

# Experimental design

Experiments are the most common and useful way to determine causality.

The question is: how to design them?

# What is a good experiment?

- Hard to say...   Experimentation is partially an art form!
- But, in general, a good experiment is one that controls for everything else -- testing only what you want it to test
- Planned well in advance
  - Controlling for other plausible hypotheses

# The first experiment

An Early Experimental Design: “Dew it both ways” Judges (Shoftim) Chapter 6

And Gideon said to G-d:

“If You will save Israel by my hand, as You have said, look, I will put a fleece of wool on the threshing-floor; if there be dew on the fleece only, and it be dry upon all the ground, then shall I know that You will save Israel by my hand, as You have said.”

And it was so; for he rose up early on the next day, and pressed the fleece together, and wrung dew out of the fleece, a bowlful of water.

And Gideon said to G-d: “Do not be angry with me, and I will speak just this once: let me try just once more, I ask You, with the fleece; let it now be dry only upon the fleece, and upon all the ground let there be dew.”

And G-d did so that night; for it was dry upon the fleece only, and there was dew on all the ground.

# An experiment vs. experiments

- Any experiment is a step in a dialog
- Experiments build on each other
- No experiment is the ultimate one

# The art of setting experiments

- Industry standards
- Elegance
- Symmetry
- Many ways to measure the same idea
- 
- What is convincing evidence?

# Single cell designs

- Not an experiment -- a study
- Parameter estimations
- Theory test
  - Examples: economics, physics
- Creating a control group from the single cell
  - Examples: ordering simulation in variety seeking

# Random assignment

- Random assignment is the **central** aspect of experiments
- By randomly assigning subjects to groups we can assume no systematic differences between groups
  - Assume they are the same on everything but the manipulation.

