PSY 501: Research Methods
Variables and Measurement

Week 6

So you want to do an experiment?

1. You've got your theory
   - *What is the behavior/cognitive process that you want to examine?*
   - *What do you think affects that behavior/cognitive process?*

2. Next, you need to derive predictions from the theory
   - *These should be stated as hypotheses.*
   - *In terms of conceptual variables or constructs*

3. Now, you need to design the experiment
   - *You need to* **operationalize** *your variables in terms of how they will be controlled, manipulated, and measured in the experiment*

An example:



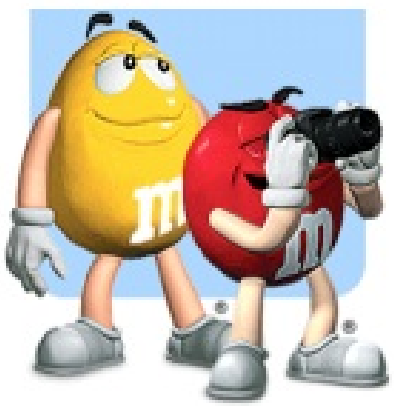
Hypothesis: Eating candy with peanuts improves memory performance

- How might we test this with an experiment?

Constants vs. Variables

Characteristics of the psychological situations:

- Constants: have the same value for all individuals in the situation
- Variables: have potentially different values for each individual in the situation



Constants:

- M&Ms are eaten

Variables:

- Type of M&M: peanut vs. plain
- Memory performance

Variables

Conceptual vs. Operational

- Conceptual variables (constructs) are abstract theoretical entities
- Operational variables are precisely defined in terms of how they will be measured or manipulated in the experiment.

Conceptual:

- Peanut candies
- Memory

Operational:

- Peanut M&Ms
- Memory score

Types of Variables

- Independent variables (explanatory)
- Dependent variables (response)
- Extraneous variables
  - Control variables
  - Random variables
- Confound variables

Independent variables

- The variables that are manipulated by the experimenter
- Each IV must have at least two levels
  - Remember: the point of an experiment is **comparison**
- Combination of all the levels of all of the IVs results in the different conditions in an experiment

Choosing your independent variable

Methods of manipulation:

1. **Straightforward manipulations**
   - Stimulus manipluation – different conditions use different stimuli
   - Instructional manipulation – different groups are given different instructions

2. **Staged manipulations**
   - Event manipulation – manipulate situational characteristics
   - May involve deception, confederates, etc.

3. **Subject manipulations**
   - There are (pre-existing, mostly) differences between the subjects in the different conditions

Choosing your independent variable

What about our candy experiment?

1 IV: Candy type (3 levels)

Peanut M&Ms

Plain M&Ms

Bottle caps

Dependent variables

- The variables that are **measured** by the experimenter
- They are "dependent" upon the independent variables

Choosing your dependent variable

How to measure your construct:

1. Can the participant provide **self-report**?
   - Introspection – specially trained observers of their own thought processes, method fell out of favor in early 1900s.
   - Rating scales – Likert scales, etc.

2. Is the dependent variable **directly observable**?
   - Choice/decision (sometimes timed)

3. Is the dependent variable **indirectly observable**?
   - Physiological measures – GSR, heart rate, etc.
   - Behavioral measures – Speed, accuracy, etc.

Choosing your dependent variable

What about our candy experiment?

- Conceptual level: Memory
- Operational level: Memory test
  - Memorize a list of words while eating the candy
  - One hour after study time, recall the list of words
  - Measure number of words recalled

Extraneous variables

Control variables – holding things constant.

- Controls for excessive random variability

Keep constant (control):

- Number of M&Ms consumed
- Time of day test taken

Extraneous variables

Random variables – may freely vary, to spread variability equally across all experimental conditions

Randomization

- A procedure that assures that each level of an extraneous variable has an equal chance of occurring in all conditions of observation
- On average, the extraneous variable is not confounded with our manipulated variable (this is the role of sample size)

- What your participants ate before the experiment
- General executive processing capacity (IQ)

Control your extraneous variables

- Can you keep them constant?
- Should you make them random variables?
- Two things to watch for:
  - Experimenter bias – experimenter may influence the results (intentionally and unintentionally)
  - Demand characteristics – cues that allow participants to figure out what the experiment is all about, hence influencing how they behave

Confound variables

Other variables that haven't been accounted for (manipulated, measured, randomized, controlled) that can impact changes in the dependent variables

Control requires good experimental design!

