

Experimental Methods for Cognitive Science

- Theories

- Bottom-up and top-down science - and interactive activation
- Theory: Overarching system of beliefs
- Hypothesis: A specific, testable statement
- Operationalism: turning a theory into an experiment by connecting all variables to observables

- Control

- Control needed to assure the validity of an experiment
- Validity: proper cause-effect relationships are inferred
- Contrast with authority, common sense, observational studies
- Good for pinning down mechanisms
- Can learn things wouldn't have come up with in arm chair

Types of Experimental Validity

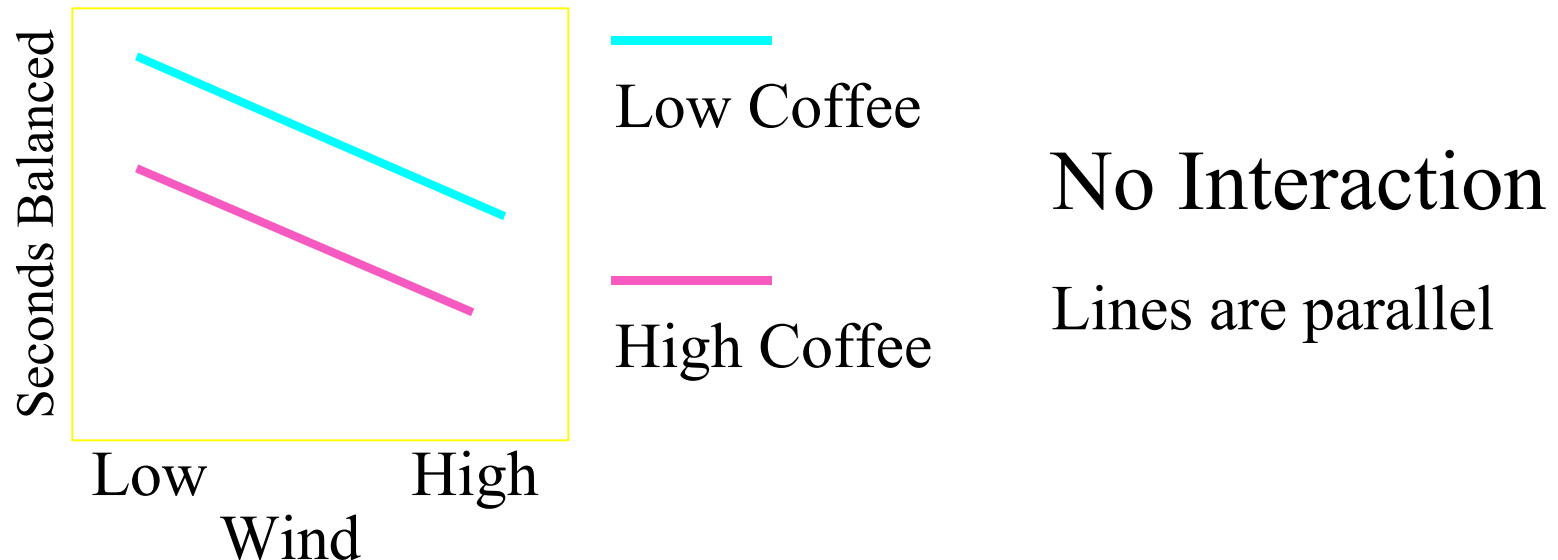
- **Internal**
 - Does the study show that treatment caused effect?
 - Problems: alternate causality, poor hygiene
- **External**
 - Can results be generalized?
 - Problems: non-random or special groups/conditions
 - Different standards for social psychology and psychophysics
- **Construct**
 - Is the experiment measuring what you think it is?
 - Problems: mislabeled conditions, confounds
- **ESP study**

Essential Terminology

- **Dependent variable**
 - What you measure: RT, % Correct, burps/minute
- **Independent variable**
 - What might affect the dependent variable
 - Factor = variable, levels of a factor = values that variable can take
- **Confound**
 - A dependency (correlation) between two dependent variables, or between two independent variables
 - Coke/Pepsi: difference due to taste, can, order, etc.