# The importance of manipulations

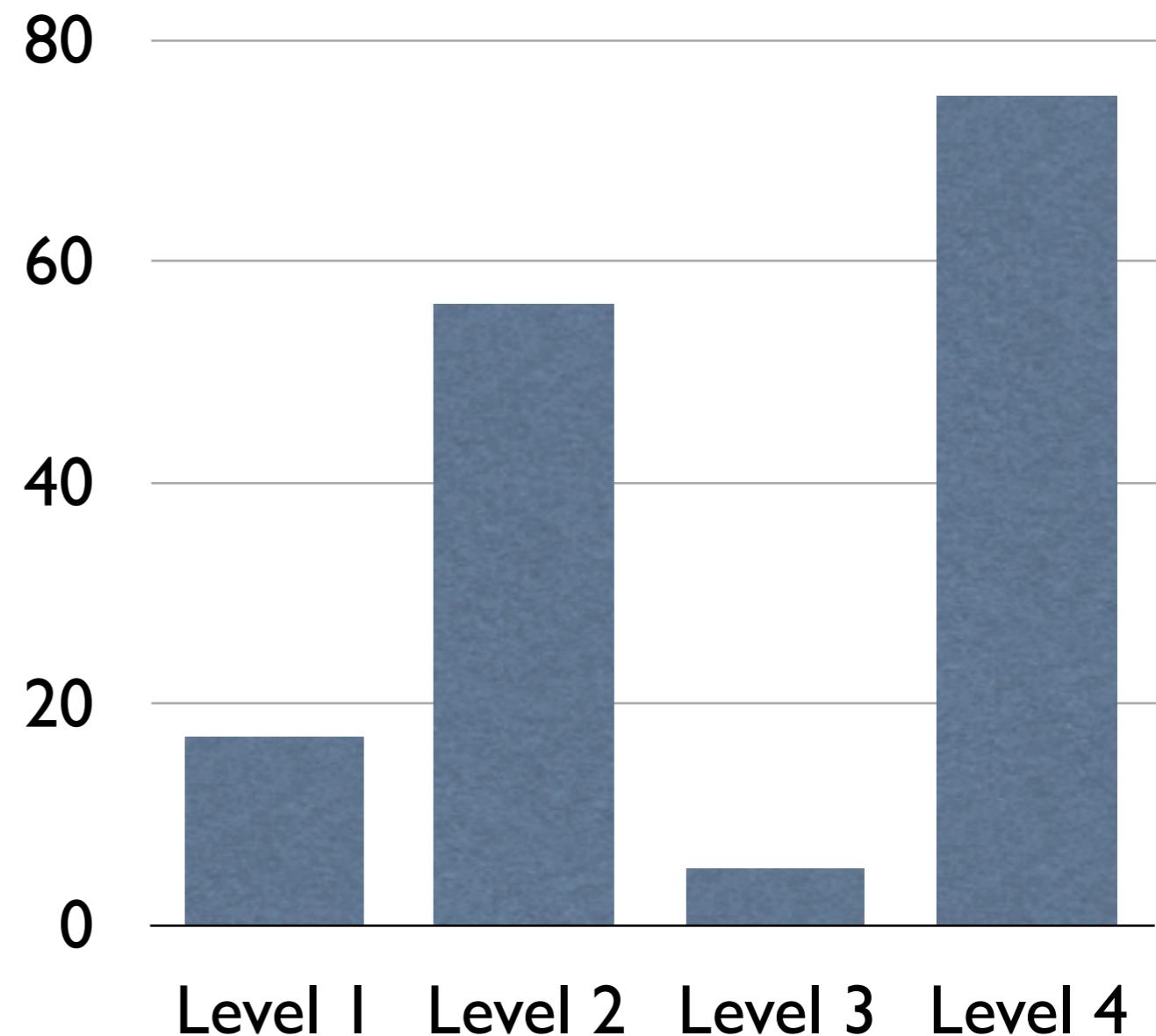
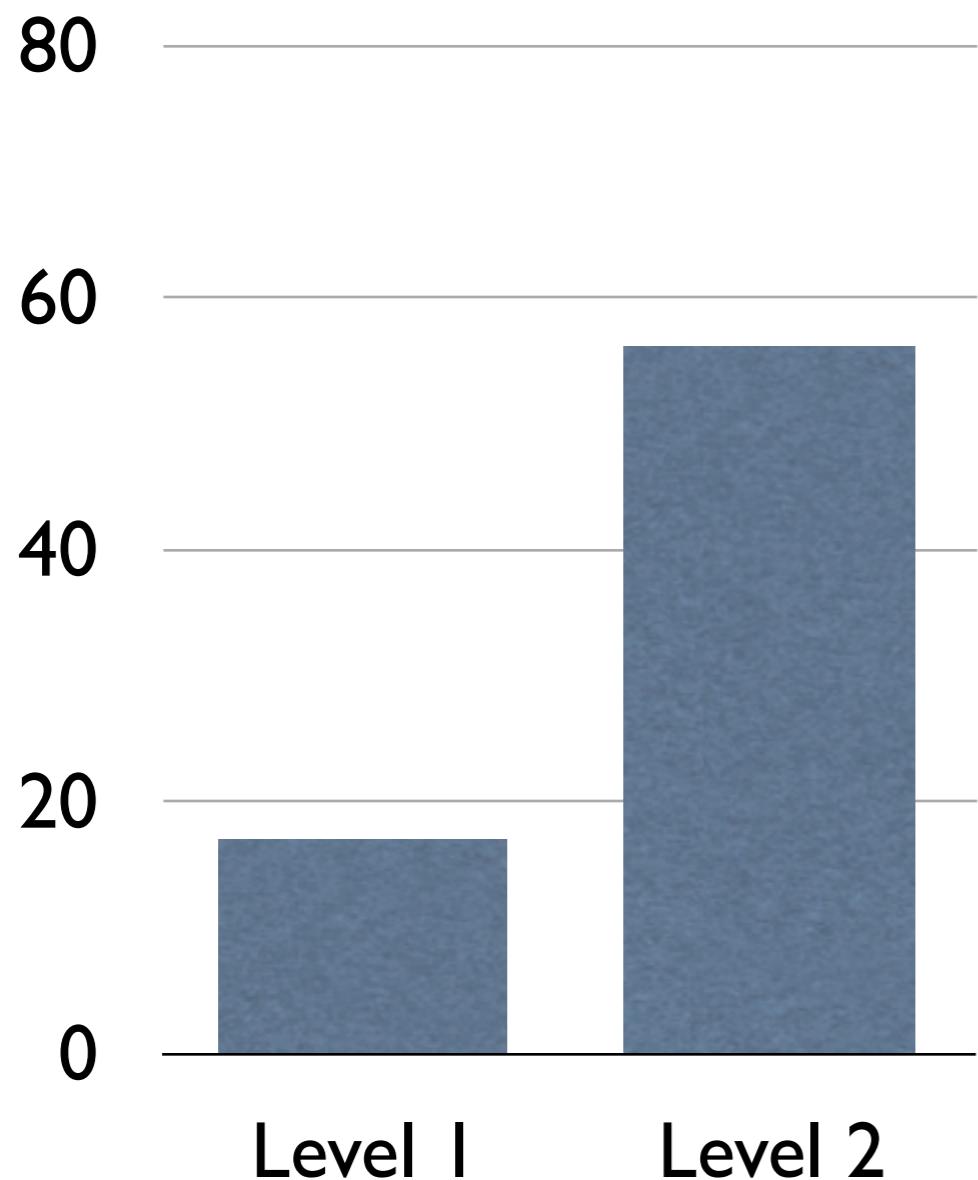
- By using a manipulation you can determine the **direction** of causality
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- Based also on random assignment we can link the outcome to our manipulation

