Empirical Research Methods in Information Science

IS 4800 / CS6350

Lecture 7

Measures

Proving causality with experiments

- What’s required?

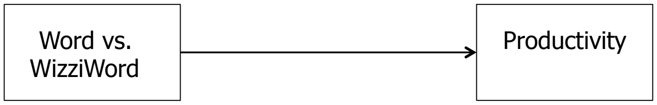
- Must manipulate the world
- Must measure an outcome/effect
- Must control extraneous variables
  - Fix
  - Randomize

Review

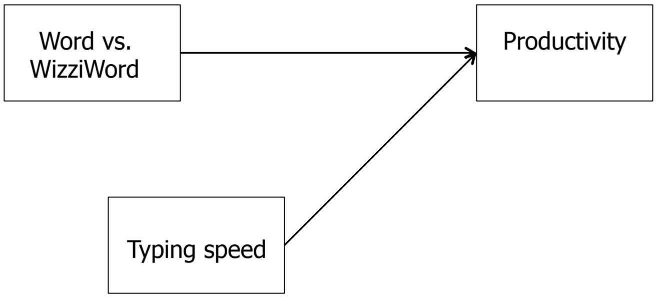
	Number of Variables	Number of IV Levels	Manipulation
Descriptive	1	NA	NA
Demonstration	≥ 1?	1	√
Correlational	≥ 2	NA	NA
Experimental	≥ 2	≥ 2	√

What do we mean by randomize?

- One example: two treatment, between subjects design



Why does randomization help?



Why does randomization help?

- On average
  - As many fast typists using WW as W
  - As many slow typists using WW as W
- The effect of typing speed “averages out” across conditions, thus is not a confound (does not systematically vary with IV)
- Same should be true for all other extraneous variables

Third Variables

- Extraneous vs. Confounding Variables?
- How to deal with them?

Study Validity

- INTERNAL VALIDITY is the degree to which your design tests what it was intended to test
- EXTERNAL VALIDITY is the degree to which results generalize beyond your sample and research setting

Homework Status?

Ethnography

Research Models

Due Tuesday

14

Making Systematic Observations

15

Quiz #4

https://tinyurl.com/IS4800QQ4

What to Measure / How to Measure it?

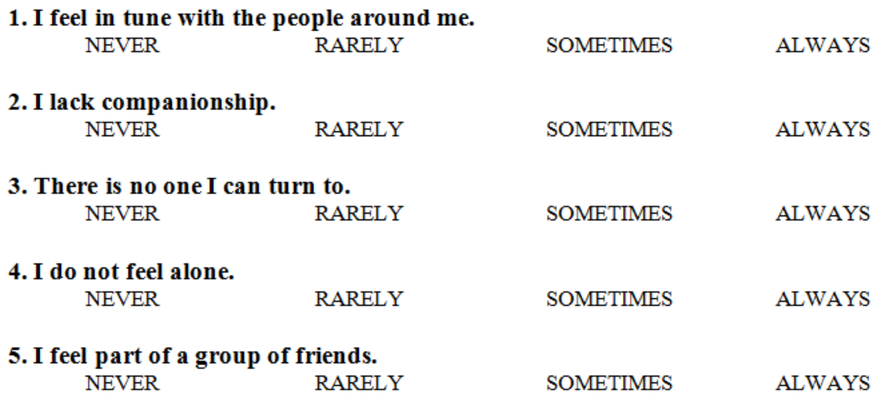
- Given the choice
  - Use a validated measure
  - Use a measure that has been used before in your field
  - Use a measure that is readily accessible or inexpensive
  - Use a measure that takes the least time and effort

What is a validated measure?

- Has reliability
- Has validity

- For questionnaire measures, these are collectively referred to as a measure’s “psychometrics”.

Example ‘Composite Scale Questionnaire’ UCLA Loneliness Scale (excerpt)



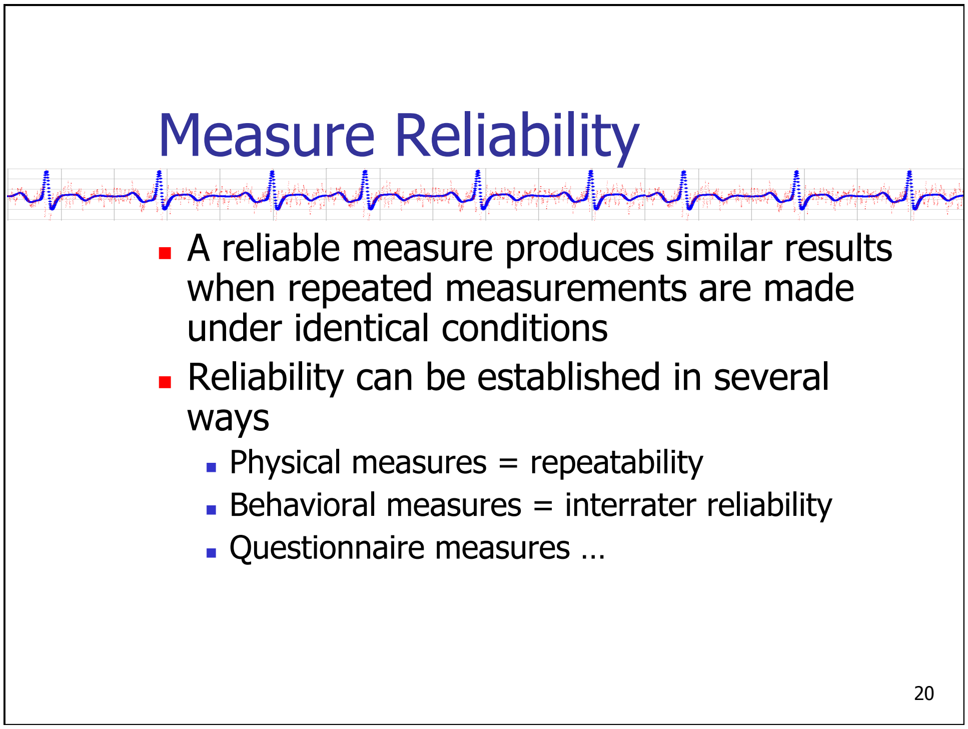
1. I feel in tune with the people around me.
NEVER RARELY SOMETIMES ALWAYS

