Lecture #10

Control problems in Experimental Research

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Contextual Interference Effects on the Acquisition, Retention, and Transfer of a Motor Skill

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This study was based on Battig's conceptualization that increased contextual interference during skill acquisition can lead to improved retention or transfer, especially under changed contextual conditions. Subjects learned three motor tasks under a blocked (low interference) or random (high interference) sequence of presentation. Retention was measured after a 10-min. or 10-day delay under blocked and random sequences of presentation. Subsequent transfer to a task of either the same complexity or greater complexity than the originally learned tasks was also investigated. Results showed that retention was greater following high interference (random) acquisition than after low interference (blocked) acquisition when retention was measured under changed contextual interference conditions. Likewise, transfer was greater for high interference (random) acquisition groups than for low interference (blocked) acquisition groups. This effect was most notable when transfer was measured for the transfer task of greatest complexity. These results are considered as support for Battig's conceptualization of contextual interference effects on retention and transfer. Implications for the teaching of motor skills are also discussed.

Questions

- Big Question: How should we practice a motor skill to optimize learning?
- Specific Question: What's better, practicing the same thing over and over, or practicing different things?

Task

- Practice performing a sequence of movements
- Each subject learned 3 different sequences

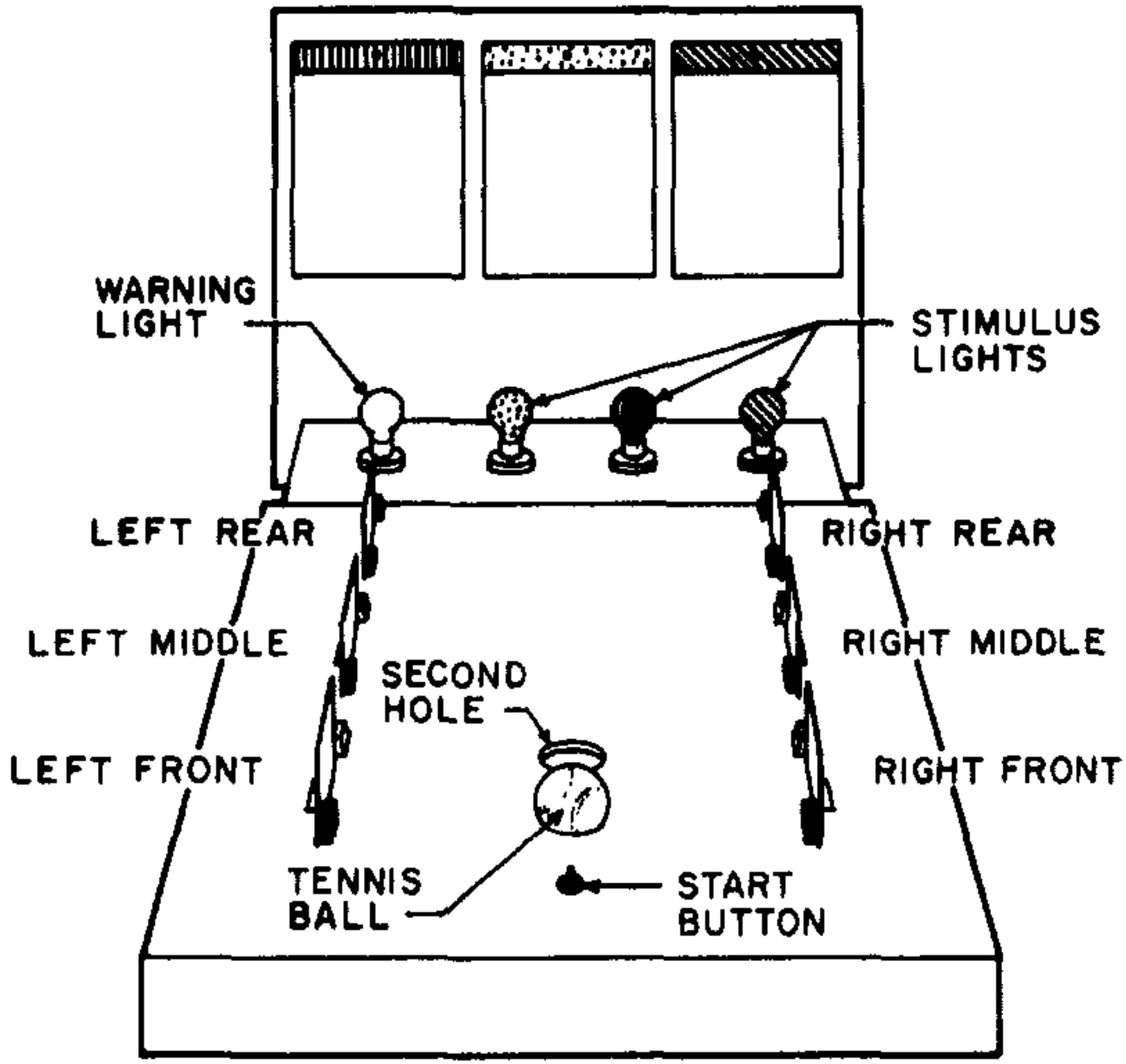
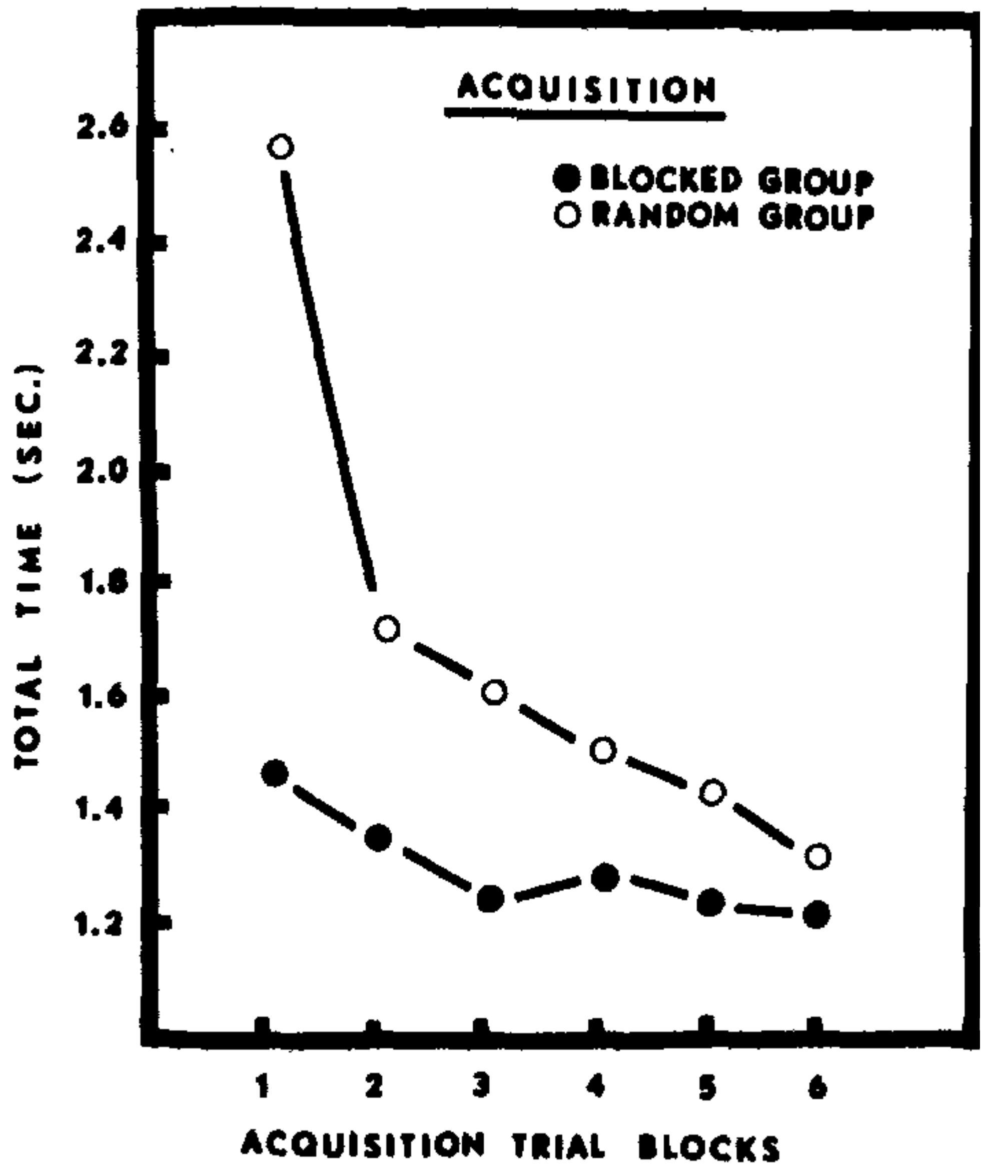


