2-Group Multivariate Research Designs & Analyses

- A "Collection of Concerns"
- Reasons & Advantages for Multivariate designs
  - Increased effects
  - Increased specificity
  - Considering confounds

Words of Caution About the terms "IVs", "DVs" & causal RH:s ...

You might have noticed that we've not yet used these terms..

- Instead we've talked about "causal variables" and "effect variables" -- as you probably remember..
  - the Independent Variable (IV) is the "causal variable"
  - the Dependent Variable (DV) is the "effect variable"

- However, from the last slide, you know that we can only say the IV ***causes*** the DV if we have ***a true experiment (and the internal validity it provides)***
  - initial equivalence (control of subject variables)
    - random assignment of participants
  - ongoing equivalence (control of procedural variables)
    - experimenter manipulates IV, measures DV and controls all other procedural variables

The problem seems to come from there being at least three different meanings or uses of the term "IV" ...

1 "the variable manipulated by the researcher"
- it's the "IV" because it is "independent" of any naturally occurring contingencies or relationships between behaviors
- the researcher, and the researcher alone, determines the value of the IV for each participant

2 "the grouping, condition, or treatment variable"

3 "the presumed causal variable in the cause-effect relationship"

In these last two, both the "IV" & "DV" might be measured !!! So…

- you don't have a True Experiment ...
  - no IV manipulation to provide temporal precedence
  - no random assignment to provide init. eq. for subject vars
  - no "control" to provide onging eq. for procedural variables
- … and can't test a causal RH:

Study attributes that do and don't directly influence the causal interpretability of the results & a couple that make it harder

Attributes that DON'T directly influence causal interpretability…

- Participant Selection (population part of external validity)
- Setting (setting part of external validty)
- Data collection (measurement validity)
- Statistical model (statistical conclusion validity)

Attributes that DO directly influence causal interpretability…

- Participant Assignment (initial eq. part of internal validity)
- Manipulation of the IV (ongoing eq. part of internal validity)

Attributes that make it harder to causally interpret the results …

- Field experiments (harder to maintain ongoing equivalence)
- Longer studies (harder to maintain ongoing equivalence)

Some of those combinations …

Research "Types" named for the data collection used

- "Survey research"
- "Observational research"
- "Trace research"

Usually implies a non-experiment conducted in the field

Remember: Any data collection method can be used to obtain causally interpretable data it is part of a properly conducted true experiment.

Research "Types" named for the research setting used

- "Field research" **usually implies a non-experiment**
- "Laboratory research" **usually implies an experiment**
- "Trace research"

Remember: Any research setting can be used to obtain causally interpretable data it is part of a properly conducted true experiment.

Research "Type" seemingly named for the statistical analysis used

- "Correlational research" **usually implied a non-experiment**

Remember: Any data collection method can be used to obtain causally interpretable data it is part of a properly conducted true experiment.

So… Can all causal RH: be tested ?????

The short version is …

Not all causal RH: can be tested because technology, ethics, and/or resources can prevent us from conducting a properly run True Experiment with random assignment of individual participants, IV manipulation and control of ongoing equivalence.

The complete answer has three parts:

Part #1: What is required to test a causal RH: ??

To test a Causal RH: you must have a properly run True Experiment !!

You must have …

- Random assignment of individual participants to IV conditions by the researcher before manipulation of the IV
- Manipulation of the IV by the researcher
- Control of the experimental procedure so that there are no ongoing equivalence confounds

So… Can all causal RH: be tested ????? continued

Part #2: We can't always run a True Experiment

Not all IVs can be randomly assigned and manipulated !!

- Sometimes we are prevented from randomly assigning individuals to specific conditions of the IV
- Sometimes we are unable to manipulate the IV – that is to "produce" the value of the IV that each participant has

Part #3: Three things may prevent us from performing RA & manipulation of some IVs

Insufficient technology - some things we "can't RA & manipulate" !

Ethics - some things we've decided "shouldn't RA & manipulate" !

