21}	s_{37}	s_{53}
			s_6	s_{22}	s_{38}	s_{54}
		e_2	s_7	s_{23}	s_{39}	s_{55}
			s_8	s_{24}	s_{40}	s_{56}
c_2	d_1	e_1	s_9	s_{25}	s_{41}	s_{57}
			s_{10}	s_{26}	s_{42}	s_{58}
		e_2	s_{11}	s_{27}	s_{43}	s_{59}
			s_{12}	s_{28}	s_{44}	s_{60}
	d_2	e_1	s_{13}	s_{29}	s_{45}	s_{61}
			s_{14}	s_{30}	s_{46}	s_{62}
		e_2	s_{15}	s_{31}	s_{47}	s_{63}
			s_{16}	s_{32}	s_{48}	s_{64}

Screening/Incomplete Designs

- A 2^{5-1} half fractional factorial with replication

			a_1		a_2	
			b_1	b_2	b_1	b_2
c_1	d_1	e_1	s_1 s_2			s_3 s_4
		e_2		s_5 s_6	s_7 s_8	
	d_2	e_1		s_9 s_{10}	s_{11} s_{12}	
		e_2	s_{13} s_{14}			s_{15} s_{16}
c_2	d_1	e_1		s_{17} s_{18}	s_{19} s_{20}	
		e_2	s_{21} s_{22}			s_{23} s_{24}
	d_2	e_1	s_{25} s_{26}			s_{27} s_{28}
		e_2		s_{29} s_{30}	s_{31} s_{32}	

Screening/Incomplete Designs

- A 2^{5-2} quarter fractional factorial without replication

			a_1		a_2	
			b_1	b_2	b_1	b_2
c_1	d_1	e_1	s_8			
		e_2				s_5
	d_2	e_1		s_6		
		e_2			s_7	
c_2	d_1	e_1	s_4			s_1
		e_2				
	d_2	e_1			s_3	
		e_2		s_2		

Screening/Incomplete Designs

- Other designs
  - Plackett-Burman (resolution III) – created to maximize main effects with limited subjects
  - Taguchi – created for quality control and focus on combination of variables (not sig testing) and test signal to noise ratios converted to dB scale

Screening/Incomplete Designs

- Other designs
  - Response-surface methodology
    - Box-Behnken – used with 3 three-level quantitative IVs. Tests for trend on the main effects with minimum subjects
    - Central-Composite – Same as Box-Behnken but each IV has 5 levels instead of 3
    - Mixture/Lattice models – used when you are testing variables that are blends or mixtures of quantitative IVs where the sum for each IV is a fixed amount (e.g. 100%)

Random Effects ANOVA

- So far, everything has assumed that the IVs were Fixed
- Fixed effects means that we as researchers pick the levels of the IV(s) and are not typically interested in generalizing beyond the levels we chose
- It's also assumed that the levels are without error (no variability)
- But what if we do want to generalize beyond or if we feel that there is some variability inherent in the IV levels?

Random Effects ANOVA

- So far we have had one effect that we have considered random; subjects
- What makes them random?
- Why do we want random subjects?
- It's the same reason(s) we want random levels of an IV

Random Effects ANOVA

- With random effects we create a "population" of possible levels (e.g. quantitative levels) for an IV and randomly select from it
- So we have a random "sample" of IV levels that will vary from study to study
- The goal is to increase the generalizability of the results beyond just the levels that were selected

Random Effects ANOVA

- Generalizability is increased to the entire range of the "population" that the levels were selected from
- This increase in generalizability comes at a power cost because in the analysis (which we don't have time for) the error term(s) is/are larger than when the IV(s) is/are treated as fixed

Random Effects ANOVA

- Random effects can be applied to any of the previous models we've covered (1-way BG, 1-way RM, Factorial, Mixed BG/RM)
- Random effects also introduces another use of the term Mixed in that you can have a model that is mixed fixed and random effects

Random Effects ANOVA

- How do you know if you have a random effect?
  - Would you use the same levels (e.g. quantitative values) in a follow-up or replication?
  - Are you interested in generalizing beyond the levels you've selected?
  - Was there (or could there be) a random process in which to choose the levels?

Random Effects ANOVA

- The most common use of random effects is for dealing with nested designs
- Often data is collected in intact groups and those groups are given different treatments (e.g. classes nested within levels of prejudice reduction curriculum)
- Even though this may not seem random in a usual sense we'd typically want to generalize beyond just the groups used