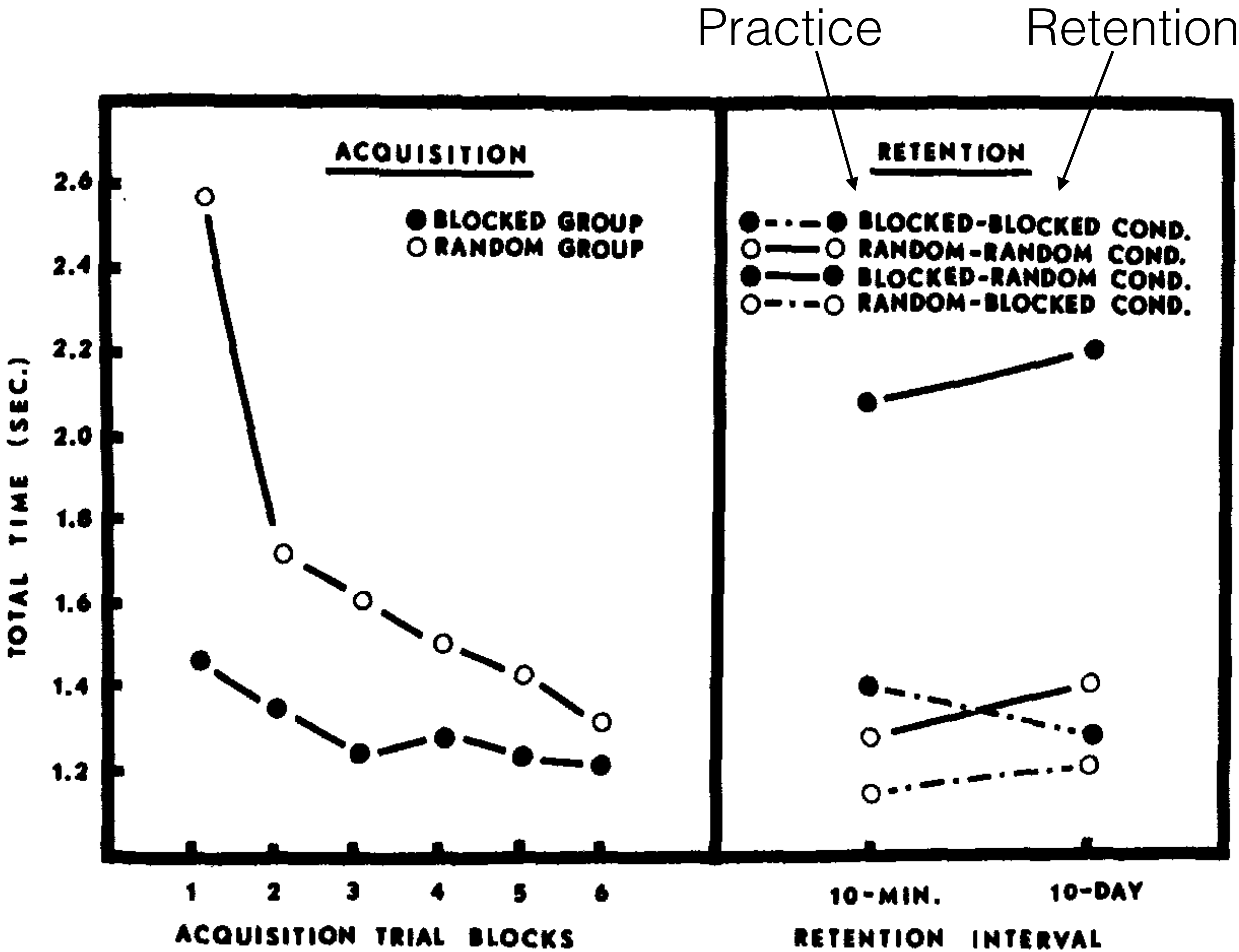
Figure 1. Diagram showing the apparatus used in the experiment form the perspective of the subject.