Interactions

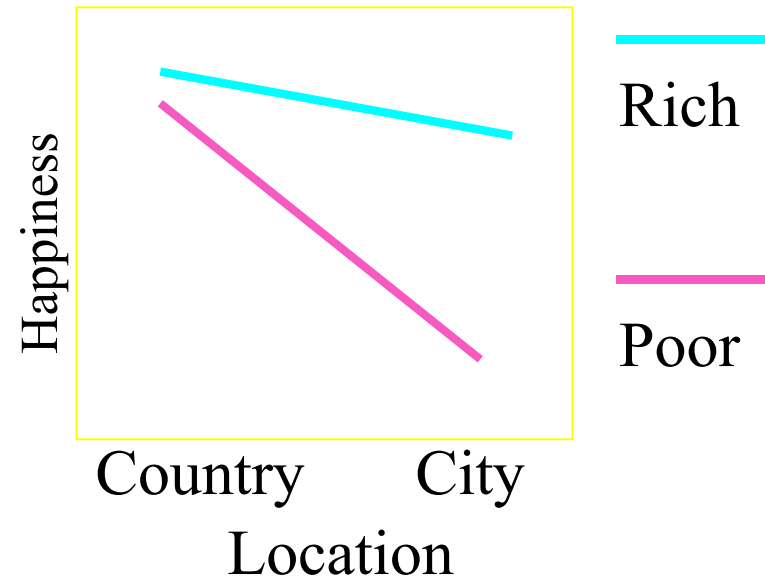
- The influence of one independent variable on a dependent variable depends on the value of another independent variable.



2 main effects (of wind and coffee) on balancing, but no interaction between them.

Main effect = effect of an independent variable on dependent variable, averaging across all levels of other variables

Interactions

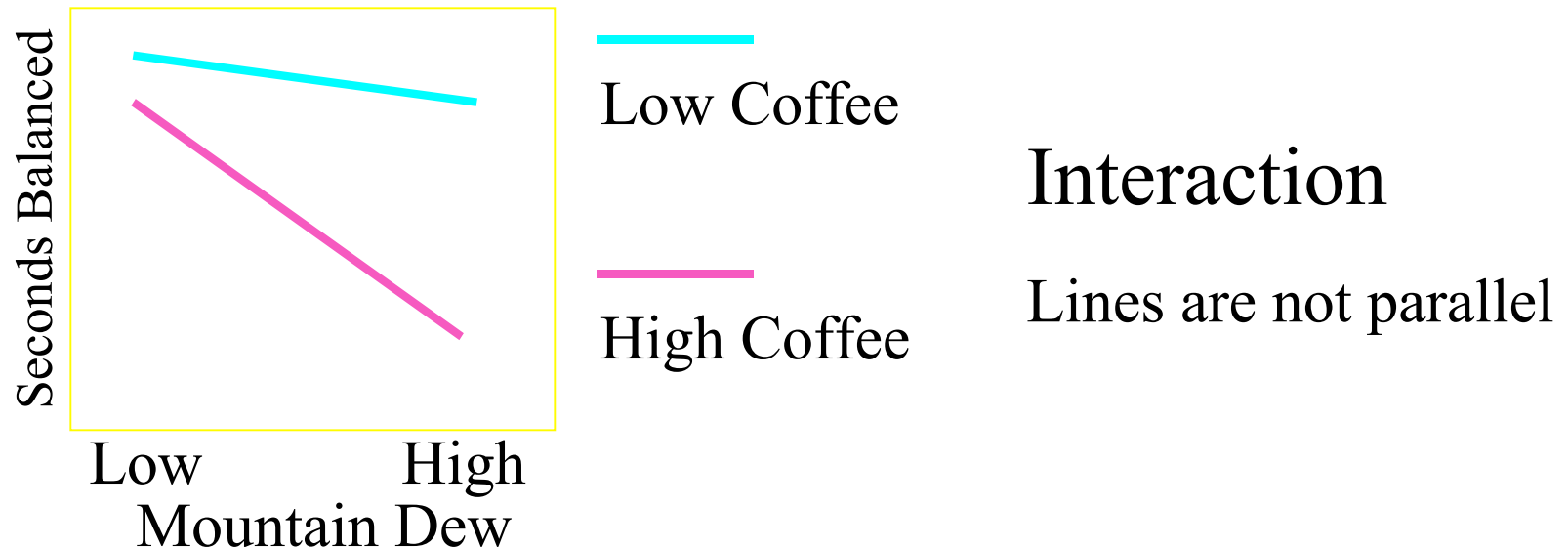


Interaction cast in doubt main effects

There may be a location so isolated that poor people are happier than rich people

Interactions

- The influence of one independent variable on a dependent variable depends on the value of another independent variable.

