

Completely Randomized Factorial Designs (Ch. 5)

- 2 or more factors
- Not the same as doing two one-way ANOVAs
- Tests for the effects of each independent variable plus their interaction.
- In the completely randomized design, a random sample is included in each cell (nest) of the design
- Each subject appears in only one combination of the AB factors (S/AB)

Completely Randomized Factorial Designs

- Each factor has at least two levels
- Examples
 - 2x2
 - 2x3
 - 2x4
 - 3x4

Completely Randomized Factorial Designs

Example: A two-way factorial design with three levels in the first IV and four levels in the second IV

IV-A	IV-B				
	B1	B2	B3	B4	Row Means
A1					
A2					
A3					
Column Means					Grand Mean

If these means differ:
Main effect A

If these means differ: Main effect B

Hypotheses

- Factor A
 - $H_0: \mu_{A1} = \mu_{A2} = \mu_{A3} = \mu$
- Factor B
 - $H_0: \mu_{B1} = \mu_{B2} = \mu_{B3} = \mu$
- AB Interaction
 - $H_0: (\mu_{AB} - \mu) - (\mu_A - \mu) - (\mu_B - \mu) = 0$ for all combinations of AB

Interactions

- Interactions are sometimes described using the term “moderation”:
 - Moderation (The effect of one factor is not the same at all levels of another factor; the effect is moderated by another variable.
 - Examples: (1) The effect of goal setting on work performance is moderated by feedback. (2) Some research suggests that the effects of alcohol on aggression is stronger for males than for females (i.e., moderated by gender)
- Other related terms “multiplicative effect, non-additive, synergistic”

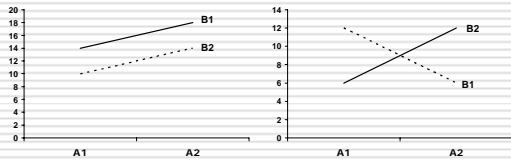
Three-way factorial design

- Three factors (independent variables): A, B, C
- AB, AC, and BC interaction
- ABC interaction
- Example: 2x2x2
- Interpretation
 - Example. Let say in the previous example of goal setting that we included a third factor involving Task Difficulty and found a three-way interaction such that the effect of goal setting on performance was moderated for by feedback and this moderation was stronger for difficult tasks. How would this look in a graph?

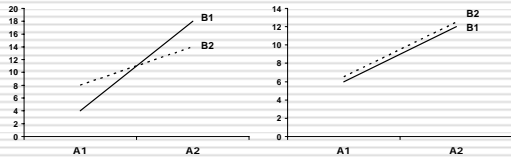
Definitional Formulae (back to two-way)

Source	Sum of Squares	df
A	$nb \sum (\bar{X}_a - \bar{G})^2$	(a-1)
B	$na \sum (\bar{X}_b - \bar{G})^2$	(b-1)
AB	$n \sum \sum (\bar{X}_{ab} - \bar{G}) - (\bar{X}_a - \bar{G})(\bar{X}_b - \bar{G})^2$	(a-1)(b-1)
S/AB	$\sum \sum \sum (X_{abj} - \bar{X}_{ab})^2$	ab(n-1)
Total	$\sum \sum \sum (X_{abj} - \bar{G})^2$	abn-1

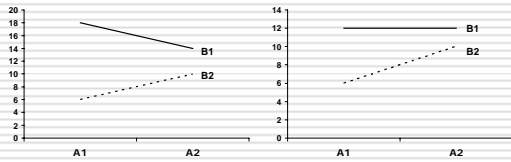
Different Patterns of Significance in a 2 x 2 Design



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Different Patterns of Significance in a 2 x 2 Design



Example

- ❑ A researcher believes that people who have High Trait Aggression (a disposition to be aggressive across various situation and occasions) differ from those with Low Trait Aggression with respect to the way they perceive the intentions of people who provoke them.
- ❑ In situations where a person (the target) has been provoked by another individual (the instigator), the target will try to understand the instigator's behaviour. Potential conclusions are that the instigator did not intend the provocation; it was an accident. Or, the instigator acted intentionally and the instigator will be perceived as hostile.

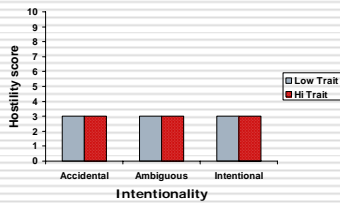
Example

- ❑ Previous research has shown that people perceive intent differently especially in ambiguous situations where intent of the instigator is unclear to the target. Some observers perceive more hostility in the actions of the instigator than others.
- ❑ One hypothesis is that in ambiguous situations, High Trait Aggression individuals see more hostility than Low Trait Aggression individuals.