Manipulation

	Practice Phase 1	Practice Phase 2	Practice Phase 3
Blocked	Sequence 1 18 times	Sequence 2 18 times	Sequence 3 18 times
Random	Sequence 1,2,3 6 each randomized	Sequence 1,2,3 6 each randomized	Sequence 1,2,3 6 each randomized

Practice Results





Practice
Retention
ACQUISITION
BLOCKED GROUP
RANDOM GROUP
RETENTION
BLOCKED-BLOCKED COND.
RANDOM-RANDOM COND.
BLOCKED-RANDOM COND.
RANDOM-BLOCKED COND.
TOTAL TIME (SEC.)
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1
2
3
4
5
6
ACQUISITION TRIAL BLOCKS
10-MIN.
10-DAY
RETENTION INTERVAL

Major findings

- Blocked practice -> better performance, worse retention (appeared to learn more during practice, but showed they learned less on retention test)
- Random practice -> worse performance, better retention (appeared to learn less during practice, but showed they learned more on retention test)

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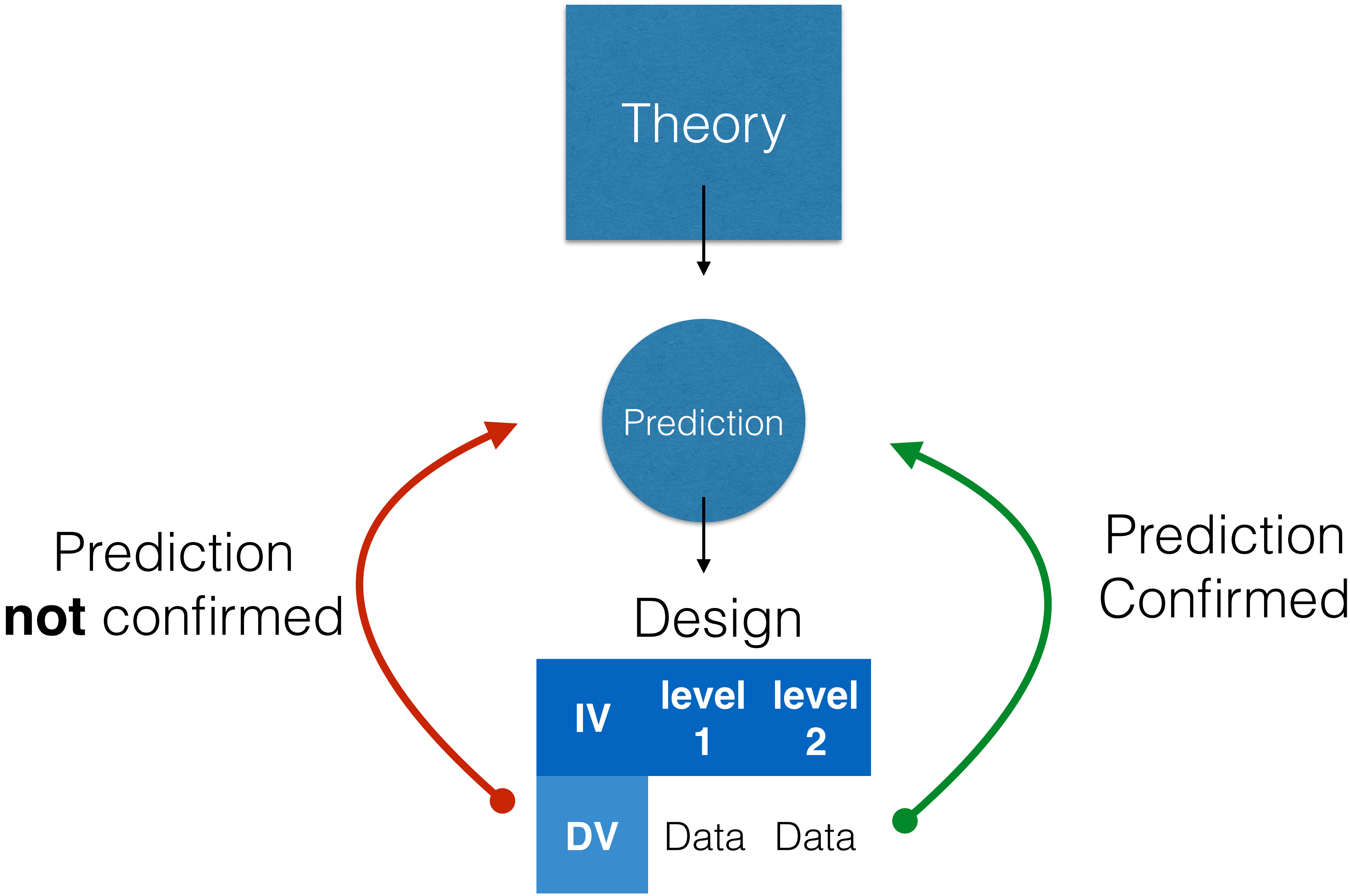
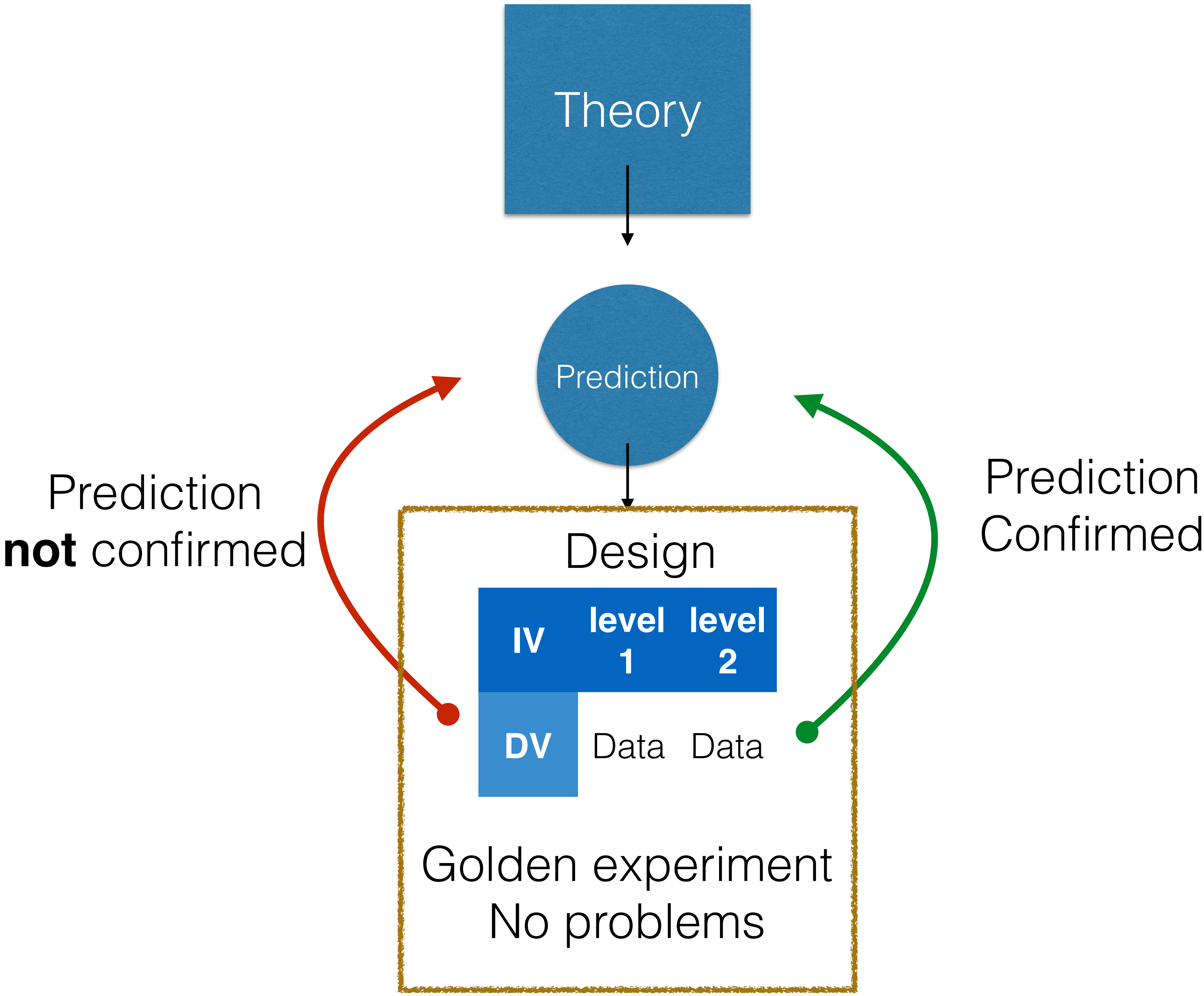
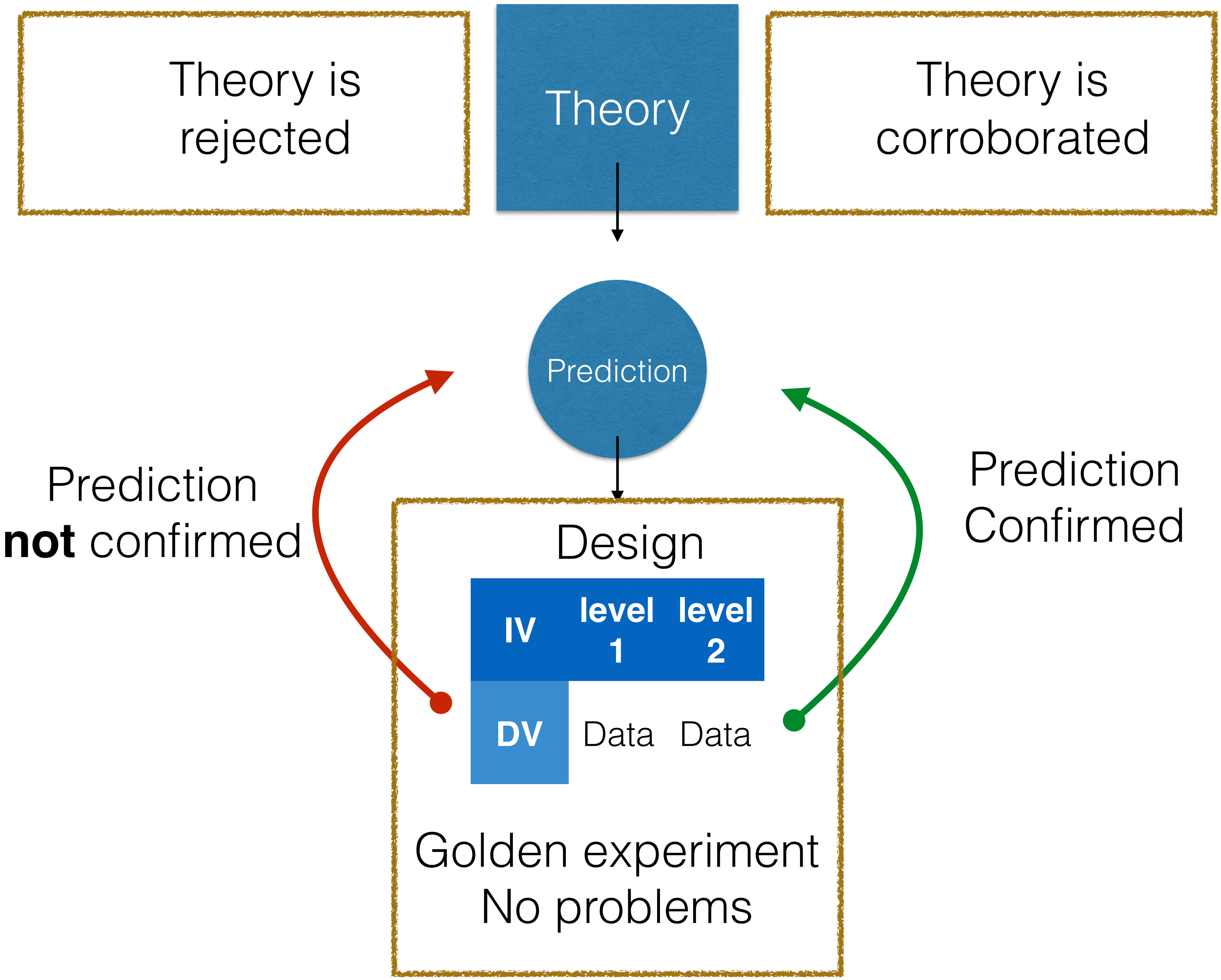
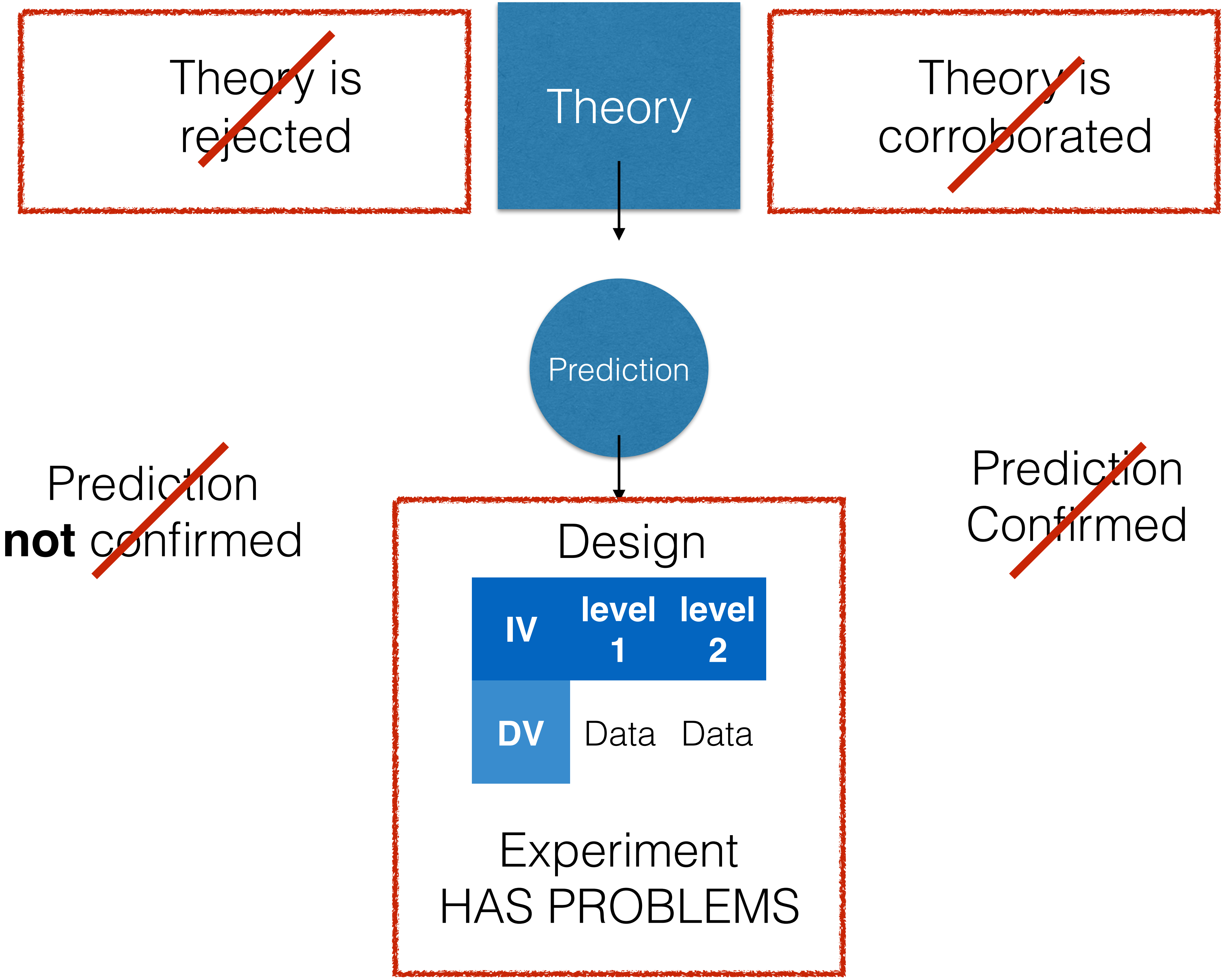
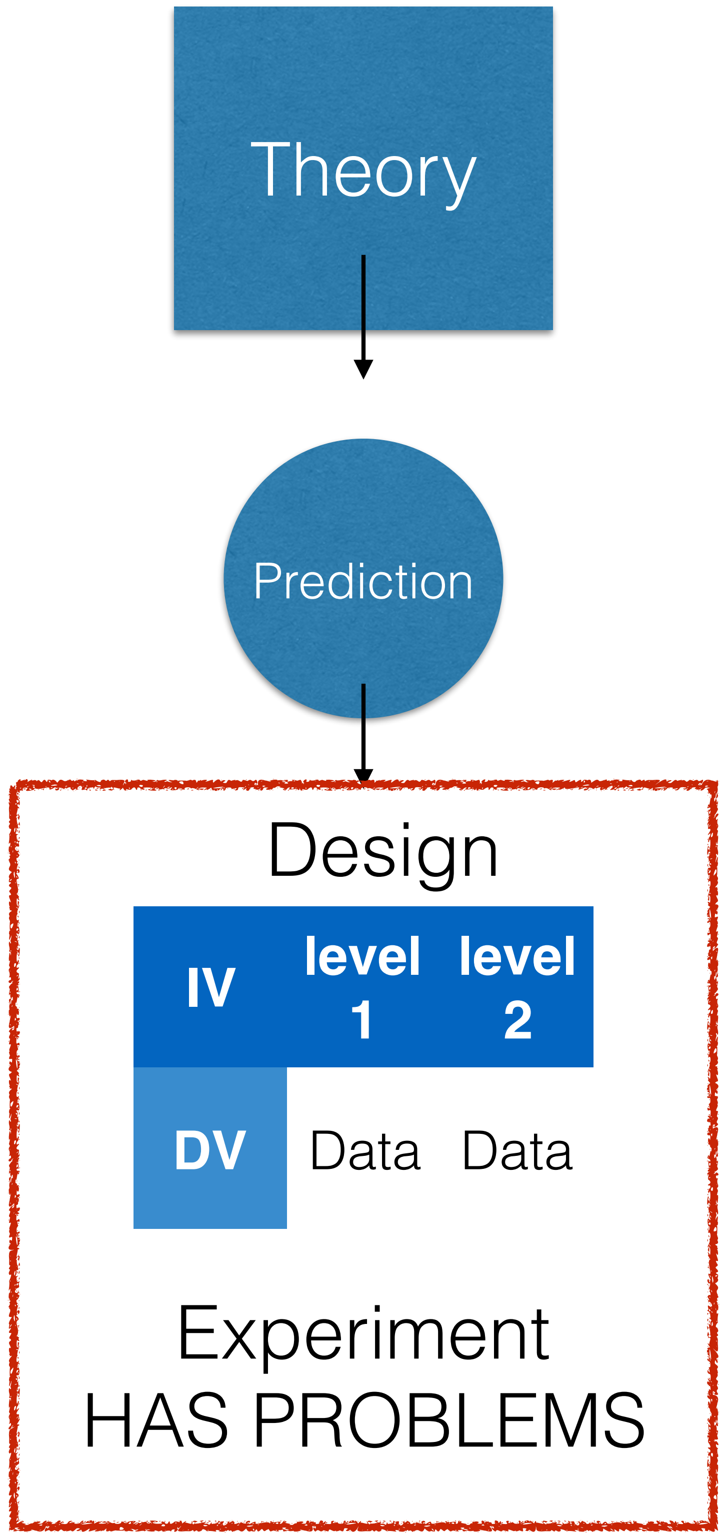

