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***Social Science
Research Methods***

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Overview

- Constructs, Variables and Definitions
- Reliability
- Validity
- Measurement Theory
- Research Design
- Internal Validity
- External Validity
- Research Design Principles
- Experimental Validity
 - ★ Internal, External, Construct, Statistical Conclusion

Constructs, Variables and Definitions

- Independent variables
 - * Presumed causes
 - * Antecedent
 - * Manipulated by the experimenter
 - * Predicted from
- Dependent variables
 - * Presumed effects
 - * Consequent
 - * Predicted to
- Stimulus – Response
- Predictor – Criterion

Constructs, Variables and Definitions

- Active variables
 - ★ *Manipulated by the experimenter*
- Attribute variables
 - ★ *Measured*
- Continuous variables
 - ★ *Capable of taking on an ordered set of values within a given range*
- Categorical variables
 - ★ *Assigned to subsets based on characteristics*

Constructs, Variables and Definitions

■ Latent variables

- ★ Unobserved entities presumed to underlie observed variables
 - ◆ Preferable to some alternative terms
 - ◆ Can now be assessed via analyses of covariance structures such as Structural Equation Modeling (using specialized software such as LISREL or EQS)

Theory Building

- “A theorist is considered great, not because his theories are true, but because they are interesting.” (Murray Davis, 1971)
- “Theories do not gain hegemony because they are better than their predecessors, but because they are able to attract adherents and withstand attacks from those who hold other positions.” (Graham Astley, 1985)

Theory Building

- Gioia & Pitre (1990) define theory as any coherent description or explanation of observed or experienced phenomena
- Appropriate approaches to theory building depend on the paradigmatic assumptions brought to bear on a topic
- Paradigms (based on Burrell and Morgan, 1979)
 - ★ **General perspective or way of thinking**
 - ◆ Functionalist (*dominant* paradigm)
 - Objective, maintain status quo
 - ◆ Interpretivist
 - Subjective, maintain status quo
 - ◆ Radical Humanist
 - Subjective, radically change constructed realities
 - ◆ Radical Structuralist
 - Objective, radically change constructed realities

Theory Building

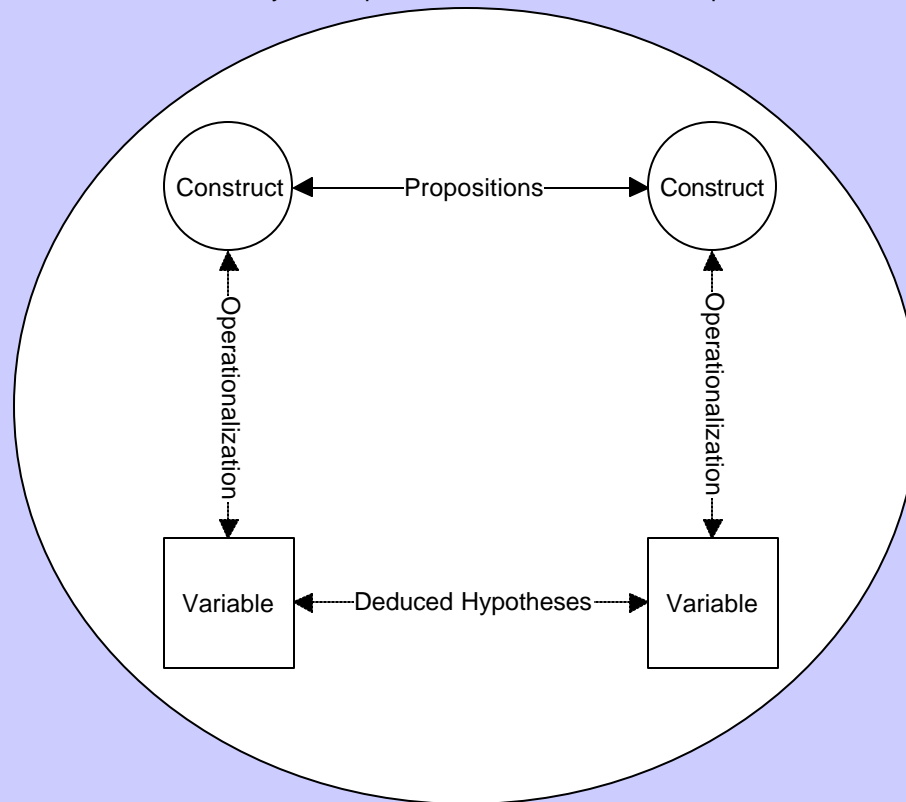
- “A theory is a statement of relations among concepts within a set of boundary assumptions and constraints The purpose of theoretical statements is twofold: to organize (parsimoniously) and to communicate (clearly)

. . . .

