

Experimental Designs

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Experiments

- ☞ Creation of *meaningful* comparisons
 - ♦ *Deliberate manipulation of independent variables*
 - ♦ *Take advantage of “natural” manipulations to create comparisons*
 - *Ex post facto studies*
 - *Quasi-experimental manipulations*
 - ♦ *Control of extraneous variables*
 - *Random assignment of subjects to groups*
 - *Maintain at a constant value*
 - *Counterbalancing*

Sources of Variability in Data

- ☞ Systematic Variability
 - ♦ *Variability attributed to the effects of manipulations of an independent variable*
 - ♦ *Treatment Variability*
- ☞ Error Variability
 - ♦ *Variability attributed to the effects of extraneous variables*
 - *Individual differences (subject variability)*
 - *Error variability of measures used (when reliability of a measure is less than 1.00)*

Error Variability

- ☞ Ideally, error variability is distributed randomly across conditions in an experiment
 - ♦ *Error variability is evaluated & controlled within the statistical analysis of the data*
- ☞ Confounded Variables
 - ♦ *Extraneous variables that are correlated with manipulations of an independent variable*
 - ♦ *Problem: Confounds confuse variation due to treatments with variation due to these extraneous variables*
 - ♦ *This variability cannot be reliably isolated using statistical procedures*

Between-Subjects Designs

- ☞ Two-group versus parametric (multi-group) designs
- ☞ Problem of non-equivalent groups
- ☞ Matched-groups Designs
 - ♦ *Matched pairs (precision matching)*
 - ♦ *Matched groups (frequency distribution matching)*

Matching

- ☞ Costs associated with matching
 - ♦ *Time and expense related to finding matching subjects*
 - ♦ *Loss of potential subjects (unable to match)*
 - ♦ *Loss of generalizability of results*
 - ♦ *Problems created by attrition after matching*
 - ♦ *Loss of degrees of freedom in the statistical analysis*
- ☞ Advantages associated with matching
 - ♦ *Control of extraneous subject variables*
 - ♦ *Potential for increased sensitivity to the effects of manipulated variables (when matching variables are related to the dependent measure)*

Within-Subjects Designs

- ☞ “Ultimate” Match – each subject is matched with itself
- ☞ Each subject participates in every condition in the design
- ☞ Individual differences (subjects) are now treated as an additional factor in the statistical analysis (*Repeated Measures Designs*)

Advantages of Within-Subjects Designs

- ☞ Efficient in the recruitment and use of subjects
- ☞ Good control of individual differences as an extraneous variable
- ☞ Statistical advantage
 - ◆ *Potential for increased sensitivity to effects of treatment*
 - ◆ *Individual differences are no longer part of error variance, but are identified as variance attributed to the Subjects variable*

Disadvantages of Within-Subjects Designs

- ☞ Time required for subject participation
- ☞ Subject attrition
 - ◆ *Loss of data (e.g., from equipment failures) in one condition will require discarding all data for that subject*
- ☞ Carryover effects
 - ◆ *Practice*
 - ◆ *Fatigue*
 - ◆ *Habituation or sensitization to manipulations*
 - ◆ *Adaptation*
 - ◆ *Contrast effects*
 - ◆ *Irreversible changes*

Minimizing Carryover Effects

- ☞ Allow subject behavior to stabilize before exposure to any data collection conditions
 - ◆ *Create room for adaptation or habituation to occur*
- ☞ Practice trials
 - ◆ *Give enough practice before data collection begins to familiarize with task and procedures*
- ☞ Create breaks to offset effects of boredom or fatigue
- ☞ Counterbalance presentation of conditions

Counterbalancing

- ☞ Complete counterbalancing
 - ◆ *All possible orders of conditions used*
- ☞ Partial counterbalancing
 - ◆ *Block Randomization*
 - ◆ *Latin Square Design*
 - ◆ *Randomization (requires many sequences)*

Block Randomization

- ☞ Each subject completes all four conditions
- ☞ $4n$ subjects required for the design
- ☞ Controls effects of order in the sequence
 - ◆ *Practice, boredom, etc.*
- ☞ Does *not* control the effects of unique effects of one condition on the following condition

Subject	Order of Conditions			
1	A	C	B	D
2	C	B	D	A
3	B	D	A	C
4	D	A	C	B

Latin Square Design

- ☞ Each subject completes all four conditions & 4n subjects required for the design
- ☞ Controls effects of order in the sequence
- ☞ Controls the unique effects of context or contrast created by experimental conditions

Subject	Order of Conditions			
1	A	B	D	C
2	B	C	A	D
3	C	D	B	A
4	D	A	C	B

Choice of Design

- ☞ **Within-Subjects Designs**
 - ♦ Large individual differences: Subject variables are correlated with performance on the dependent measure
 - ♦ Economic use of subjects
 - ♦ Interest in practice or order effects as manipulations requires use of a within-subjects design
- ☞ **Matched Groups Designs**
 - ♦ Need to control individual differences but carryover effects are a serious concern
- ☞ **Between-Subjects Designs**
 - ♦ Participation in conditions requires extensive time
 - ♦ Concern over carryover effects

Factorial Designs

- ☞ Two or more independent variables
- ☞ Test Hypothesis about Main Effect of each IV separately (as occurs in single factor designs)
- ☞ Test Hypothesis about Interaction Effects

Single Factor Experiment: Noise Intensity		Two Factor Experiment	
Soft	Loud		
		Predictability	Noise Intensity
			Soft Loud
		Predictable	Grp 1 Grp 2
Group 1	Group 2	Unpredictable	Grp 3 Grp 4

Three Hypotheses Tested in a Two Factor Experiment

- ☞ What is the effect of Noise Intensity?
 - ♦ Main Effect of Noise
- ☞ What is the effect of Noise Predictability?
 - ♦ Main Effect of Predictability
- ☞ Interaction of Noise and Predictability
 - ♦ Interaction Effect
 - ♦ Cell Means

Two Factor Experiment			
	Noise Intensity		
Predictability	Soft	Loud	
Predictable	Grp 1	Grp 2	X
Unpredictable	Grp 3	Grp 4	X
	X	X	

Notation for Factorial Designs

- ☞ Identifying the number of factors in the design
- ☞ Identifying the number of levels for each factor in the design
 - ♦ 2 x 2 design
 - ♦ 3 x 3 design
 - ♦ 2 x 3 design
- ☞ All designs are expected to be fully crossed

	Factor A	
Factor B	A1	A2
B1	A1B1	A2B1
B2	A1B2	A2B2

	Factor A		
Factor B	A1	A2	A3
B1	A1B1	A2B1	A3B1
B2	A1B2	A2B2	A3B2
B3	A1B3	A2B3	A3B3

Factorial Designs

- ☞ **Between Subjects**
 - ♦ n x n design requires n x n independent groups
- ☞ **Within Subjects (Repeated Measures)**
 - ♦ n x n design requires each subject to do n x n tasks
- ☞ **Mixed Designs**
 - ♦ One or more factors manipulated within-subjects
 - ♦ Other factors manipulated between subjects

Higher Order Designs

- ∞ Three or more Factors
- ∞ Test one main effect for each factor
- ∞ Test all possible combinations of two-way interactions
- ∞ Test all possible combinations of higher-order interactions (three-way, four-way, etc.)
- ∞ Problem in interpretation of higher-order interactions