Theory
Prediction
Design
IV
level 1
level 2
DV
Data
Data
Prediction
not confirmed
Prediction
Confirmed


Theory
Prediction
Prediction
not confirmed
Prediction
Confirmed
Design
IV
level 1
level 2
DV
Data
Data
Golden experiment
No problems


Theory is rejected
Theory
Theory is corroborated
Prediction
Prediction **not** confirmed
Prediction Confirmed
Design
IV
level 1
level 2
DV
Data
Data
Golden experiment
No problems


~~Theory is rejected~~
Theory
~~Theory is corroborated~~
Prediction
~~Prediction **not** confirmed~~
~~Prediction Confirmed~~
Design
IV
level 1
level 2
DV
Data
Data
Experiment
HAS PROBLEMS



Results could be driven by IV (manipulation)

Results could be driven by a **confound**

Control problems in experimental research

- **Between/ within subject designs**
- Equivalent groups, Randomization, matching
- Sequence, item, & repetition effects
- Counterbalancing
- Experimenter bias
- Participant bias

Between subjects vs. within subjects designs

- Manipulations (IVs) can be conducted using two basic research designs

- Between-subjects

    - One group of subjects receives one treatment, a different group of subjects received another treatment

- Within-subjects

    - All subjects receive both levels of treatment

    - sometimes also called repeated measures design

Between and within Designs and sources of variability

- There are many reasons why a dependent variable may change

1. the independent variable

2. Variance due to error

    1. systematic due to a confound, or uncontrolled variable

    2. nonsystematic, random, unknown

Between-subjects & sources of variability

What are the possible reasons for the difference between groups?

Golf pro group A	Golf Ball A	Golf pro Group B	Golf Ball B
Pro 1	255	Pro 6	269
Pro 2	261	Pro 7	266
Pro 3	248	Pro 8	260
Pro 4	256	Pro 9	273
Pro 5	245	Pro 10	257
M SD	253 6.44	M SD	265 6.52

Within subjects & sources of variability

What are the possible reasons for the difference between groups?

Golf pro group A	Golf Ball A	Golf Ball B
Pro 1	255	269
Pro 2	261	266
Pro 3	248	260
Pro 4	256	273
Pro 5	245	257
M SD	253 6.44	265 6.52

Why use Between subjects?

- Usually because the question demands the design:
    - necessary when participating in condition makes it impossible for the same person to be in a second condition
- Try to avoid these designs when possible

Example: Change blindness

http://www.youtube.com/watch?v=1foEfsm5a0Y&NR=1

http://www.youtube.com/watch?v=hj_SmXBEnho&feature=related

Example: Change blindness

Once you have seen the change, you can't unsee it

As a participant you get to participate in just one condition, and it could be pointless for you to participate in the control or comparison condition involving the same item

Control problems in experimental research

- Between/ within subject designs
- **Equivalent groups, Randomization, matching**
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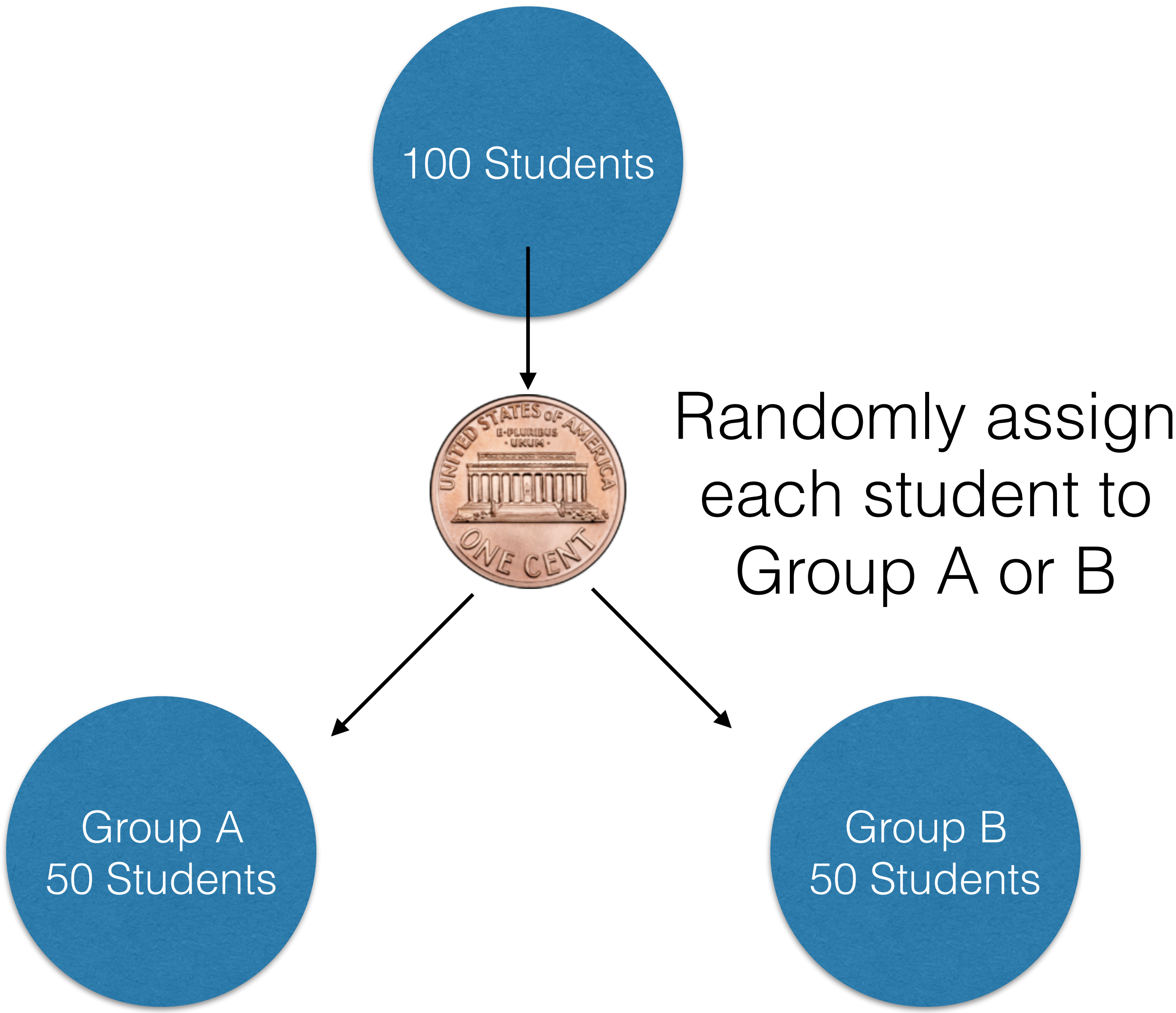
Between subjects: The equivalent groups problem