In more detailed terms, a theory may be viewed as a system of constructs and variables in which the constructs are related to each other by propositions and the variables are related to each other by hypotheses.”
(Samuel Bacharach 1989)

Theory Building

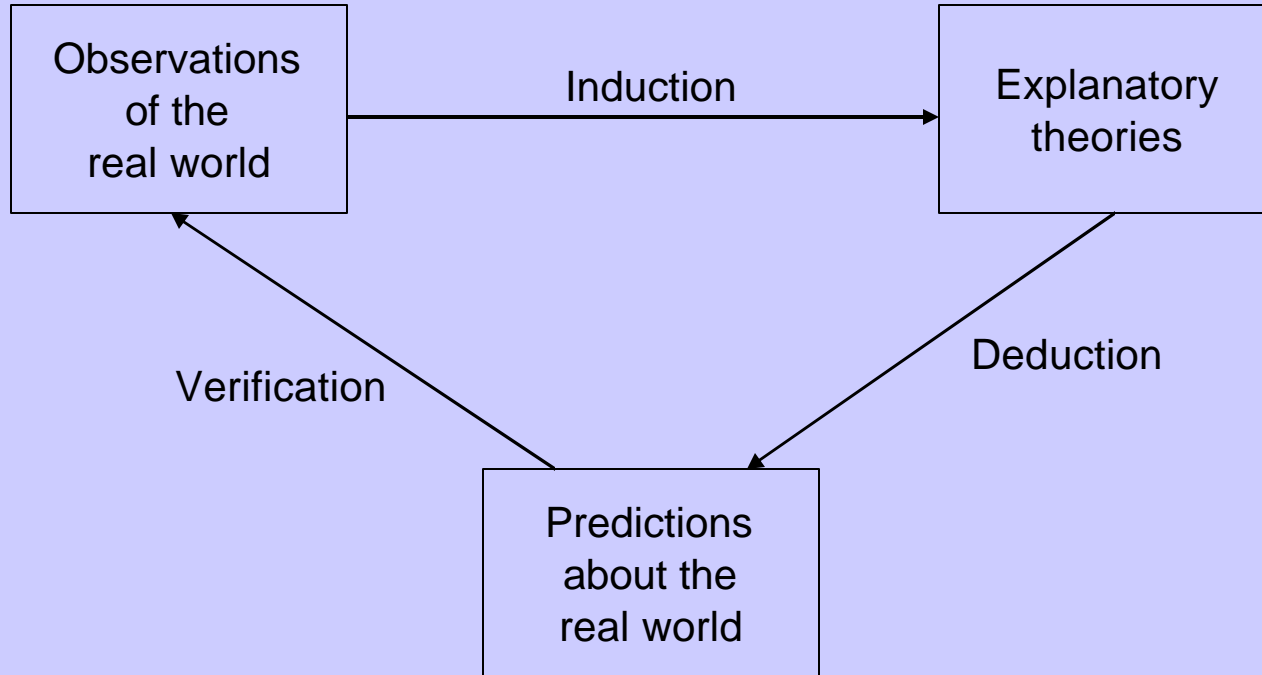
Boundary assumptions about values, time and space



Theory Building

- “The two primary criteria upon which any theory may be evaluated are (a) falsifiability and (b) utility.” (Bacharach)
- Brief and Dukerich argue against the usefulness criterion
- Qualitative v. quantitative research
 - ★ *Naturalistic inquiry*

The Hypothetico-Deductive Method



Normative, Descriptive, Prescriptive Models

■ Models

- ★ A model is “a representation of reality to explain the behavior of some aspect of it” (Montgomery & Urban, 1969)
- ★ Some researchers use ‘model’ and ‘theory’ interchangeably
- ★ Some researchers distinguish
 - ◆ Theoretical models (causal models)
 - ◆ Descriptive models based on studying behavior

Normative, Descriptive, Prescriptive Models

■ Models

- ★ Representations of particular aspects of some domain problem based on specifying
 - ◆ Relations between constructs derived from theory (theoretical models)
 - ◆ Relations between measured variables
 - As a result of operationalizing theoretical models
 - Derived from studies of observations (descriptive models)