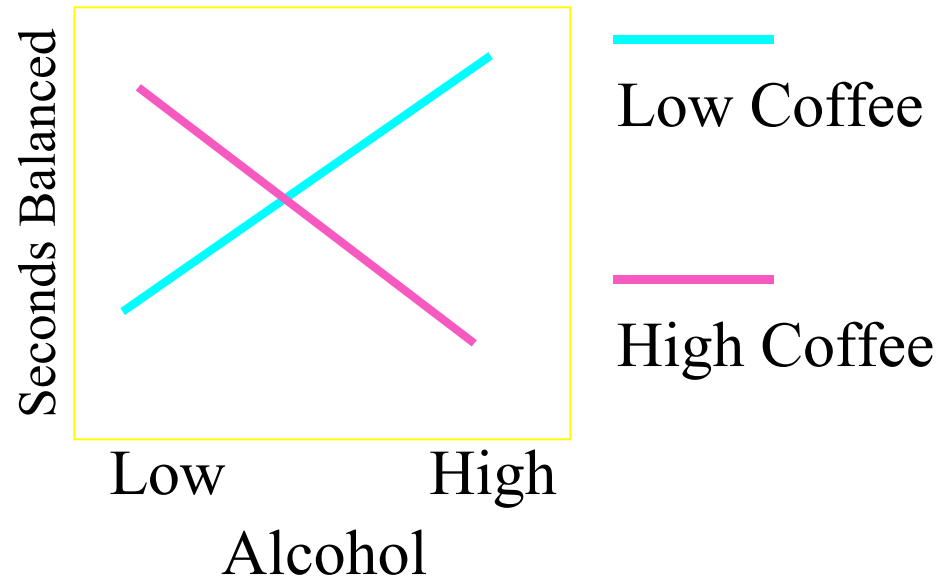


Stating an interaction: The influence of coffee on balancing is affected by the amount of Mountain Dew.

Specific result: For low levels of Mountain Dew, coffee does not have much influence. For high levels of Mountain Dew, a lot of coffee leads to much worse balancing than low coffee intake.

Cross-over interactions

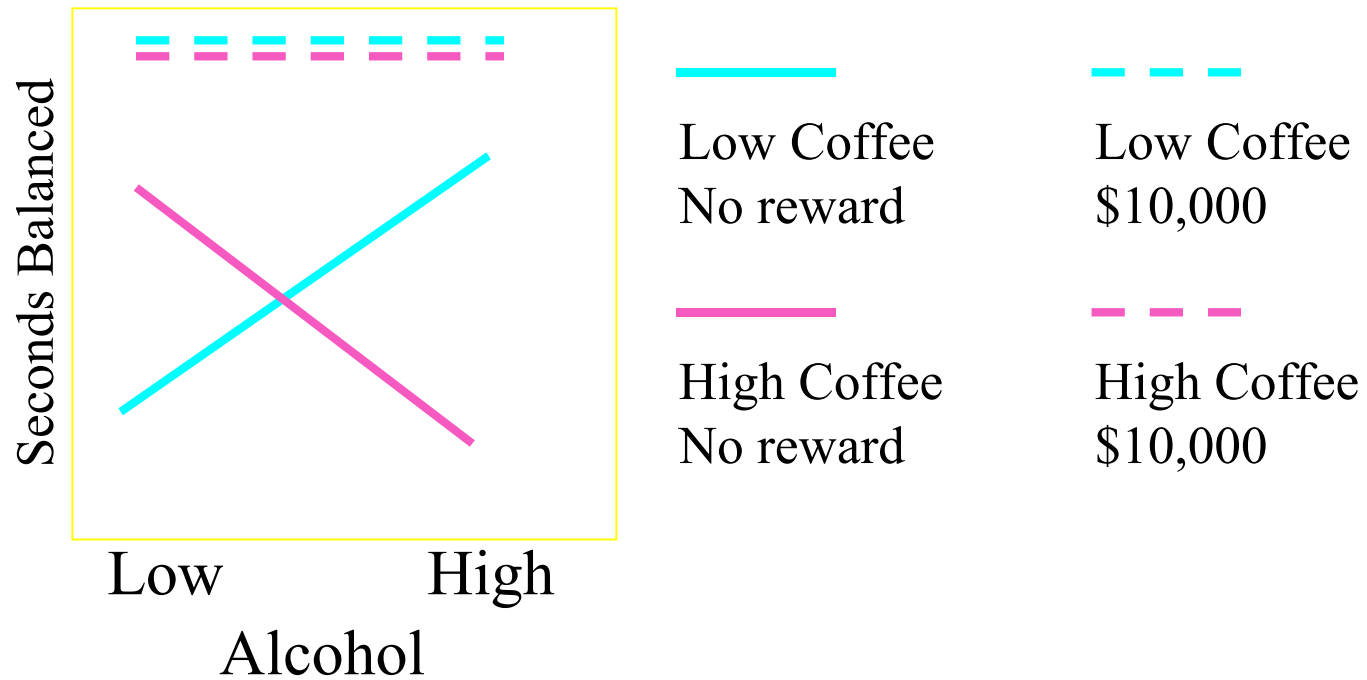
- For one level of independent variable X, variable Y has the opposite effect on a dependent variable as it does for the other level of variable X.