2. I lack companionship.
NEVER RARELY SOMETIMES ALWAYS

3. There is no one I can turn to.
NEVER RARELY SOMETIMES ALWAYS

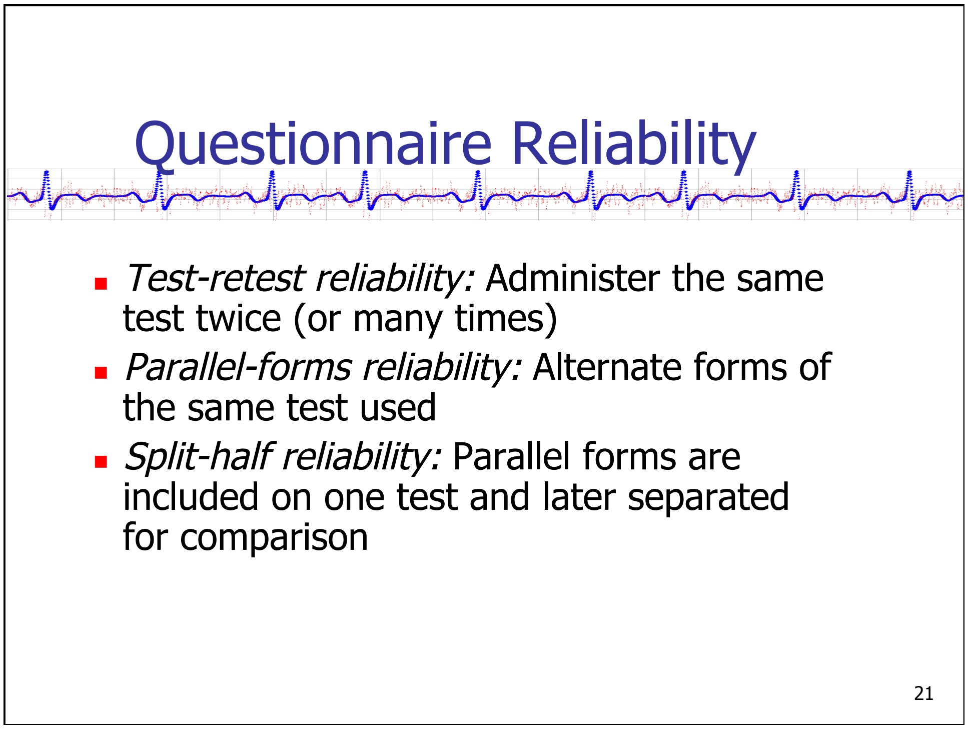
4. I do not feel alone.
NEVER RARELY SOMETIMES ALWAYS

5. I feel part of a group of friends.
NEVER RARELY SOMETIMES ALWAYS



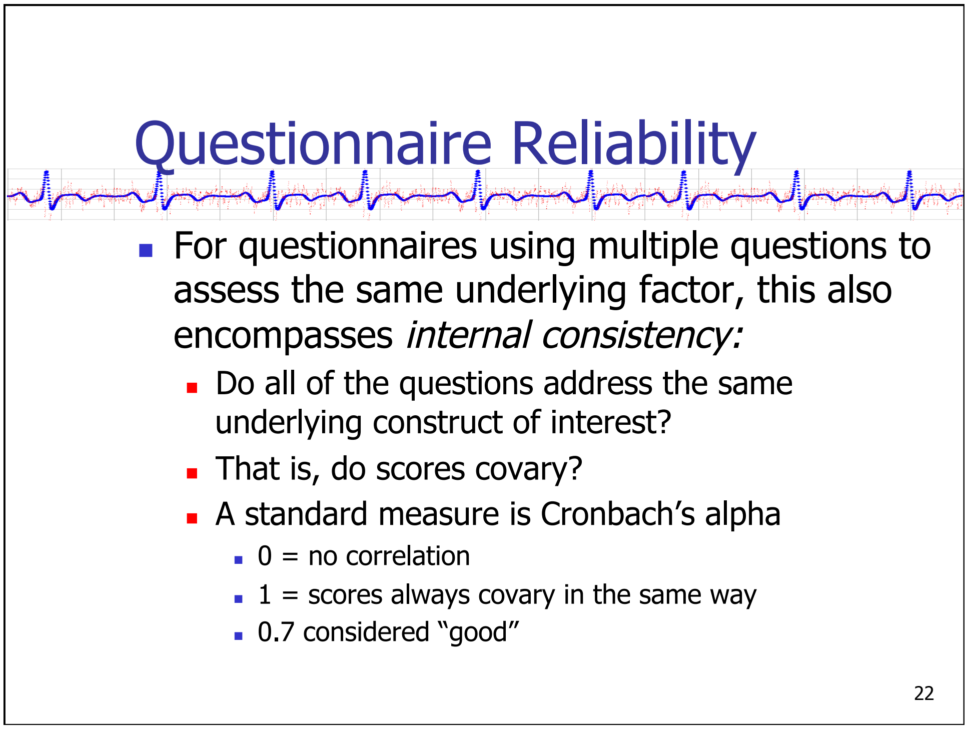
Measure Reliability

- A reliable measure produces similar results when repeated measurements are made under identical conditions
- Reliability can be established in several ways
  - Physical measures = repeatability
  - Behavioral measures = interrater reliability
  - Questionnaire measures …