Normative, Descriptive, Prescriptive Models

- Normative theories specify relations that *should* exist between constructs
 - ★ Thus, for subjective Bayesians, Bayes Rule' is normative for belief revision
- Descriptive theories specify relations *discovered* to exist between constructs
 - ★ Thus, Einhorn & Hogarth's is a descriptive model of belief revision
- Prescriptive theories specify relations *required* to exist between variables
 - ★ Many audit firms adopted implementations of the Audit Risk Model that staff were required to apply during audit planning

Operationalization

- Recall that *operationalization* involves specifying procedures for
 - ★ Measurement
 - or
 - ★ Experimentation
- We will evaluate two features of measurement
 - ★ Reliability
 - ★ Validity
- Over next two weeks we will also study experimentation

Foundations of Measurement

- Measurement
 - ★ The assignment of numerals to objects or events according to rules
- Number
 - ★ A numeral that has been assigned quantitative meaning
- Assigned
 - ★ A mapping – a rule of correspondence
- Meaningful measurement
 - ★ Requires rules that are isomorphic to reality

Foundations of Measurement

■ Isomorphism

- ★ Identical form
- ★ 1-1 correspondence
- ★ X and Y are isomorphic iff
 - ◆ Each member of X corresponds to exactly one member of Y
 - ◆ Each member of Y corresponds to exactly one member of X
- ★ Of course, if X is 'unobserved' reality, it may be hard to know!

Foundations of Measurement

- In fact, all we can measure is *indicants* of the *properties* of objects
- Indicants are specified by operational definitions
- Our starting point is to define the objects of the universe of discourse
- Measurement requires that this universe be broken down into at least two subsets – this is *classification*, which may be:
 - ★ **Dichotomous**
 - ★ **Polychotomous**

Foundations of Measurement

■ Four general levels of measurement

★ Nominal

- ◆ Labels without 'number' meanings
- ◆ All members of a subset are assigned the same numeral
- ◆ No two subsets are assigned the same numeral

★ Ordinal

- ◆ Objects in a set are rank ordered
- ◆ This ordering is transitive
- ◆ Equal spacing of numerals does not imply to equal spacing of the underlying properties

Foundations of Measurement

■ Four general levels of measurement

★ Interval

- ◆ At least ordinal
- ◆ Equal distances on the scale represent equal distances in the property being measured
- ◆ E.g., Celsius scale

★ Ratio

- ◆ Highest level
- ◆ At least interval
- ◆ Has a natural absolute zero
- ◆ Ratios of values are meaningful

Foundations of Measurement

- Many numerical measurements are, strictly speaking, at best ordinal
- However, they may be approximately ‘interval’ scales
 - ★ We can often assume this if we have multiple measures and they are all substantially and linearly related
- Ratio scales are rarely *required*

Foundations of Measurement

■ Likert scales

strongly disagree – disagree – neutral – agree – strongly agree

-2

-1

0

1

2

■ Units of analysis

- ★ Individual
- ★ Group
- ★ Company / firm

Foundations of Measurement

■ Measurement Scales

- ★ Equality of units
- ★ Comparability of scales
- ★ Transformations of scores
(we will return to this next week)
 - ◆ Percentiles
 - ◆ Standard scores
 - ◆ Standardized scores
 - ◆ Normalized scores
- ★ Building composite scores out of standardized components

Foundations of Measurement

- Description
 - ★ Classification (qualitative)
 - ★ Measurement (quantitative)
- Variables
 - ★ Qualitative
 - ★ Quantitative
 - ◆ Ranked
 - ◆ Scalar
 - Discontinuous
 - Continuous
- Scales

Reliability

■ Reliability

- ★ Dependability
- ★ Stability
- ★ Consistency
- ★ Reproducibility
- ★ Predictability
- ★ Lack of distortion

Reliability

- Will we get the same results if we measure the same objects with the same instrument
 - ★ *Stability, dependability, predictability*
- Are the measures obtained from the instrument 'true' measures
 - ★ *Lack of distortion*
- How much measurement error is there?