Theoretically important in Cognitive Science: strong evidence for a genuine interaction that is not simply caused by ceiling or floor effects.

Higher-order interactions

- (For one level of independent variable X, variable Y has the opposite effect on a dependent variable as it does for the other level of variable X) - This relation itself is affected by a third independent variable Z



Spot the problem

- Panty hose preference
 - Confound brand with position
 - Right-side preference
- Speed of maze running in Rats on Jolt and Mountain Dew
 - Hidden confound with selection procedure.
 - Random assignment procedure needed
 - Landon over Roosevelt according to Literary Digest post card poll
- Three-year wilderness training course
 - Longitudinal tests have age-related confounds
 - subject drop-out (pre- vs post-course quizzes)
 - experimenter influences (42 and up)
- Influence of external rewards on college students and 7 year olds
 - Addition problems with and without Simpsons
 - Ceiling and floor effects
- Influence of noise on performance: 21 versus 22 decibels
 - too small a range is a problem for statistical power
- Influence of complexity on preference: white screen versus white noise
 - too wide a range is a problem for U-shaped functions

Spot the problem

- Reading test, expose poor readers to MTV, Post-test improvement
 - Regression to the mean
 - Problem when select subjects based on measure, and use the same measure to gauge performance.
 - Performance is due to ability **plus random noise**
 - Choosing poor performers will select low-ability people, but also unlucky people
 - Benefits of punishment, costs of reward in Israeli jet fighters
- Mirror reading with Mozart, then Beck. Beck makes you smart.
 - Practice effects
 - Fatigue effects
- Pollyanna effect: Better memory for positive words? 4 sets of words: two positive sets and two negative sets. Use the following order:
Positive 1 - Negative 1 - Negative 2 - Positive 2
 - U-shaped “serial position curve”
 - Primacy effect: Better memory for early items
 - Recency effect: Better memory for recent, late items
- GRE Logic problems and different drugs: LSD (A), cheesecake (B), alcohol (C), ecstasy (D)
Four orders: ABCD, BCDA, CDAB, DABC. Cheesecake performance worst
 - Sequence effect: The position of one condition relative to another matters
 - Can control for order and sequence: ABCD, BDAC, CADB, DCBA

Within and Between Subject Designs

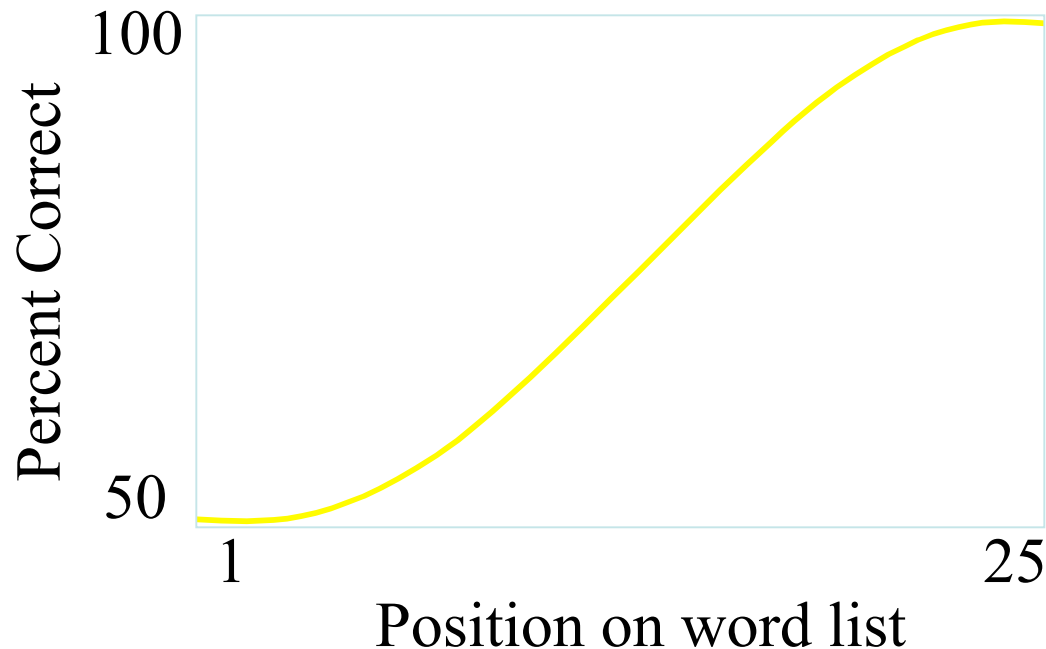
- Between subjects design
 - One treatment (level of a factor) per subject
 - Advantages
 - Cleaner design - no sequence or order effects
 - Less likely to have fatigue or practice effects
- Within subject design
 - Each subject receives every treatment
 - Advantages
 - Increased power because decreased variability
 - Subject is his/her own control
 - Individual differences do not increase noise
 - Many fewer subjects required
- Controlling for order and sequence effects
 - Latin squares
 - Randomize order of treatments
 - Randomization and the central limit theorem