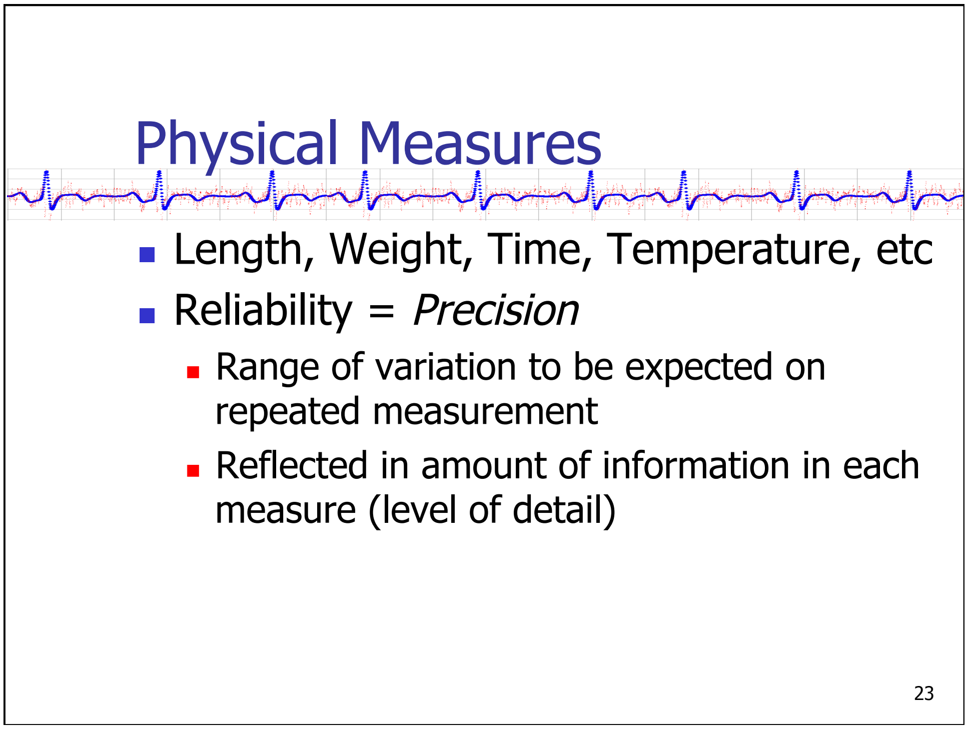
Questionnaire Reliability

- *Test-retest reliability:* Administer the same test twice (or many times)
- *Parallel-forms reliability:* Alternate forms of the same test used
- *Split-half reliability:* Parallel forms are included on one test and later separated for comparison



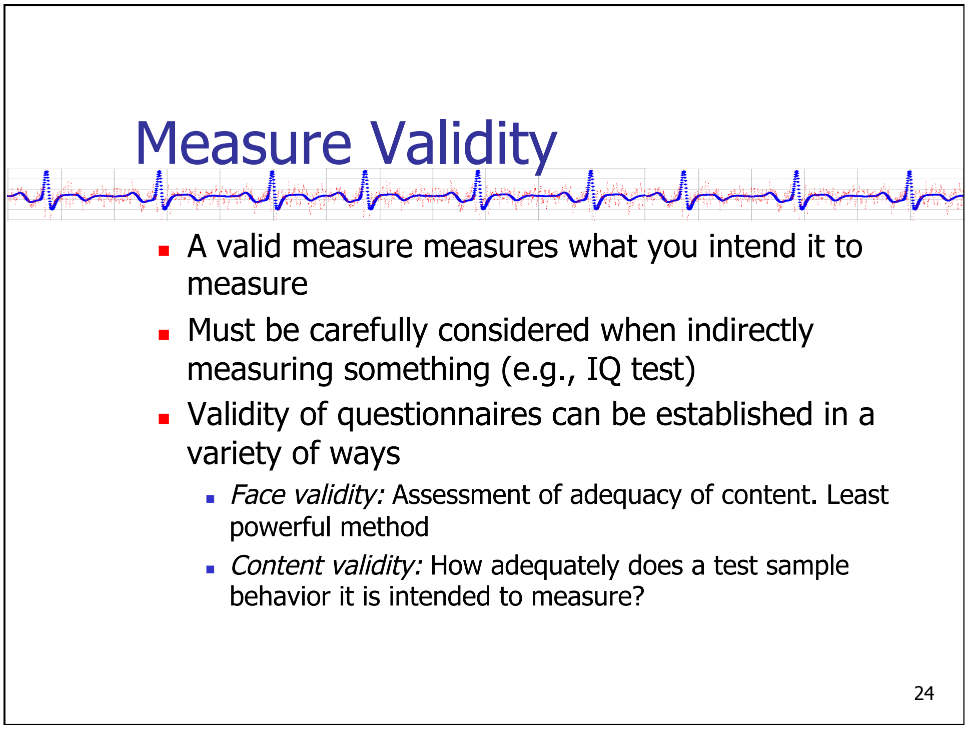
Questionnaire Reliability

- For questionnaires using multiple questions to assess the same underlying factor, this also encompasses *internal consistency:*
  - Do all of the questions address the same underlying construct of interest?
  - That is, do scores covary?
  - A standard measure is Cronbach’s alpha
    - 0 = no correlation
    - 1 = scores always covary in the same way
    - 0.7 considered “good”