Resources -- tech. exists to perform the study and it is "allowed,"

but you "can't afford to RA & manipulate"

The Relationship between Internal & External Validity

There are two different ways to think about the relationship between these two types of validity. Actually they are mutually exclusive, but we seem to alternate between using them both

- "Trade-off" characterization
  - it is impossible to promote both internal and external validity within a single study
  - the researcher must choose which will be emphasized in a particular study
    - internal validity (control)
    - external validity (representativeness)
- "Precursor" characterization
  - without causal interpretability (from having internal validity), what is there to generalize ???
  - focuses on causal information - suggesting associative information is not valuable

Multivariate Research -- when there are multiple DVs

Advantages of Multivariate Research

Increasing the Number of "Effects" in theResearch

- by including measures of multiple possible effects, we have a greater chance of finding "an effect" -- something that is influenced by or related to the IV
- e.g., If the IV were some sort of clinical treatment, using the Beck Depression Inventory & State Anxiety Measure & Somatic Complaint Scale gives us a better chance of detecting some type of "improvement" than would using just one of these
- research is costly (time & $) -- multiple measures typically add little to the cost but increase the chances of "finding something"

Advantages of Multivariate Research, cont.

Increasing the specificity of "the effects" we find

- there is no one measure that is the perfect representation of "the effect" we are studying -- different measures of "the same thing" often are only moderately correlated (r = .3-.5)
- using multiple related DVs allows us to more precisely define what is "the effect"
- e.g., If the construct DV under study were anxiety, we might want to have measures of anxiety physiological measures, self-report measures, observational measures
- that we we can better specify what we mean when we say 'the treatment decreases anxiety" because we can say what types of anxiety showed the effect and which didn't

Advantages of Multivariate Research, cont.

Combining the Two Approaches in a Single Study

multiple indices of multiple constructs

- give the most precise and dependable results
- greater chance of finding something influenced by IV
- greater specificity about what is (& isn't) influenced by IV
- replication is still important

• by using Beck Depression Inventory, MMPI Depression Scale, MCMI Depression Scale, State Anxiety Measure, Trait Anxiety Measure, Somatic Complaint Scale, MMPI Hypochondriasis Scale would allow us to determine if the treatment is specific to depression (& what "kind"), or includes anxiety and/or somatic complaints (& what "kinds")

Using Multiple DVs in Quasi-Experimental and Natural Groups Designs

Remember that "confounds" come in two kinds

- subject variable confounds
  - IV groups start with different means, on something like age, education, personality attributes or motivation
- procedural variable confounds
  - during IV manipulation or DV measurement, something besides the IV is done differently between the IV conditions, like instructions, amount of stimulus exposure or practice

The presence of either type of confound interferes with the causal interpretation that mean differences on the DV indicate an effect of the IV

- confounds provide an "alternative hypothesis" about what caused the DV differences for the IV conditions

Using Multiple DVs in Quasi-Experimental and Natural Groups Designs, cont.

Measuring subject variables that you fear may be subject variable confounds can help

- any subject variable that does have a mean difference between IV conditions is a subject variable confound -- can't causally interpret the results of the study !!!
  - that subject variable is an "alternative hypothesis"
- any subject variable that does not have a mean difference between the IV conditions can't possibly be a confounding subject variable
- remember that a subject variable working "against" the IV is a confound (technically), but does not refute that the IV may be causing the effect!
- you can't give a causal interpretation to the study, but you can establish whether or not a particular subject variable is a likely

Multivariate approach to confound evaluation

Design is a quasi-experiment w/o random assignment of participants – 2 different kinds of exam prep

		Tx	control	p	r
Intended DV % correct on the exam	-- looks pretty good !	89%	78%	.02	.38
% grade on last exam	-- effect in same direction a likely confound	86%	77%	.02	.37
GPA prior to this class	-- no effect – can't be confound of the IV-DV relationship	2.87	2.86	.95	.001
Exam prep time (hrs)	-- a confound (even though not "inflating" the IV/DV relationship)	2.22	2.78	.03	.29
Credit card interest rate	– a "statistical" confound – relationship to DV is either complicated or spurious	14.3	17.1	.04	.12

Where we go from here ...