Hazards of averaging over subjects

Cat	1	Goose	2	Panda	1
Dog	2	Calf	1	Poodle	2
Fox	2	Horse	2	Otter	2
Ram	1	Ant	1	Whale	1
Hog	2	Aardvark	1	Shark	1
Cow	2	Owl	2	Olive	2
Rat	1	Wolf	2	Arm	1
Frog	2	Lark	1	Opium	2
Snake	1	Swan	1	Oil	2
Raven	1	Dolphin	2	Ankle	1
Carp	1	Hawk	1	Asylum	1

Hazards of averaging over subjects

Is learning all-or-none or gradual?



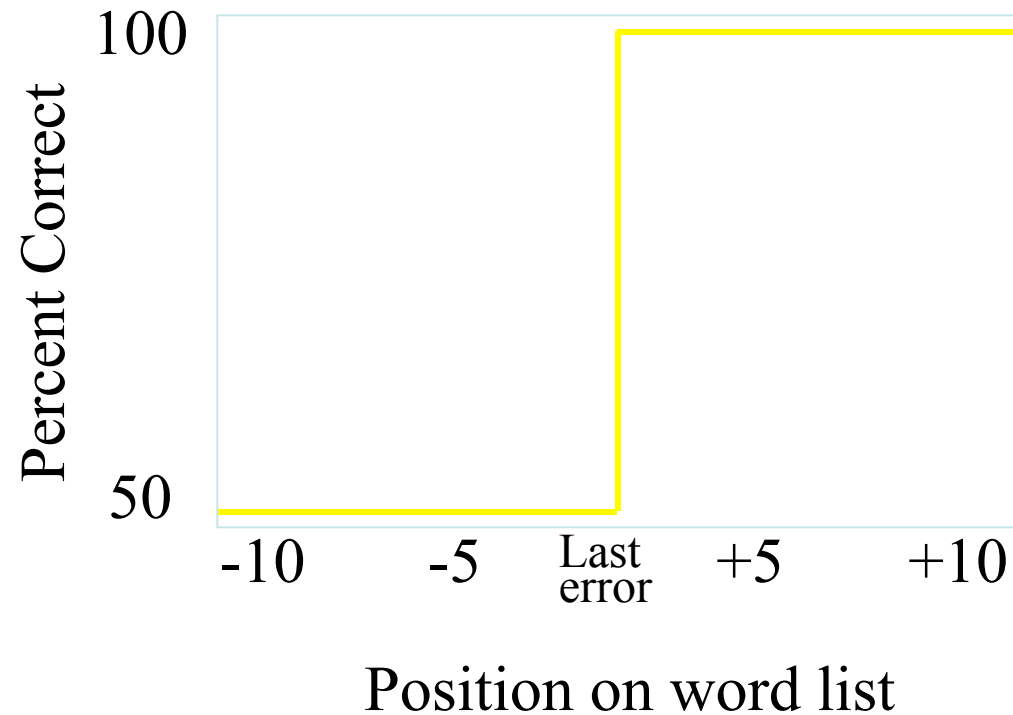
Therefore, learning is gradual?

Why is this conclusion wrong?

May be averaging over individuals who learn at different rates, but when they learn, they go immediately from 50% to 100%

Backward Learning Curve

Plot graph by lining subjects up according to last error made.



Learning in each subject is all-or-none

Moral: Make sure that you are not averaging inappropriately