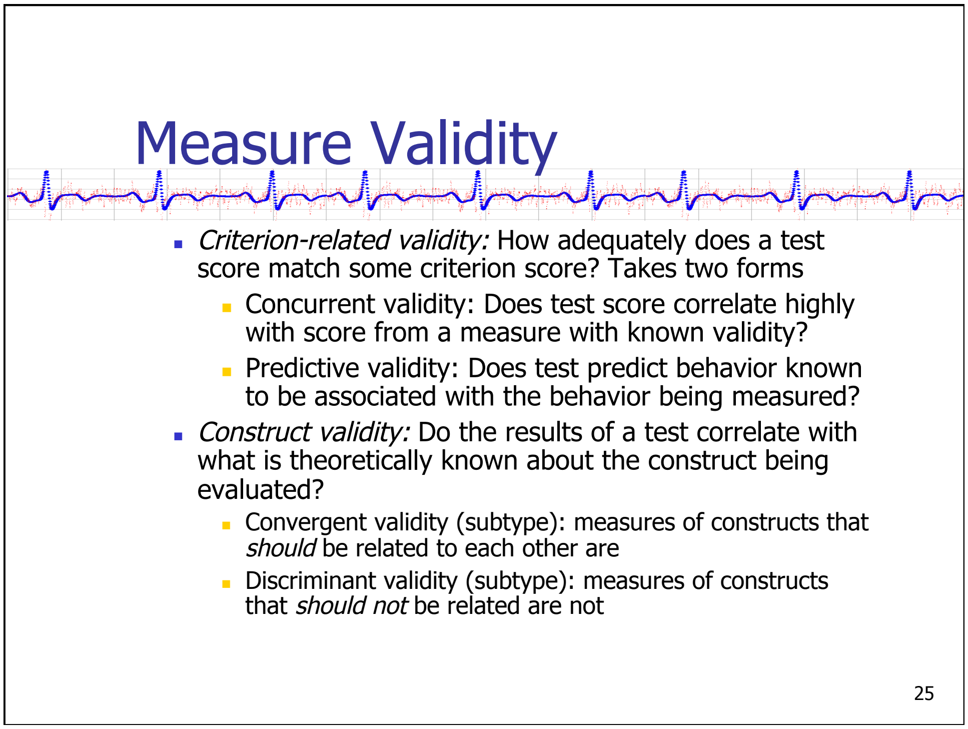
Physical Measures

- Length, Weight, Time, Temperature, etc
- Reliability = *Precision*
  - Range of variation to be expected on repeated measurement
  - Reflected in amount of information in each measure (level of detail)



Measure Validity

- A valid measure measures what you intend it to measure
- Must be carefully considered when indirectly measuring something (e.g., IQ test)
- Validity of questionnaires can be established in a variety of ways
  - *Face validity:* Assessment of adequacy of content. Least powerful method
  - *Content validity:* How adequately does a test sample behavior it is intended to measure?

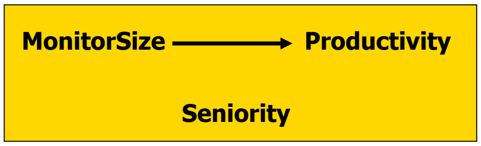


Measure Validity

- *Criterion-related validity:* How adequately does a test score match some criterion score? Takes two forms
  - Concurrent validity: Does test score correlate highly with score from a measure with known validity?
  - Predictive validity: Does test predict behavior known to be associated with the behavior being measured?
- *Construct validity:* Do the results of a test correlate with what is theoretically known about the construct being evaluated?
  - Convergent validity (subtype): measures of constructs that *should* be related to each other are
  - Discriminant validity (subtype): measures of constructs that *should not* be related are not

Example

- Assume we have good evidence for this model of the world..



- We now propose a new measure for **Productivity**
  - What would be evidence for convergent construct validity?
  - What would be evidence for discriminant construct validity?

Physical Measures

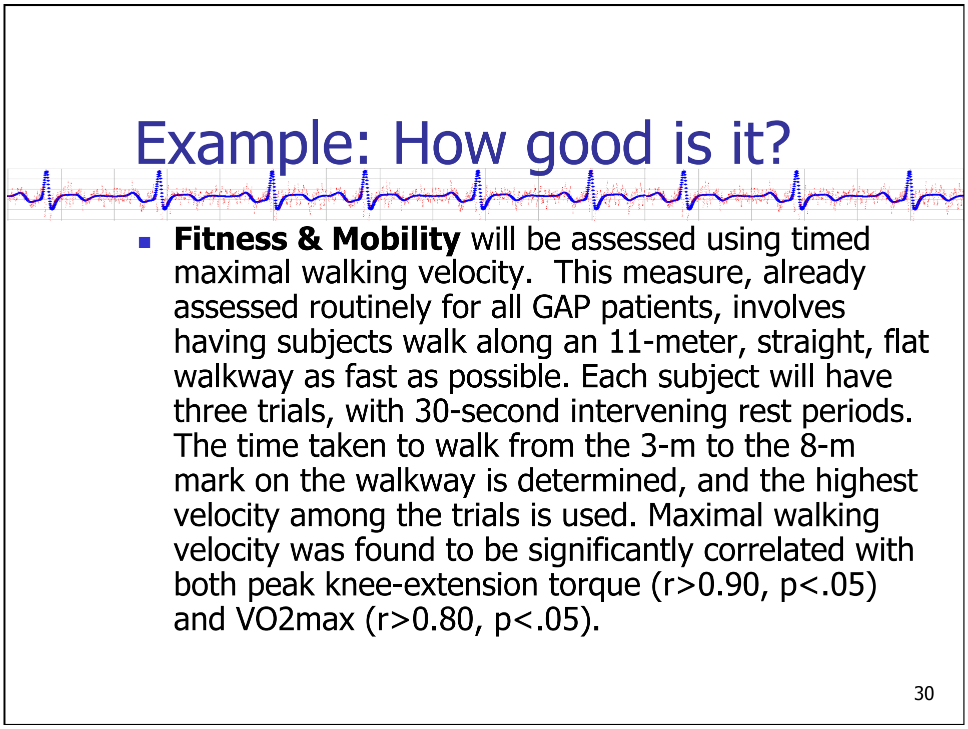
- Length, Weight, Time, Temperature, etc
- Validity = *ACCURACY*
  - An accurate measure produces results that agree with a known standard (i.e. is "correct")

