Where Do Data Come From?

Chapter 3

CLEAR-SIGHTED STATISTICS

EDWARD VOLCHOK

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Lecture Outcomes

The research process	Primary and Secondary Research	Pure Research versus Applied Research	Types of research: Exploratory, descriptive, causal, and meta-analysis
Define the term big data	Basic sampling techniques	Sampling error	Systematic errors
	Reliability and Validity	Steps to take when reviewing research	

1

The Research Process

2

Two broad categories of research

Applied Research	Basic or Pure Research
• Pragmatic solutions to pressing problems • Research to help decision-makers	• Advance knowledge, not than solve immediate problems

3

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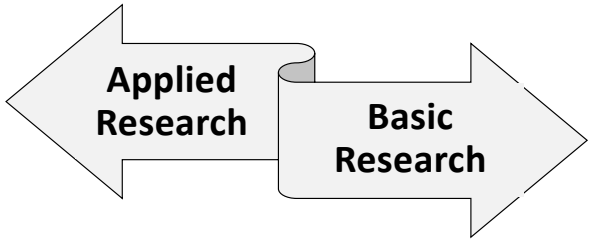
A continuum, not binary



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4

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The multi-stage research process

- The Research Process
- Research Question
  - Review available research
  - Develop research design
  - Generate hypotheses
  - Collect data
  - Analyze Data
  - Report results

5

5

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Typical research questions

- How do Facebook users feel about the privacy of their data?
- Which candidates for President of the United States get increased Google searches after a presidential debate and who is searching?
- What behavioral, biological, pharmacological, and treatment factors contribute to better blood glucose control for Type I diabetics?
- What factors have contributed to the decline of Cable TV subscriptions?
- What factors are associated with higher graduation rates at community colleges and four-year colleges?

6

6

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Review available research

Secondary Research	Primary Research
• Previously conducted research that's available to public • Published studies • Government reports	• Proprietary research, not available to public

7

7

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Secondary research is useful

- Provides background information
- Can help researchers refine their questions
- Might answer the researchers' question
- Might alert researchers about problems they need to avoid
- Might help researchers decide on the most appropriate research methods to use
- Might provide information that will help researchers with their sampling

8

8

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Questions to ask about secondary research…

- Who conducted the research?
- For what purpose was the research done?
- How were the data collected?
- When was the data collected?
- What is included in the data and what is not?
- Are the findings consistent with other research?

9

9

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Limitations of Secondary Research

- Appropriate secondary data may not be available
- May be out-of-date
- May lack relevance for the problem being investigated
- May be inaccurate
- While useful, they may not adequately address the problem under investigation

10

10

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Is primary research necessary?

- Does the secondary research answer the research question?
- If yes, primary research may not be needed
- If no, primary research may be needed when the research question is important and there is enough time and money to conduct that research

11

11

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Research objectives must be SMART

- **S**pecific
- **M**easurable
- **A**chievable
- **R**elevant
- **T**imed

12

12

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Four basics types of research

- Exploratory
- Descriptive
- Causal (Experiment or Random Controlled Tests)
- Meta-Analysis

13

13

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Exploratory Research

- Preliminary study designed to get a deeper understanding of a problem
- No quantitative information is obtained
- No hypotheses are tested
- Focus groups, in-depth interviews

14

14

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Descriptive Research

- Addresses: Who? What? Where? When?
- Can be qualitative or quantitative
- Examples: Observational Studies, Case Studies, and Surveys

15

15

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Observational Studies

Prospective	Retrospective
• Data collected as events occur	• Data collected after events have occurred

16

16

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Case Studies

Detailed investigations of one or two examples of an issue in hopes of finding lessons for all similar cases

Quantitative and qualitative data are collected

17

17

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Surveys

Respondents provide data by answering a questionnaire

Wording of the questionnaire is extremely important (Avoid Bias)

Validity and Reliability (to be reviewed)