Experiment Design

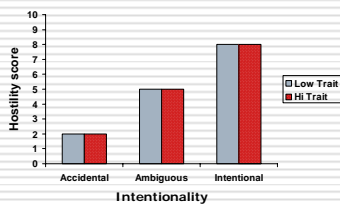
- IV₁ = Trait Aggression.** Participants complete the Aggression Questionnaire and are placed in the High or Low Trait Aggression Group based on their score.
- IV₂ = Intentionality.** Participants from each group are assigned to one of three experimental conditions (Accidental, Ambiguous, and Intentional). Each participant is asked to walk to an office at the end of a hallway. A confederate bumps into the participant. Depending on the condition, the confederate "makes it look like" his action was Accidental (i.e., tripping and apologizes), Ambiguous (i.e., leaves no cues as to his intentions), and Intentional (i.e., clearly displays anger and purposefully shoves the participant out of his way).
- DV = Hostility score.** The RA witnesses the event and tells the participant that she is developing a hostility rating scale and ask the participant to rate the instigator's behaviour on a score of 0 to 10.

Potential Results



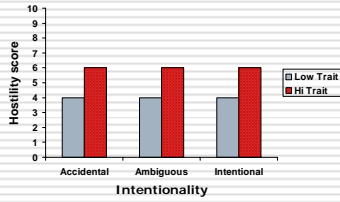
What effect(s) do you see?

Potential Results



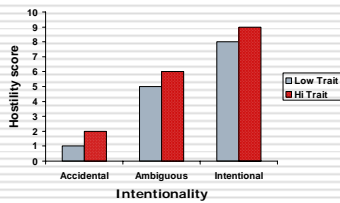
What effect(s) do you see?

Potential Results



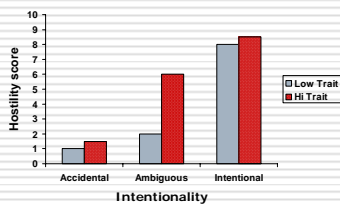
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Potential Results



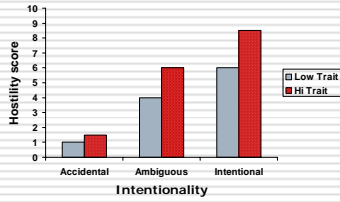
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Potential Results



What effect(s) do you see?

Potential Results



What effect(s) do you see?

Analysis

Descriptive Statistics
Dependent Variable: Hostility_score

Trait_Agg	Intentionality	Mean	Std. Deviation	N
low trait_agg	accidental	1.80	.789	10
	ambiguous	2.80	.789	10
	intentional	7.80	.919	10
	Total	4.13	2.788	30
high trait_agg	accidental	2.40	.699	10
	ambiguous	5.70	.949	10
	intentional	8.20	.789	10
	Total	5.43	2.542	30
Total	accidental	2.10	.788	20
	ambiguous	4.25	1.713	20
	intentional	8.00	.858	20
	Total	4.78	2.725	60

Analysis

Levene's Test of Equality of Error Variances^a

Dependent Variable: Hostility_score				
F	df1	df2	Sig.	
.155	5	54	.978	

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept+Trait_Agg*Intentionality+Trait_Agg * Intentionality

Analysis

Tests of Between-Subjects Effects

Dependent Variable: Hostility_score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power ^a
Corrected Model	401.263 ^b	5	80.253	117.449	.000	.916	537.244	1.000
Intercept	1372.817	1	1372.817	2009.000	.000	.974	2009.000	1.000
Trait_Agg	25.350	1	25.350	37.098	.000	.407	37.098	1.000
Intentionality	356.633	2	178.317	260.951	.000	.906	521.902	1.000
Trait_Agg * Intentionality	19.300	2	9.650	14.122	.000	.343	28.244	.998
Error	38.900	54	.683					
Total	1811.000	60						
Corrected Total	438.183	59						

a. Computed using alpha = .05
b. R Squared = .916 (Adjusted R Squared = .908)

Note: Use Corrected Total as denominator for Eta-Squared
(e.g., $25.350/438.183 = .058$ (Trait Agg))

Interpreting Results

- Main Effects
- Interaction
 - Meaning of main effects when interaction is significant
 - Simple main effects
 - Comparing levels of A at different levels of B (holding B constant)
 - Comparing levels of B at different levels of A (holding A constant)

Posthoc Tests of Means

- Main Effects
 - If only two levels, no need for posthoc
 - If three or more, can use Tukey HSD
 - Be careful to use the correct sample size (collapse across levels of B)
 - Formula for q on page 110 or use POSTHOC
- Simple Main Effects
 - Hold one variable constant
 - Compare cell means of the other variables
 - Formula for q on page 111 or use POSTOC