Reliability vs. Accuracy

- A measurement instrument can be inaccurate but reliable
- The reverse cannot be true

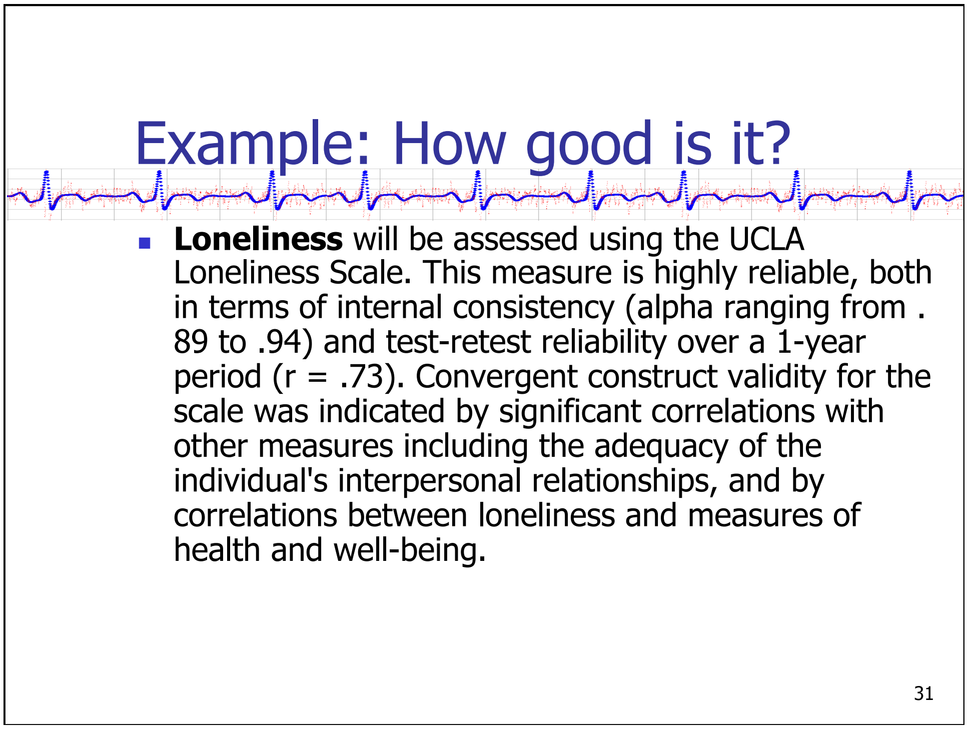
Example: How good is it?

- **Diabetes Knowledge**. Diabetes knowledge will be assessed using the Diabetes Knowledge (DKN) Scales, three separate 15-item multiple choice questionnaires that measure general diabetes knowledge. Reliability for the items in the scales (Cronbach’s alpha) was 0.92, indicating high internal consistency. Validity was assessed by determining that 219 participants who participated in a 1-1/2 day class on diabetes scored significantly higher posttest on the measures compared to pretest (11.27 vs. 7.61, p<.001).



Example: How good is it?

- **Fitness & Mobility** will be assessed using timed maximal walking velocity. This measure, already assessed routinely for all GAP patients, involves having subjects walk along an 11-meter, straight, flat walkway as fast as possible. Each subject will have three trials, with 30-second intervening rest periods. The time taken to walk from the 3-m to the 8-m mark on the walkway is determined, and the highest velocity among the trials is used. Maximal walking velocity was found to be significantly correlated with both peak knee-extension torque (r>0.90, p<.05) and VO2max (r>0.80, p<.05).



Example: How good is it?

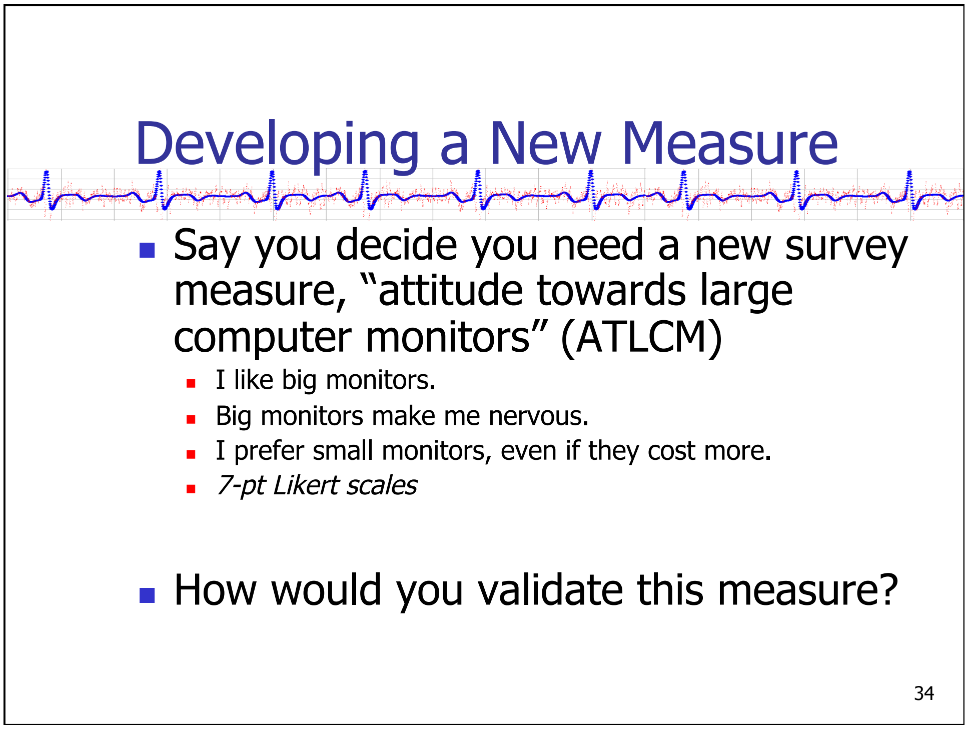
- **Loneliness** will be assessed using the UCLA Loneliness Scale. This measure is highly reliable, both in terms of internal consistency (alpha ranging from .89 to .94) and test-retest reliability over a 1-year period (r = .73). Convergent construct validity for the scale was indicated by significant correlations with other measures including the adequacy of the individual's interpersonal relationships, and by correlations between loneliness and measures of health and well-being.