Choosing your independent variable

Choosing the correct range (the right levels) of your independent variable

- Review the literature
- do a pilot experiment
- consider the costs, your resources, your limitations
- be realistic
- pick levels found in the "real world"
- pick a large enough range to show the effect

Potential problems

These are things that you want to try to avoid by careful selection of the levels of your IV (issues for your DV as well)

- Demand characteristics
- Experimenter bias
- Reactivity
- Floor effects
- Ceiling effects

Demand characteristics

- Characteristics of the study that may give away the purpose of the experiment
- May influence how the participants behave in the study

Experimenter bias

The experimenter may influence the results (intentionally and/or unintentionally)

- E.g., Clever Hans

One solution is to keep the experimenter "blind" as to what conditions are being tested

- Single blind – participant doesn't know the condition
- Double blind – neither the participant nor the experimenter knows the condition

Reactivity

Having the participant knowing that they're being measured

- just being in an experimental setting, people don't respond the way they "normally" would
- "good subjects" – try to figure out and confirm your hypothesis
- "bad subjects" – try to mess things up

Floor effects

A value below which a response cannot be made

- Imagine a task that is so difficult that none of your participants can do it
- As a result, the effects of your IV can't be seen

Ceiling effects

When the dependent variable reaches a level that cannot be exceeded

- Imagine a task that is so easy that everybody scores a 100% (imagine accuracy is your measure)
- So while there may be an effect of the IV, that effect cannot be seen because everybody has "maxed out"

So, you want to pick levels of your IV that result in **middle level performance in your DV**

Measuring your dependent variables

Scales of measurement:

- nominal scale
- ordinal scale
- interval scale
- ratio scale

The scale you use will (partially) determine what kinds of statistical analyses you can perform!

Scales of measurement

A **nominal scale** consists of a set of categories that have different names

- Measurements on a nominal scale label and categorize observations, but do not make any quantitative distinctions between observations
- e.g., eye color: brown, blue, black, hazel, green

Scales of measurement

An **ordinal scale** consists of a set of categories that are organized in an ordered sequence

- Measurements on an ordinal scale rank observations in terms of size or magnitude
- e.g., T-shirt size: Sm, Med, Lrg, XL, XXL

Scales of measurement

An **interval scale** consists of ordered categories where all the categories are intervals of exactly the same size.

- With an interval scale, equal differences between numbers on the scale reflect equal differences in magnitude.
- Ratios of magnitudes are not meaningful
- e.g., Fahrenheit temperature scale

Scales of measurement

A **ratio scale** is an interval scale with the additional feature of an absolute zero point

- With a ratio scale, ratios of numbers DO reflect ratios of magnitude
- e.g., height, weight

Reliability and validity of your measures

Reliability

- If you measure the same thing twice, do you get the same value?

Validity

- Does your measure really measure what it is supposed to measure?

Reliability

- True score + measurement error
  - A reliable measure will have a small amount of error
- Test-retest reliability
  - Test the participants more than once
- Internal consistency reliability
  - Multiple items testing the same construct
- Inter-rater reliability

Validity

- Face validity
- Construct validity
- External validity
- Internal validity
- Many others (e.g., convergent, discriminant, criterion, etc.)

Face validity

At the surface level, does it look as if the measure is testing the construct?

Construct validity

Usually requires multiple studies, a large body of evidence that supports the claim that the measure really tests the construct

External validity

Are experiments "real life" behavioral situations, or does the process of control put too much limitation on the "way things really work?"

External validity

- Variable representativeness – relevant variables for the behavior studied along which the sample may vary
- Subject representativeness – characteristics of sample and target population along these relevant variables
- Setting representativeness – ecological validity

Internal validity

- The accuracy of the results
- Did the change result from changes in the IV or did it come from somewhere else

Threats to internal validity

- History – an event happens in the experiment
- Maturation – participants get older (and other changes)
- Selection – nonrandom selection can lead to biases
- Mortality – participants drop out or can't continue
- Testing – being in the study actually influences how the participants respond
- Statistical regression – regression toward the mean.
  - If you select participants based on high (or low) scores (e.g., IQ, SAT, etc.), their scores later tend to move toward the mean.

Debugging your study

- Pilot studies
  - A trial run-through
  - Don't plan to publish these results, just try out the methods
- Manipulation checks
  - An attempt to directly measure whether the IV really affects the DV
  - Look for correlations with other measures of the desired effects