- If a difference between experimental conditions is found, is it due to:
  - 1. The Experimental manipulation?
  - 2. The fact that the groups had different people in them?

Random Assignment

- People get assigned randomly into groups
  - Any given person has the same chance of being in any given group

Why is it important to do this?


100 Students
Randomly assign each student to Group A or B
Group A
50 Students
Group B
50 Students

Random Assignment: The farming example

You are a farmer, and you have a big field

Random Assignment: The farming example

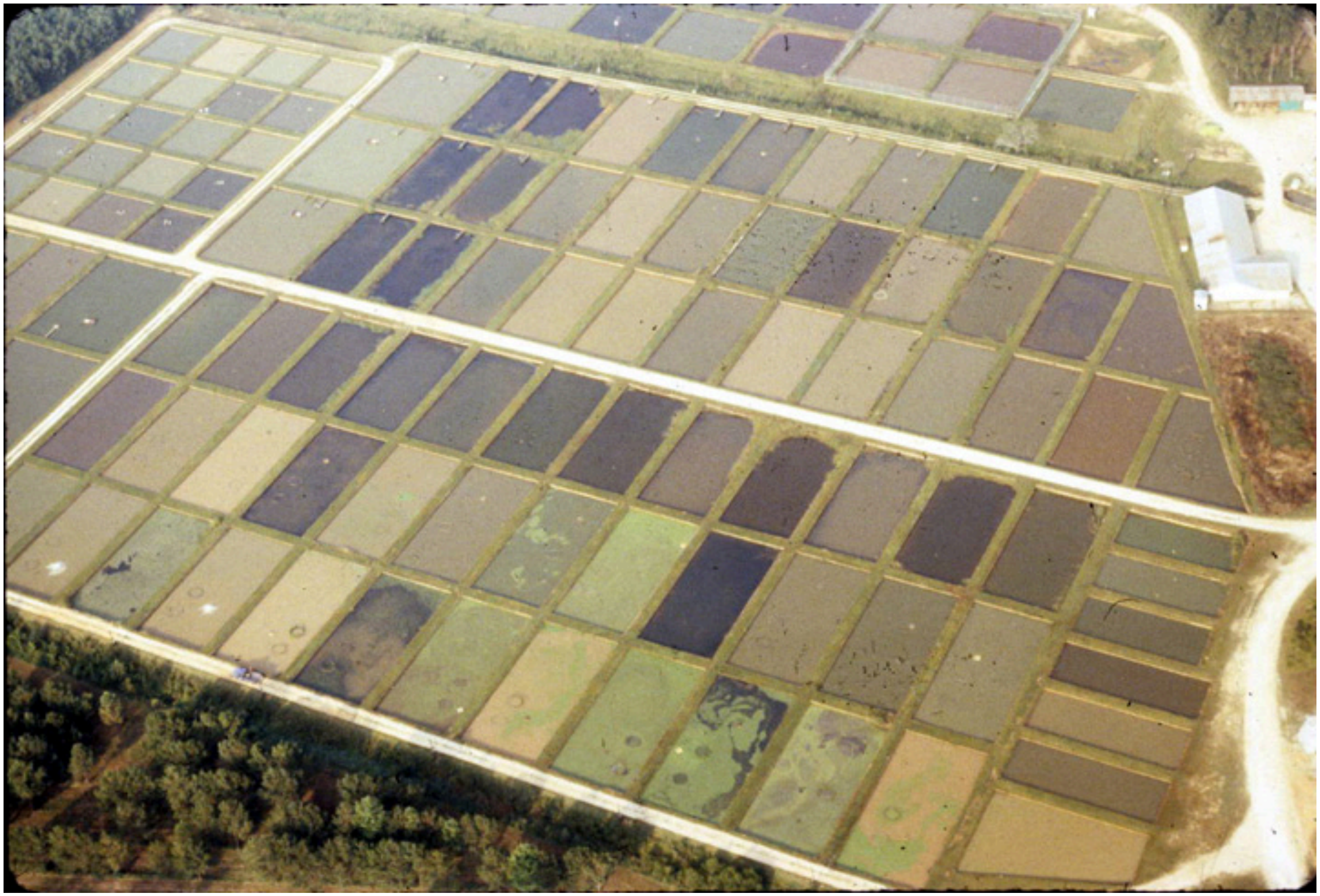
You are a farmer, and you have a big field

What kind of experimental test can you conduct to determine if your new fertilizer actually improves crop growth?