Example: How good is it?

- **Exercise Self Efficacy.** The five-item Self Efficacy Scale for exercise assesses perceived confidence to perform exercise across a wide variety of challenging situations. Recently, a new measure was developed addressing the multidimensionality of the self-efficacy construct. The short form (α = .82) of this measure includes six items, answered on a five point Likert response format and assesses negative affect, excuse making, exercising alone, equipment access, resistance from others and weather.

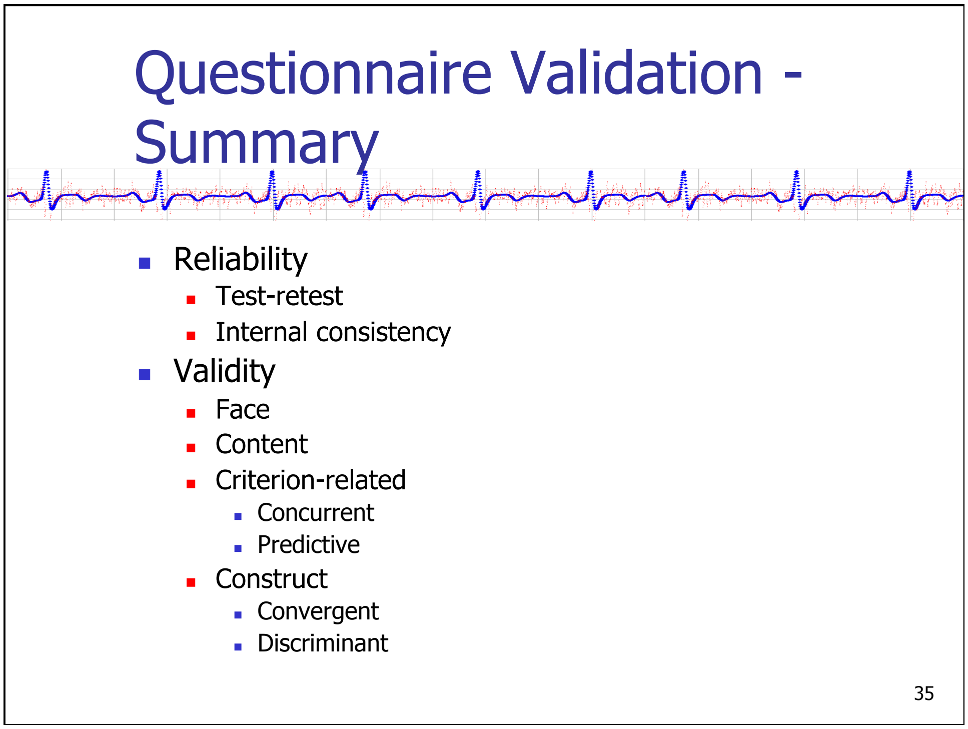
Example: How good is it?

- **Patient Activation.** Patient activation will be assessed using the Patient Activation Measure (PAM). This 22-item self-report questionnaire assesses: a) beliefs about the importance of the patient role; b) confidence and knowledge necessary to take action; c) actions actually taken; and d) ability to stay the course when under stress. In an assessment involving a national sample of 1,515 individuals aged 45 and over, the instrument was shown to have high reliability and construct validity: those with higher activation reported significantly better health as assessed by the SF-8 (r=.38, p<.001) and have significantly lower rates of doctor office visits, emergency room visits, and hospital nights (r=-.07, p<.01).



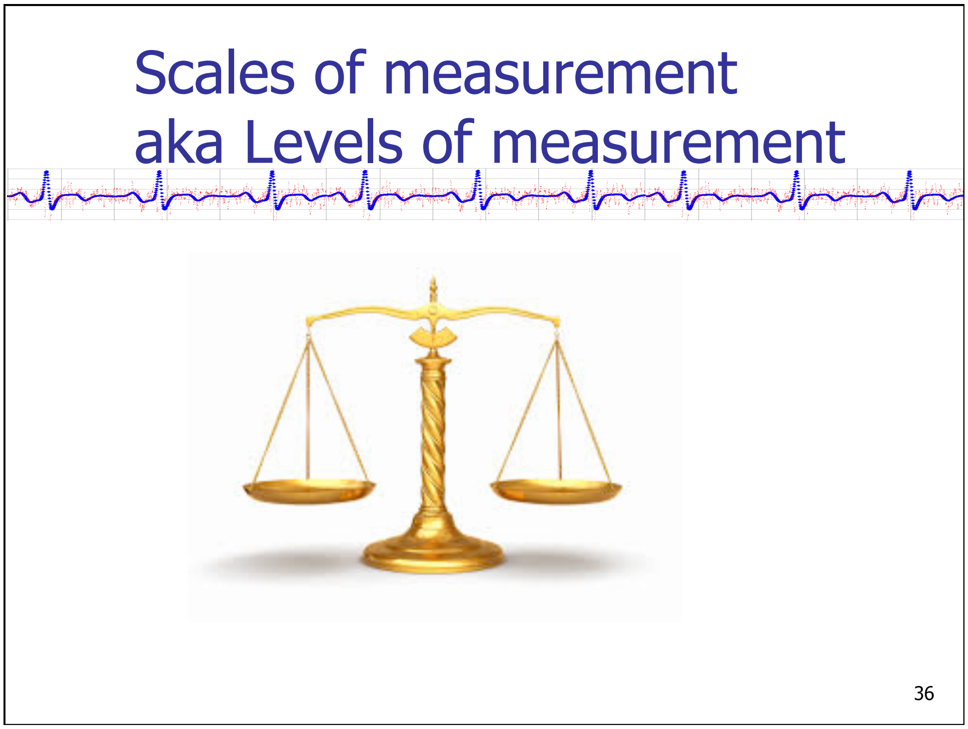
Developing a New Measure

- Say you decide you need a new survey measure, “attitude towards large computer monitors” (ATLCM)
  - I like big monitors.
  - Big monitors make me nervous.
  - I prefer small monitors, even if they cost more.
  - *7-pt Likert scales*
- How would you validate this measure?