18

18

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Causal Research

Addresses the "why" question

Controlled experiments used to determine cause and effect

Other forms of research may establish causality

Cause must precede the effect

Concomitant variations between cause and effect

19

19

Meta-Analysis

Statistical techniques used to develop quantitative analyses of multiple studies on the same or similar subjects

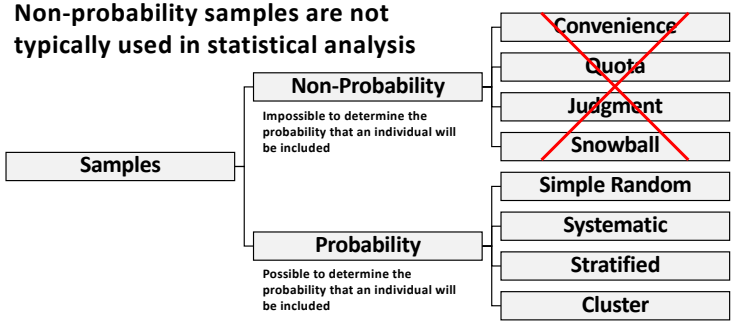
20

Sampling Techniques

21

Types of Samples

Non-probability samples are not typically used in statistical analysis



22

Simple Random Samples

Sample is chosen on the basis of chance

Each item in the population has the same chance of being included

Examples: Mega Millions and Powerball lotteries

23

Probability of a population element being selected

$$\frac{\text{Sample Size}}{\text{Population Size}} = \frac{50}{15{,}000} = 0.0067 = 0.67\%$$

24

Advantages & Disadvantages of Simple Random Samples

Cost & Use	Advantages	Disadvantages
• High cost • Most common use is random dialing	• Minimal advanced knowledge of the population is needed • Easy to analyze data and computer error	• Requires a sampling frame • Does not use established knowledge of the population • Larger sample error per sample size • Respondents my be widely dispersed

25

Systematic Random Samples

Population elements are ordered

Random starting point is selected, and then every k^{th} member of the population is selected

When physical order of population is related to characteristics, this method should not be used

26

Advantages & Disadvantages of Systematic Random Samples

Cost & Use	Advantages	Disadvantages
• Moderate cost • Moderate use	• Simple to draw • Easy to check	• Order on the population may introduce errors

27

Stratified Samples

Population is first divided into subgroups (strata) based on important characteristics

Sample is then selected from each stratum

Ensures proportionate representation of each stratum

28

Stratified Sample: Example

Study advertising spending for 400 large corporations (Sample Size = 50)

Question: Do firms with high Return on Equity invest more in advertising?

To make sample representative, companies are grouped by Return on Equity

Stratum	Return on Equity	Number	Relative Frequency	Number Sampled
1.00	30% or more	10.00	2.50%	1.00
2.00	20% < 30%	77.00	19.25%	10.00
3.00	10% < 20%	192.00	48.00%	24.00
4.00	0% < 10%	109.00	27.25%	14.00
5.00	Deficit	12.00	3.00%	1.00
	Total	400	100.00%	50

29

Advantages & Disadvantages of Stratified Samples

Cost & Use	Advantages	Disadvantages
• High cost • Moderate use	• Ensures representation of all groups in the sample • Allows for estimates of the population and comparisons of the strata • Reduces variability for the sample	• Requires accurate information of the proportion of each stratum • If stratified lists are not available, if can be costly to develop these lists

30

Cluster Samples

Population is first divided into sub-groups (clusters), then samples are randomly selected from the clusters

Example: Determine citizens' views on environmental protection

Use cluster sampling by dividing population into smaller units (clusters)

Divide country into clusters and sample from a selected number randomly selected clusters

31

Advantages & Disadvantages of Cluster Samples

Cost & Use	Advantages	Disadvantages
• Low cost • Frequent use	• Geographic clusters yield the lowest field costs • Can accurately estimate characteristics of clusters and population	• Larger sampling error than other methods • The researcher must assign population members to a cluster

