Describing Factorial Effects

- Kinds of means & kinds of effects
- Inspecting tables to describe factorial data patterns
- Inspecting line graphs to describe factorial data patterns
- Inspecting bar graphs to describe factorial data patterns
- Choosing among tables & graphs
- Other descriptions of factrorial data patterns & interactions

Interpreting Factorial Results based on "Inspection"

Now that we have the basic language we will practice examining and describing main effects and interactions based on tables, line graphs and bar graphs portraying factorial results.

Once you know how to describe the results based on "inspection" it will be a very simple task to learn how to apply NHST to the process.

As in other designs we have looked at "an effect" as a numerical <u>difference</u> between two "things", in factorial analyses…

Main effects involve <u>differences</u> between marginal means.

Simple effects involve <u>differences</u> between cell means.

Interactions involve the <u>differences</u> between simple effects.

Inspecting a Table to determine simple effects & interaction…

Task Difficulty	Task Presentation: Paper	Task Presentation: Computer
Easy	90	90
Hard	50	70

We'll look at describing the interaction using each set of simple effects in turn. Then we'll look at describing each main effect (and checking if each is descriptive or misleading)

Inspecting a Table to determine simple effects & interaction…

Simple Effects of Task Presentation

Task Difficulty	Task Presentation: Paper	Task Presentation: Computer
Easy	90	90
Hard	50	70

SE of Task Pres for EasyTasks

90 vs. 90 SE = 0

SE of Task Pres for HardTasks

50 vs. 70 SE = 20

There is an interaction of Task Difficulty and Task Presentation as they relate to performance. There is no effect of presentation for easy tasks, however for hard tasks computer presentations led to higher scores than did paper presentations.

Inspecting a Table to determine simple effects & interaction…

Simple Effects of Task Difficulty

Task Difficulty	Task Presentation: Paper	Task Presentation: Computer
Easy	90	90
Hard	50	70

SE of Task Diff for Paper Pres.

90 vs. 50 SE = 40

SE of Task Diff for Computer Pres.

90 vs. 70 SE = 20

There is an interaction of Task Difficulty and Task Presentation as they relate to performance. Easy tasks are consistently performed better than hard tasks, however this effect is larger for paper presentations than for computer presentations.

Inspecting a Table to determine main effects …

marginal means for Task Difficulty

90 vs. 60 Easy > Hard

Task Difficulty	Task Presentation: Paper	Task Presentation: Computer	
Easy	90	90	90
Hard	50	70	60

This main effect is descriptive..

Easy > Hard for BOTH

Paper & Computer tasks

Overall, easy tasks were performed better than hard tasks.

Inspecting a Table to determine main effects …

marginal means for Task Presentation

70 vs. 80 Paper < Computer

Task Difficulty	Task Presentation: Paper	Task Presentation: Computer
Easy	90	90
Hard	50	70
	70	80

This main effect is potentially misleading ...

Paper < Computer only for hard tasks

Paper = Computer for easy tasks

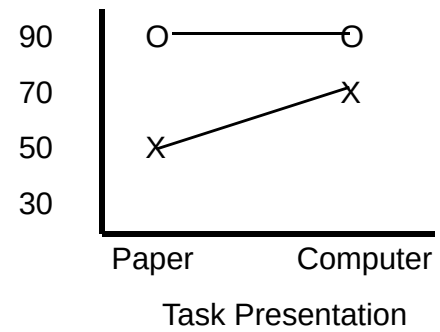
Overall, there was better performance on computer than paper tasks. However, this was not descriptive for easy tasks.

Inspecting a line graph …

"Different differences" and "Differential Simple Effects" both translate into NONPARALLEL LINES in a figure.

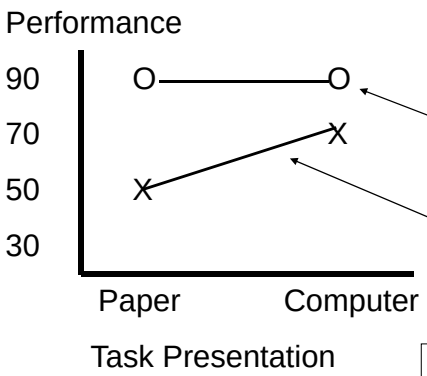
Key for Task Difficulty

O = Easy X = Hard



	P	C
Easy	90	90
Hard	50	70

Inspecting a line graph to determine simple effects & interaction…



Simple Effects of Task Presentation

SE of Task Pres for EasyTasks

90 vs. 90 SE = 0

SE of Task Pres for HardTasks

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Key for Task Difficulty

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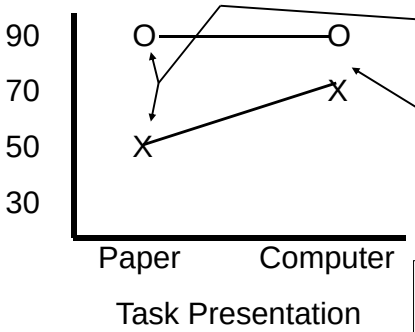
Inspecting a line graph to determine simple effects & interaction…

Performance

Simple Effects of Task Difficulty



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There is an interaction of Task Difficulty and Task Presentation as they relate to performance. Easy tasks are consistently performed better than hard tasks, however this effect is larger for paper presentations than for computer presentations.