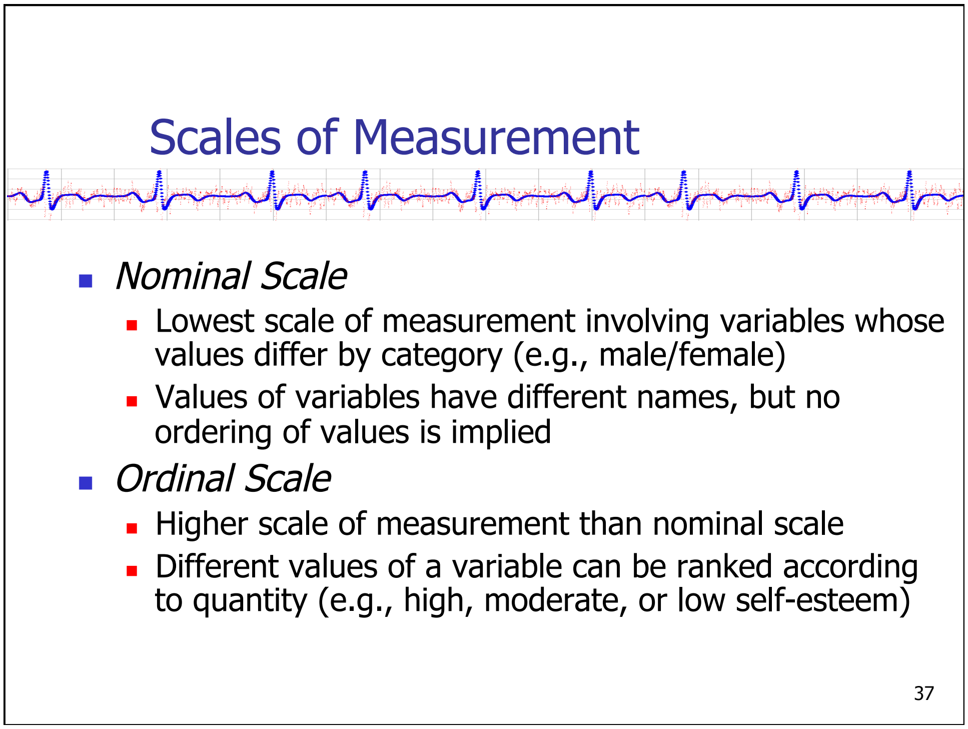


Questionnaire Validation - Summary

- Reliability
  - Test-retest
  - Internal consistency
- Validity
  - Face
  - Content
  - Criterion-related
    - Concurrent
    - Predictive
  - Construct
    - Convergent
    - Discriminant

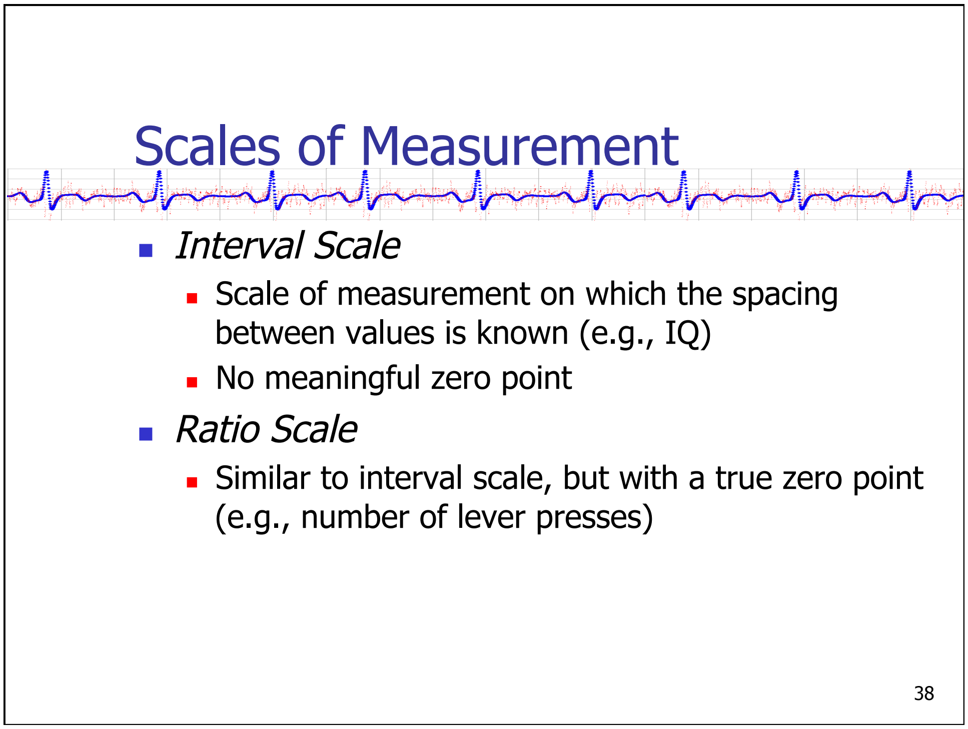


Scales of measurement aka Levels of measurement



Scales of Measurement

- *Nominal Scale*
  - Lowest scale of measurement involving variables whose values differ by category (e.g., male/female)
  - Values of variables have different names, but no ordering of values is implied
- *Ordinal Scale*
  - Higher scale of measurement than nominal scale
  - Different values of a variable can be ranked according to quantity (e.g., high, moderate, or low self-esteem)