32

Random Sampling Error

33

Random Sampling Errors

- Sample Statistic ≠ Population Parameter
- Not due to human error
- All samples have some degree of sampling error
- Sampling error is a major issue in inferential statistics

34

Systematic Errors

35

Systematic Errors

Human errors in the design and execution of the research

Sample Design Errors: Problems with how the sampling was conducted

Measurement Errors: Errors made when the data are collected (Can happen with samples and censuses)

Sample Design Errors: Frame Error

Sample frame is a list of all the elements in a population

Frame error occurs when the sample frames are inaccurate

Frame error biases research results

Sample Design Errors: Population Specification Error

Errors that result from incorrectly defining the population

Sample Design Errors: Selection Error

Even with an accurate sample frame and properly defined population, selection error may happen

Selection errors occur when the sampling procedures are not properly followed or the procedures are poorly thought out

Example: Interviewer avoids interviewing certain types of people

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Sample Design Errors: Measurement Error – Surrogate Information Error

Errors due to an inconsistency between the information sought and the information needed to solve a problem

These errors arise when the researcher fails to understand how respondents view the questions

40

40

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Sample Design Errors: Measurement Error – Possessing Error

Errors that occur after the data have been collected

These are errors in coding, transcribing, assigning weights to the data as well as use of inappropriate statistical techniques

41

41

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Measurement Errors: Interviewer Error

Interviewer consciously or unconsciously influences respondents' answers

Respondents' reaction to the interviewer may introduce bias

42

42

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Measurement Errors: Instrument or Questionnaire Bias

Leading Questions: Embed answers in the question and bias results

How dumb was President Obama's policy on North Korea?

43

43

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Measurement Errors: Instrument or Questionnaire Bias

Loaded Question: Contain unjustified assumptions that skew responses

Do you think the liberal media push fake news to undermine President Trump?

44

44

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Measurement Errors: Instrument or Questionnaire Bias

Double Barreled: Two or more questions embedded in a single question

Would you vote for a candidate who supports cutting spending on education and health care?

45

45

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Measurement Errors: Response Bias

Acquiescence Bias: Tendency of respondents to agree with all questions, or to answer all question with positive responses

Extremity Bias: Tendency of respondents to use extremely positive or negative responses

Auspices Bias: Tendency of respondents to be influenced by the study's sponsor

46

46

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Measurement Errors: Non-Response Bias

Bias that occurs when respondents fail to participate fully in the survey

Theoretical difference between a perfect survey in which everyone participates and the actual survey

Self-Selection Bias: Respondents tend to have strongly positive or negative views

47

47

Experimental Errors:

The reactive effects that happen when respondents know they are participating in a study

Hawthorne Effect: Participants do not behave normally because they know they are in a study

Placebo Effect: All participants show positive results regardless of what group they are assigned

John Henry Effect: Participants in the control group work harder

48

Reliability and Validity

49

Reliability and Validity

Reliability refers to the consistency of the questionnaire's results

Validity refers to the accuracy of the measurements

50

Reliability and Validity

Poor Validity, Good Reliability

Poor Validity, Poor Reliability

Good Validity, Good Reliability

51

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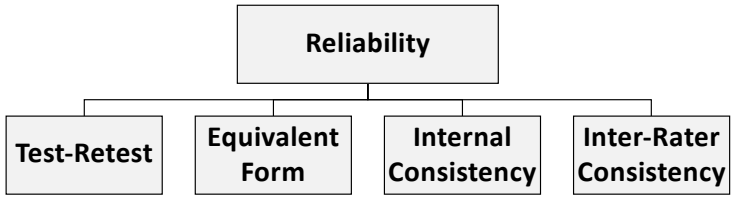
4 Types of Reliability