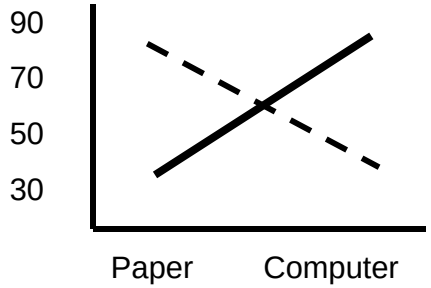
Key for Task Difficulty

O = Easy X = Hard

How ***not*** to Inspect a line drawing to determine if there is an interaction…

This is a "cross-over" interaction -- it certainly IS an interaction but it IS NOT the only kind !!

Performance



Key for Task Difficulty

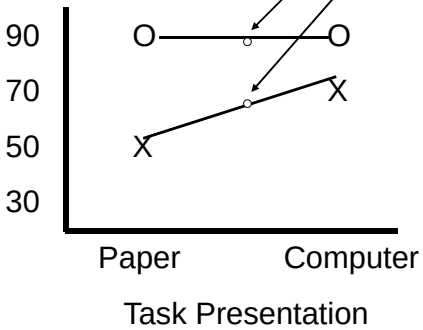
Easy Hard

Inspecting a line graph to determine if there are main effects…

marginal means for Task Difficulty

Performance

90 vs. 60 Easy > Hard



This main effect is descriptive..

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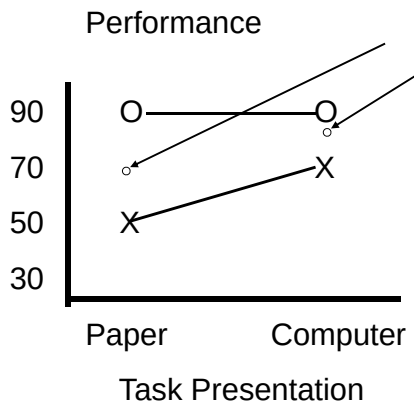
Paper & Computer tasks

Overall, easy tasks were performed better than hard tasks.

Key for Task Difficulty

O = Easy X = Hard

Inspecting a line graph to determine if there are main effects…



marginal means for Task Pres
70 vs. 80 Paper < Computer

This main effect is potentially misleading ...

Paper < Computer for hard tasks

but...

Paper = Computer for easy tasks

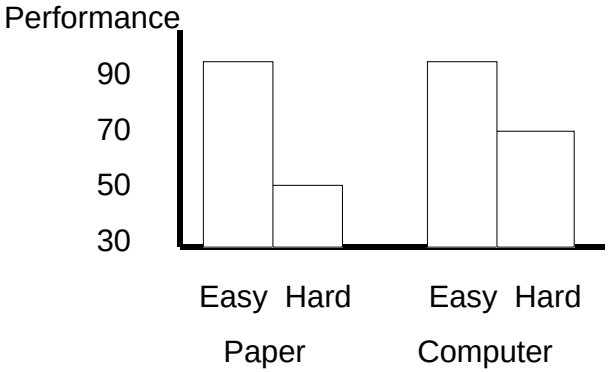
Key for Task Difficulty

O = Easy X = Hard

Overall, there was better performance on computer than paper tasks. However, this was not descriptive for easy tasks.

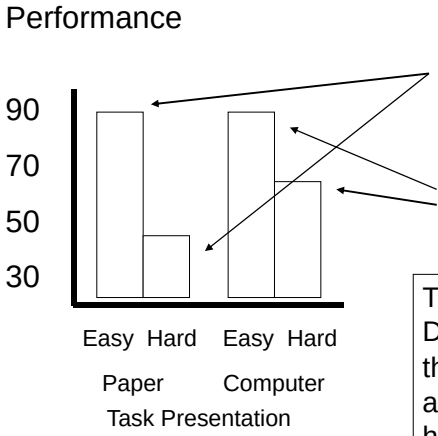
Inspecting a Bar Graph …

"Different differences" and "Differential Simple Effects" both translate into "different height differences" in a bar graph.