# One-factor designs

# One-factor designs

	Level 1	Level 2
DV	XX.XX	XX.XX

# One-factor designs



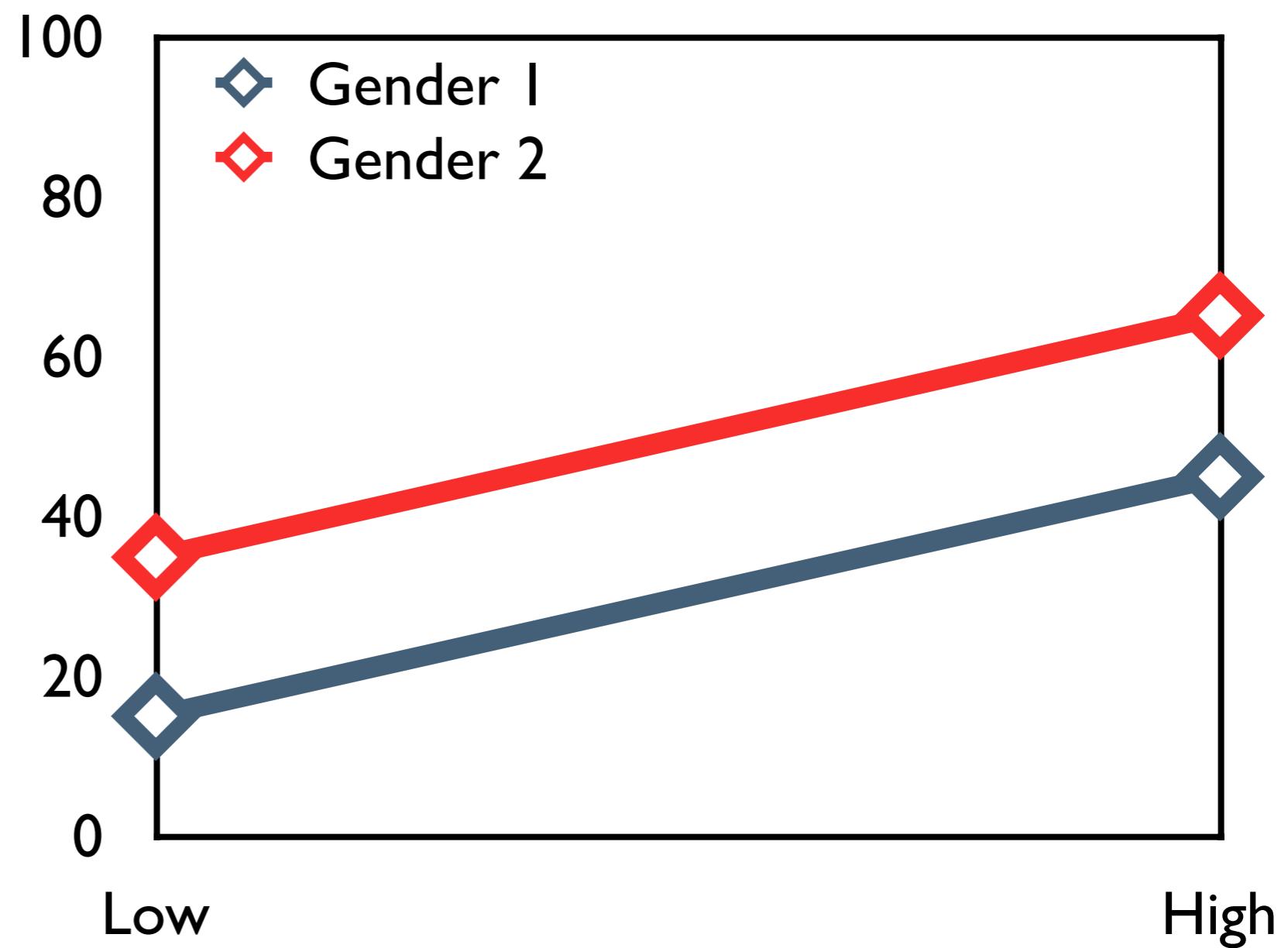
# Multiple-factor designs

# Multiple-factor designs

		Factor 1	
		Level 1	Level 2
Factor 2	Level 1	XX.XX	XX.XX
	Level 2	XX.XX	XX.XX

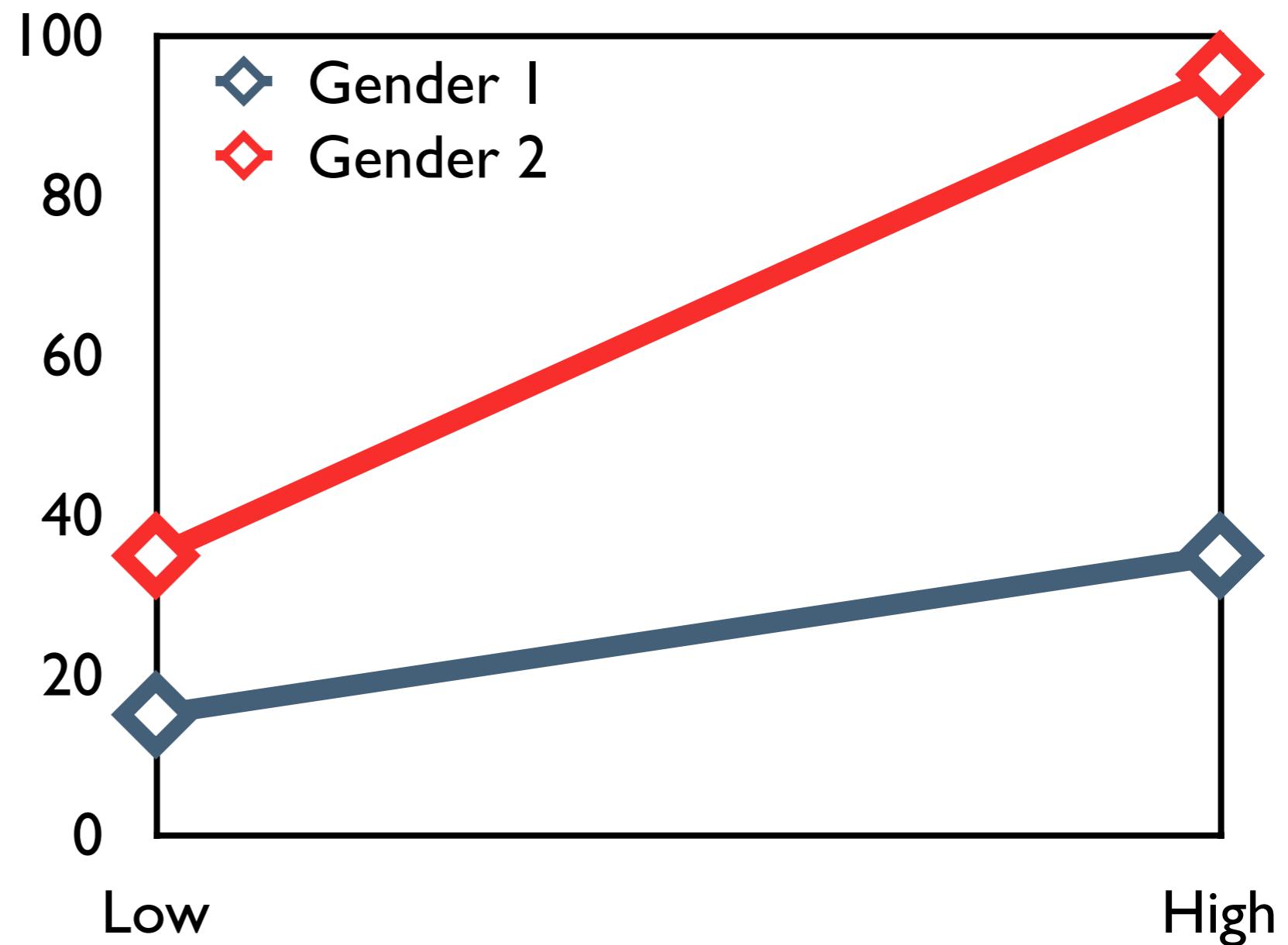
# The importance of interactions

- No interaction



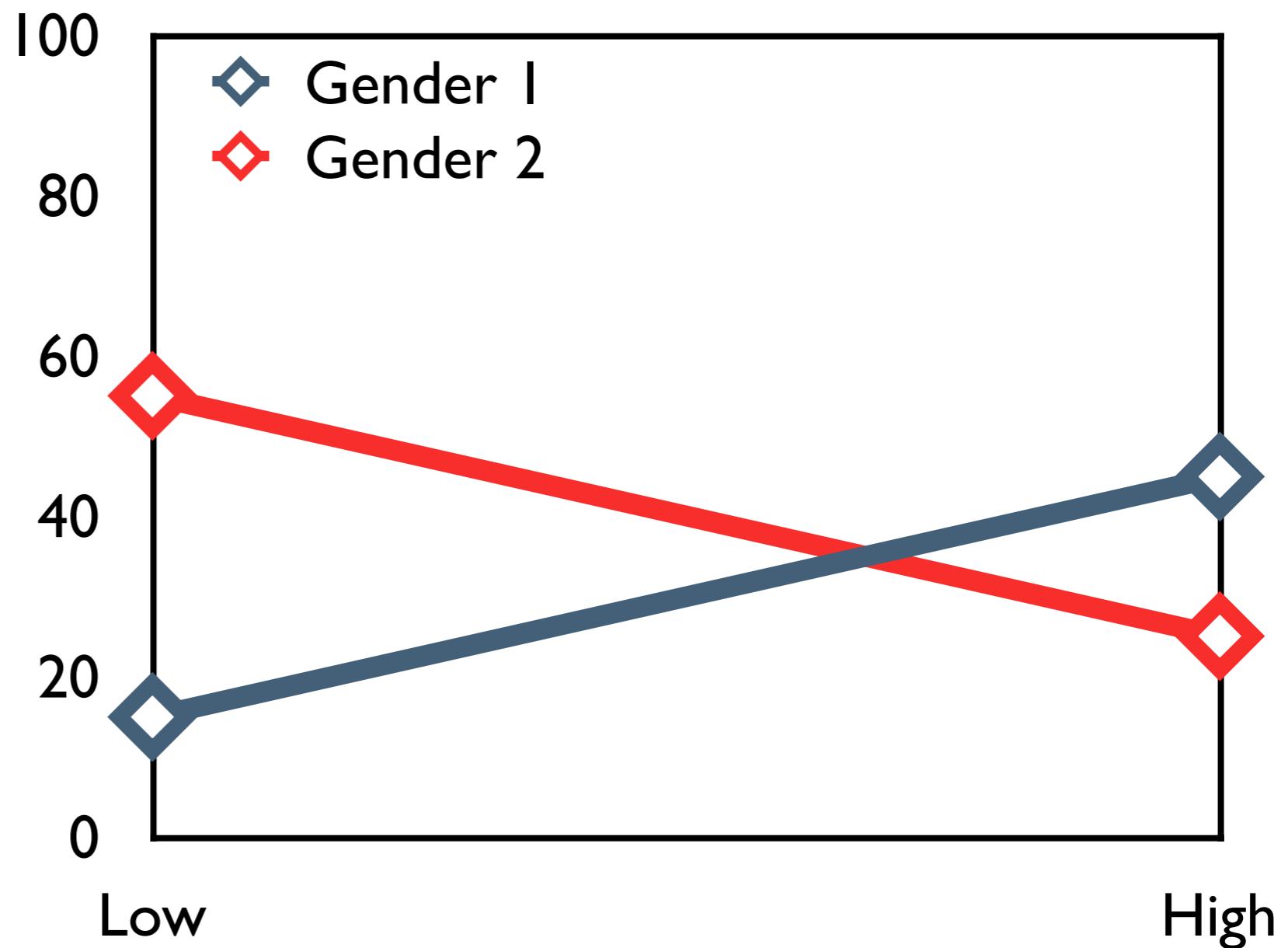
# The importance of interactions

- Ordinal interaction
  - Assumptions?



# The importance of interactions

- Dis-ordinal interaction
  - Assumptions?



# The importance of interactions

- Ordinal
- Disordinal
- 
- Interactions help us rule out alternative explanations
  - Examples.....

# Within vs. between subject designs

- Which is better? Why
- What are the advantages of each?
- What are the disadvantages of each?

# Experimental design: summary

- Experimental design is about the design of the structure of the experiment
- The origins of this is in agriculture
- Without a good design it is hard to know for sure what we have learned

# Summary

- Experiments
  - Random assignment
  - Controls
- Types of experiments
  - Once cell, one factor, multiple factors
  - The role of interactions
  - Within and between subjects designs