C'MON OUT TO THE FARM FOR A TEXAS-SIZED GOOD TIME

FARM FRESH FUN IS A FAMILY TRADITION


BEES ONLY
CALF ROPE
TOKENS
GET LOST!
MAIZE
Fort DewHickey
THE BLACK HOLE
GEMS
BBQ
PAVILION
DEWBERRY FARM
A FAMILY TRADITION
BAKERY
TICKETS
COUNTRY STORE
WELCOME!
RUBBER DUCK RACES
PIG RACES
C'MON OUT TO THE FARM FOR A TEXAS-SIZED GOOD TIME
FARM FRESH FUN IS A FAMILY TRADITION



What does Random Assignment accomplish?

What does Random Assignment accomplish?

- Experiments are interested in whether X causes some change in Y

- Experiments happen in the real world, and the world is full of other factors that can change Y, even if we try to control everything

- Randomization attempts to spread out the influence of these extraneous variables.

What does Random Assignment accomplish?

- Randomization attempts to spread out the influence of these extraneous variables.

- Attempts to make all other unwanted factors contribute equally to the experiment, this way they have “no effect”, or an equal effect

Problems with random assignment

- Random assignment is just one method to make groups equivalent

- Randomness can not guarantee that all groups are equal

- Mathematically things equal out in the long run, but when there are small groups of subjects randomization can create very unequal groups

Matching

- Instead of randomly assigning people into groups, the experimenter can make sure the same kinds of people are in the different groups

- Age-matched controls

- IQ matched controls

Within subjects

- All subjects are exposed to all levels of the independent variable

- If a difference between experimental conditions is found, is it due to:

    - 1. The Experimental manipulation?

    - ~~2. The fact that the groups had different people in them?~~
      ~~- *no the within subjects design rules out this confound*~~

    - 3. The order in which subjects experienced the different levels of the independent variable

Advantages to within-subjects

- Less subjects are needed because everyone participates in each level of the design
- rules out the confound of experimental groups (no group equivalence problem)
- determine changes within individuals and not between groups

Problem with within-subjects design

- Sequence or order effects
- People have to something first, and then something else second
- The first thing might influence the second thing
- People get better with practice
- The influence of a manipulation may change with time, get bigger or smaller

Control problems in experimental research

- Between/ within subject designs
- Equivalent groups, Randomization, matching
- **Sequence, repetition, and item effects**
- Counterbalancing
- Experimenter bias
- Participant bias

Sequence effects

- Within-subject designs present experimental manipulations in sequence

- What is a sequence effect?

- How do we control for sequence effects?

Sequence effects

- Any case where the order of the IV manipulation has an effect on the measure (DV)

Progressive sequence effects

- General effects of time spent on task across trials
    - e.g., practice, performance gets better
    - fatigue, boredom, performance gets worse

Example: Is memory better for different word categories?

Animals Cities Vehicles Kitchen items

Memorize Recall Memorize Recall Memorize Recall Memorize Recall

Time on Task

Carryover sequence effects

- Performance depends on the specific sequence of events

Carryover sequence effects

- The task switching cost is a carry-over sequence effects

Last trial	Current trial		
odd/even	odd/even	→	fast performance
odd/even	magnitude	→	slow performance

Repetition effects

- Occurs whenever repeating something influences performance
- E.g., Repetition priming

Repetition effects

Last trial	Item	Current trial	Item
odd/even	3	odd/even	3

Confound: Performance could be faster on current trial because of item repetition (not task repetition)

Item effects

- Some test items are harder or easier than others
- If your conditions have different items, then the items are confounded with your manipulation

Control problems in experimental research

- Between/ within subject designs
- Equivalent groups, Randomization, matching
- Sequence, repetition, and item effects
- **Counterbalancing**
- Experimenter bias
- Participant bias

Counterbalancing

- Formal method for controlling order effects, and item effects

Complete counterbalancing

- Identify every possible sequence (X factorial, or X!)
    - $3! = 3 \times 2 \times 1 = 6$
    - $4! = 4 \times 3 \times 2 \times 1 = 24$

Say, three conditions A B C, there are 6 possible orders

ABC
ACB
BCA
BAC
CAB
CBA

Ensure an equal number of subjects participate in each order

Example

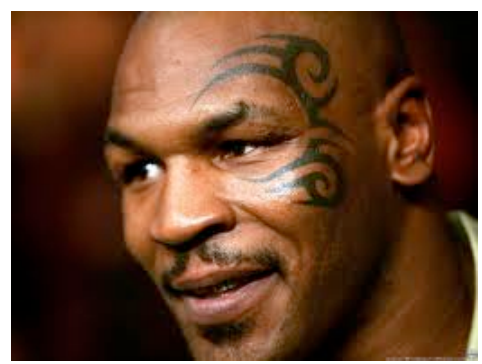
- Running a blocked face inversion task

List A




List B






Example

- Full counterbalance fully crosses the order of the lists with the order of the conditions

	Block 1	Block 2
1	List A Upright	List B Inverted
2	List B Upright	List A Inverted
3	List B inverted	List A upright
4	List A Inverted	List B Upright

Partial counterbalancing

- Identify every possible sequence (X factorial, or X!)
    - $3! = 3 \times 2 \times 1 = 6$
    - $4! = 4 \times 3 \times 2 \times 1 = 24$
    - $5! = 5 \times 4 \times 3 \times 2 \times 1 = 120$

Options

1. Randomly sample from the possible sequences
2. Use a latin square

Latin Square

- Every item occurs equally often in each position
- every item comes before, and after every other item exactly once

Different orders

A	B	F	C	E	D
B	C	**A**	D	F	E
C	D	B	E	**A**	F
D	E	C	F	B	**A**
E	F	D	**A**	C	B
F	**A**	E	B	D	C

Reverse counterbalance

1. Do the experiment in one order, and then redo it in the reverse order

ABCD -> DCBA

Block randomization

1. Randomly pick orders, but make sure that every condition occurs once before it repeats

BCDA -> CADB

Summary: Counterbalancing & randomization

Counterbalancing and Randomization are essential strategies for controlling against item and sequence effects

Control problems in experimental research

- Between/ within subject designs
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