	P	C
Easy	90	90
Hard	50	70

Inspecting a Bar Graph to determine simple effects & interaction…
"Different differences" and "Differential Simple Effects" both translate into "different height differences" in a bar graph.



Simple Effects of Task Difficulty

SE Task Diff for Paper Pres.

90 vs. 50 SE = 40

SE Task Diff for Computer Pres.

90 vs. 70 SE = 20

There is an interaction of Task Difficulty and Task Presentation as they relate to performance. Easy tasks are consistently performed better than hard tasks, however this effect is larger for paper presentations than for computer presentations.

Inspecting a Bar Graph to determine simple effects & interaction…

"Different differences" and "Differential Simple Effects" both translate into "different height differences" in a bar graph.

Performance

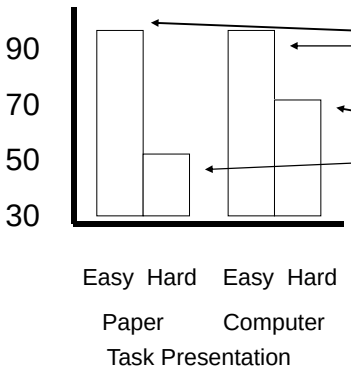
Simple Effects of Task Presentation

SE of Task Pres for EasyTasks

90 vs. 90 SE = 0

SE of Task Pres for Hard Tasks

50 vs. 70 SE = 20



There is an interaction of Task Difficulty and Task Presentation as they relate to performance. There is no effect of presentation for easy tasks, however for hard tasks computer presentations led to higher scores than did paper presentations.

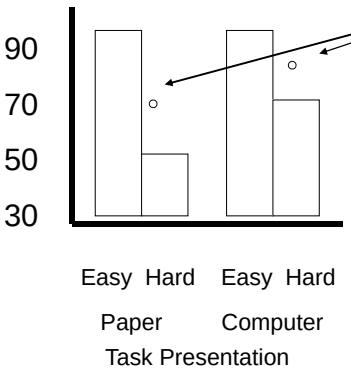
Inspecting a Bar graph to determine if there are main effects…

"Different differences" and "Differential Simple Effects" both translate into "different height differences" in a bar graph.

Performance

marginal means for Task Presentation

70 vs. 80 Paper < Computer



This main effect is potentially misleading ...

Paper < Computer for only for hard tasks

Paper = Computer for easy tasks

Overall, there was better performance on computer than paper tasks. However, this was not descriptive for easy tasks.

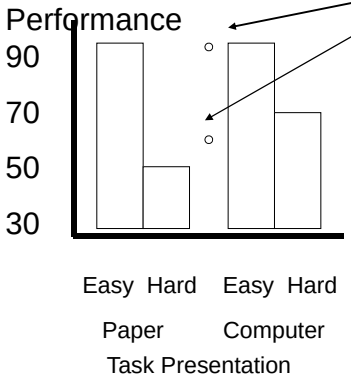
Inspecting a Bar graph to determine if there are main effects…

"Different differences" and "Differential Simple Effects" both translate into "different height differences" in a bar graph.

marginal means for Task Difficulty

90 vs. 60 Easy > Hard

Performance



This main effect is descriptive..

Easy > Hard for BOTH

Paper & Computer tasks

Overall, easy tasks were performed better than hard tasks.

Choosing Among Tables, Line Graphs and Bar Graphs

Tables

- Provides more detail (exact means and standard deviations)
- Easier to see main effects (can include marginal means)
- Harder to see the interaction

Line Graphs

- Easier to see interaction pattern (than tables)
- Harder to see main effects (than tables)
- "Formally" limited to using when quantitative IV on X axis

Bar Graphs

- Interactions -- easier than tables, not as easy as line graphs
- Mains -- harder to see than tables

Note: Any of these can include std, or SEM "whiskers"

Sometimes our hypotheses aren't about patterns of simple effects, but … are about other kinds of mean difference patterns…

		Training Modality	
		Visual	Touch
Testing Modality	Visual	VV	TV
	Touch	VT	TT

The IVs are "Training Modality" and "Testing Modality" leading to this 2x2 factorial design…

Among these conditions, 2 are "intramodal" (VV & TT) & 2 are "cross-modal" (VT & TV).

RH:s for the study were…

RH1: VV > TT → hypothesized dif among intramodal conditions

RH2: VT > TV → hypothesized dif among cross-modal conditions

Neither of which corresponds to a "simple effect" !