52

52

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Test-Retest Reliability

Respondents are given the survey at two different times under similar conditions

When there are few differences, the questionnaire it said to be reliable

53

53

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Problems with Test-Retest Reliability

It may be difficult or impossible to get respondents to complete the questionnaire twice

The administration of the first survey may cause a respondent's answers to change

Extraneous factors in the environment may cause the respondents' answers to change

54

54

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Equivalent Form Reliability

Similar surveys are used to determine whether they yield similar results

When results are similar, the surveys are considered reliable

55

55

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Internal Consistency Reliability

Questionnaire returns similar measurements when given to different samples during the same time period

Split ballot technique: Questions that probe the same construct are divided into two groups of equal numbers of questions

Chonbach's Alpha: Calculates the mean reliability scores for all possible ways of splitting the questions

56

56

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Interpreting Chonbach's Alpha, α

	Internal Consistency
α ≥ 0.9	Excellent
0.8 ≥ α < 0.9	Good
0.7 ≥ α < 0.8	Acceptable
0.6 ≥ α < 0.7	Questionable
0.5 ≥ α < 0.6	Poor
α < 0.5	Unacceptable

57

57

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Inter-Rater Consistency Reliability

How independent observers compare their assessments when they observe the same behavior

Example: Are the quantitative scores of Olympic gymnastics judges consistent?

58

58

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Validity

Validity deals with how accurately a questionnaire measures a concept or "construct"

59

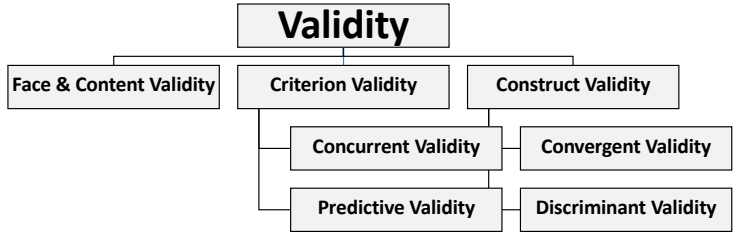
59

Two definitions for constructs

Theoretical Definition	Operational Definition
• States the essential meaning of the construct	• A description of the observable features of a construct that will be measured

60

Types Validity



61

Face and Content Validity

Non-quantitative forms of validity

Face Validity: Degree to which non-experts *judge* the results to be accurate

Content Validity: Degree to which experts *judge* the results to be accurate

62

Criterion Validity

Degree to which the questionnaire can predict the designated criterion

Concurrent Validity

Predictive Validity

63

Criterion Validity: Concurrent Validity

The degree to which one variable can be predicted by the instrument concurrently—at the same time—with another variable of interest

When we have a predictive relationship, we say that these variables concur

64

Criterion Validity: Predictive Validity

The degree to which the future value of the criterion variable can be predicted by the instrument

SAT scores would have predictive validity if they predict students' academic performance in college

65

Construct Validity

The degree to which the questionnaire accurately measures the construct

Convergent Validity

Discriminant Validity

66

Construct Validity: Convergent Validity

The strength of the association among different questions or questionnaires that purport to measure the same construct

When the measures for these constructs are similar—when they converge—we have convergent validity

67

Construct Validity: Discriminant Validity

The lack of association among constructs that are supposed to be different

When test results show that measures that are supposed to be dissimilar are, in fact, dissimilar

68

10 questions to ask when reviewing research

69

Questions skeptics ask when reviewing research

Have the study's goals been identified?	Has the study's methodology been described?	Who funded the study?	Have the results been replicated?
Is the sample size sufficient?	Are the variables adequately defined and measured?	Is the questionnaire reliable and valid?	Have potential sources of systematic errors been identified?
	Are the tables and charts misleading?	Are there alternate explanations?	

70

71

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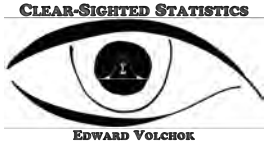

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