Reliability

- Reliability is the *lack of distortion or precision* of a measuring instrument
- Total obtained variance includes
 - * **Systematic variance**
 - * **Error variance**
- Reliability is the proportion of 'true' variance to the total obtained variance of the data yielded by the measurement instrument
- Reliability is the proportion of 'error' variance to the total variance yielded by the measurement instrument, subtracted from 1

Reliability

■ Attenuation

- ★ Unreliable measures mask relationships
- ★ Correction for attenuation
 - ◆ Measures correlation supposing perfectly reliable measures: $r_{xy} / \sqrt{r_{xx} * r_{yy}}$
 - ◆ E.g., $0.28 / \sqrt{0.3 * 0.4} = 0.8$
- ★ The more items in a measure, the greater the reliability (*ceteris paribus*)

Reliability

- Theory of True and Error Scores
- $V_t = V_g + V_\varepsilon$ or $V_o = V_T + V_\varepsilon$
- The reliability coefficient $r_{tt} = V_t / V_g = V_o / V_T$ is the square of the correlation between 'true' scores and observed scores
- The correlation itself is sometimes called the *index* of reliability
- Since we don't know the 'true' scores, we can only estimate r_{tt}

Reliability

- One way to estimate it is to compute the correlation between scores for the same subject at different points in time: this is the *test-retest reliability*
- Reliability may also be estimated from the correlation between two alternative but *equivalent (parallel) forms* of the instrument

Reliability

- Another technique is to split scores on test item into odd and even items, and compute the correlation between the two subsets: the *split-half reliability*
- This is one example of measures based on *internal consistency*
- Since additional items on a test increase reliability, split-half correlations underestimate reliability
- There are a number of alternative ways to correct for this, including the Spearman-Brown Prophecy formula $r_{tt}' = \frac{nr_u}{1+(n-1)r_u}$ or, for split-halves, $r_{tt}' = \frac{2r_u}{1+r_u}$

Reliability

- Two other internal consistency measures of reliability that are well known and have been used extensively are the *Kuder-Richardson formulae* KR-20 and KR-21
- These formulae assume that every test item has the same mean and variance, and that the scoring is binary or dichotomous
- KR-21 is a special case of KR-20 where item difficulties are the same

Reliability

- There is also a more sophisticated theory of reliability called Generalizability Theory (formerly known as Domain Sampling Theory) produced by Cronbach and others
- Out of this theory comes probably the best known of current indicators of reliability, Cronbach's alpha $r_{tt} = \alpha = \frac{k}{k-1} \left(1 - \frac{\sum V_i}{V_t} \right)$ or $r_{tt} = \frac{n\bar{r}_i}{1+(n-1)\bar{r}_i}$
- The Kuder-Richardson formulae can be shown to be special cases of coefficient alpha

Reliability

- In order to improve reliability
 - ★ Write test items unambiguously
 - ★ Add additional items of equal kind and quality
 - ★ Give clear and standard instructions
- *Item analysis* is used to check that additional items are of equal kind and quality (a validity issue)
 - ★ Item difficulty
 - ★ Item discrimination

Reliability

- How much reliability do we need?
 - ★ **Dan Spencer (University of Kansas)**
 - ◆ 0.6 – 0.8: acceptable
 - ◆ 0.8 – 0.9: very good

Reliability

- Designing test instruments
 - ★ **Item properties**
 - ◆ Difficulty
 - ◆ Homogeneity
 - ◆ Validity
 - ★ **Weighting? (arguments against!)**
 - ★ **Cross-validation against hold-out sample**

Reliability

■ Scoring

- ★ For robust measures, raw scores may be meaningful
- ★ But if departures from Normal too great, may need to normalize for analysis purposes
- ★ Kolmogorov-Smirnoff test (or others) for normality
- ★ Percentiles are ordinal only

Reliability

- Combining scores from different samples
 - ★ Measured under same conditions
 - ◆ Combine raw scores
 - ★ Measured under different conditions
 - ◆ Standard scores (and normalize if desired)
 - ★ When groups differ
 - ◆ Combine raw scores
 - ◆ Then use standard-score transformation

Reliability

- Standard scores

$$z = \frac{X - \bar{X}}{s_X}$$

- Standardized scores

$$T = \frac{10X}{s_X} + \left(50 - \frac{10\bar{X}}{s_X} \right)$$

- Normalized standard scores

- ★ Distribution converted to normal (e.g., via percentile scores)

Inter-rater Reliability

- The extent to which two or more individuals (coders or raters) agree
- The degree of stability exhibited when a measurement is repeated under identical conditions by different raters
- Often reported as correlation, or using Cohen's κ statistic
- For a calculator, see www.med-ed-online.org/rating/reliability.html
- For recent work on inter-rater reliability, see, for example, www.staxis.com

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- New Edition:
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for Generalized Casual Inference”
Shadish, Cook & Campbell
Houghton Mifflin 2002

References

- For web sites of academics with strong personal views on the inadequacy of the 'standard views' on science and theory building, you might enjoy visiting:
- <http://www.sit.wisc.edu/%7Ecrusbult/methods/science.htm>
- <http://www.dharma-haven.org/science/>