In this case there is an "organizational" solution…

Just re-label the IVs…

"Training Modality" → Vision vs. Touch &

"Testing Modality" → Intramodal vs. Cross-modal then…

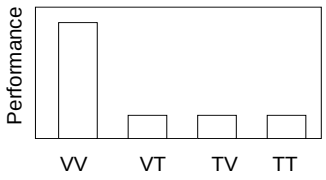
		Training Modality	
		Visual	Touch
Testing Modality	Intra	VV	TT
	Cross	VT	TV

RH1: VV > TT → SE of Training Modality for Intramodal tests

RH2: VT > TV → SE of Training Modality for Cross-modal tests

Another Example – same research area…

This was the common design for studying intra- and cross-modal memory with the usual RH: VV > VT > TV = TT



… which can be directly & completely tested using the 6 pairwise comparisons among the 4 conditions.

After several studies, someone noticed that these conditions define a factorial…

Testing Modality \ Training Modality	Visual	Touch
Visual	99.6%	24.8 %
Touch	26.2 %	25.6 %

There was an interaction!

There was a (misleading) main effect of Training Modality.

There was a (misleading) main effect of Testing Modality.

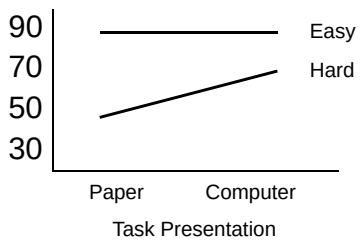
Testing Modality \ Training Modality	Visual	Touch
Visual	99.6%	24.8 %
Touch	26.2 %	25.6 %

Notice how the very large VV cell mean "drives" both main effects (while ensuring they will each be misleading) as well as driving the interaction!?!

However interesting and informative was the idea from the significant interaction, that "performance is the joint effect of Training and Testing Modalities" – none of these "simple effect tests" give a direct test of the RH:

The set of 6 pairwise comparisons gives the most direct RH test!!!

"Describing a pattern of data that includes an interaction" vs.
"Describing the Interaction in a pattern of data"



The pattern of data shown the figure demonstrate that while Task Presentation has no effect for Easy tasks, for Hard tasks, those using Computer did better than when using Paper.

This is "a description of a pattern of data that includes an interaction"

Technically, it would be **wrong** to say that "The interaction shown in the figure demonstrates that while Task Presentation has no effect for Easy tasks, for Hard tasks, those using Computer did better than when using Paper.

In order to "describe the interaction effect" we have to isolate the "interaction effect" from the main effects…

The process, called “mean polishing,” involves residulaizing the data for the main effects, leaving the interaction effect…

	Presentation			
	Paper	Comp	means	row effect
Easy	90	90	90	+15
Hard	50	70	60	-15
means	70	80	75	← grand mean
col effect	-5	+5		

Correcting for row effects
(subtract +/- 15)

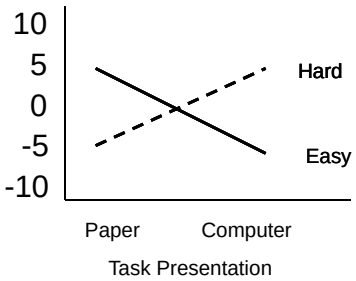
	Presentation	
	Paper	Comp
Easy	75	75
Hard	65	85

Correcting for column effects
(subtract +/- 5)

	Presentation	
	Paper	Comp
Easy	80	70
Hard	70	80

Correcting for Grand Mean
(subtract 75)

	Presentation	
	Paper	Comp
Easy	5	-5
Hard	-5	5

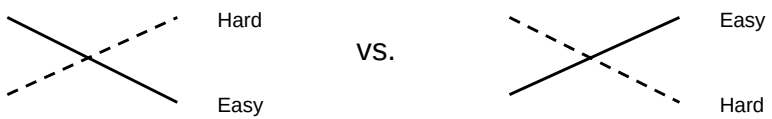


The proper description of “the interaction effect” is

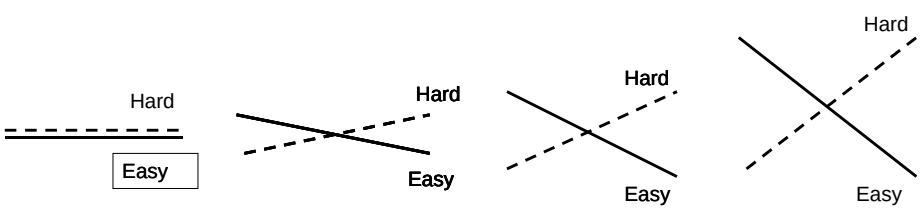
The interaction shown in the figure demonstrates that for Easy tasks those using Paper performed better than those using Computer, however, for Hard tasks, those using Computer performed better than those using Paper.

Looked at in this way, interactions differ in only 2 ways…

Which group has “increase” and which had “decrease”



The “strength” of the interaction effect…



null small medium large