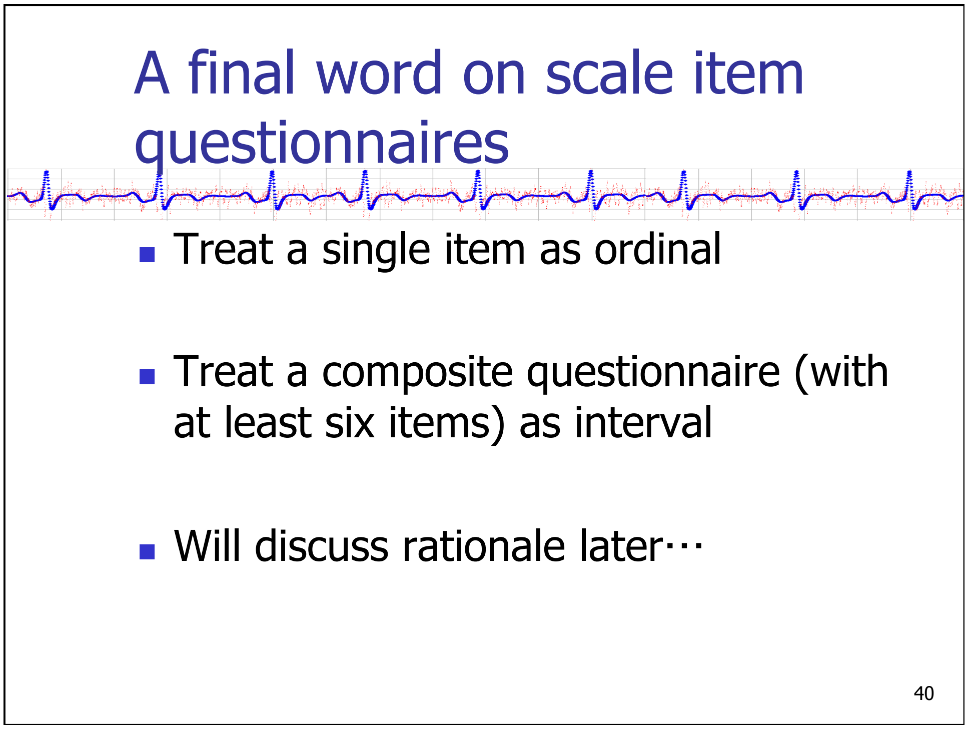


Scales of Measurement

- *Interval Scale*
  - Scale of measurement on which the spacing between values is known (e.g., IQ)
  - No meaningful zero point
- *Ratio Scale*
  - Similar to interval scale, but with a true zero point (e.g., number of lever presses)

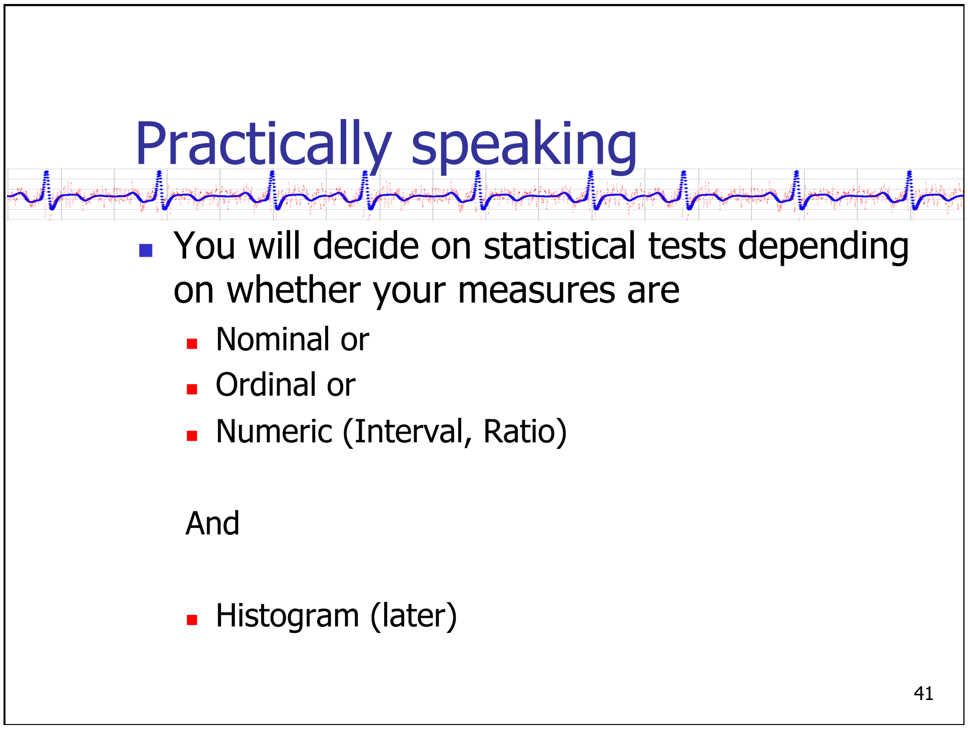
What kind is it?

- Age
- Gender
- Job Category (Engineer, Manager…)
- Weight
- School Year (Freshman…)
- Temperature (Celsius)
- Olympic medal (Gold, Silver, Bronze)
- Monitor Size
- Weather (Rain, Snow, …)
- Salary
- Productivity (wpd)
- Owns Pet (or not)



A final word on scale item questionnaires

- Treat a single item as ordinal
- Treat a composite questionnaire (with at least six items) as interval
- Will discuss rationale later…



Practically speaking

- You will decide on statistical tests depending on whether your measures are
  - Nominal or
  - Ordinal or
  - Numeric (Interval, Ratio)

  And

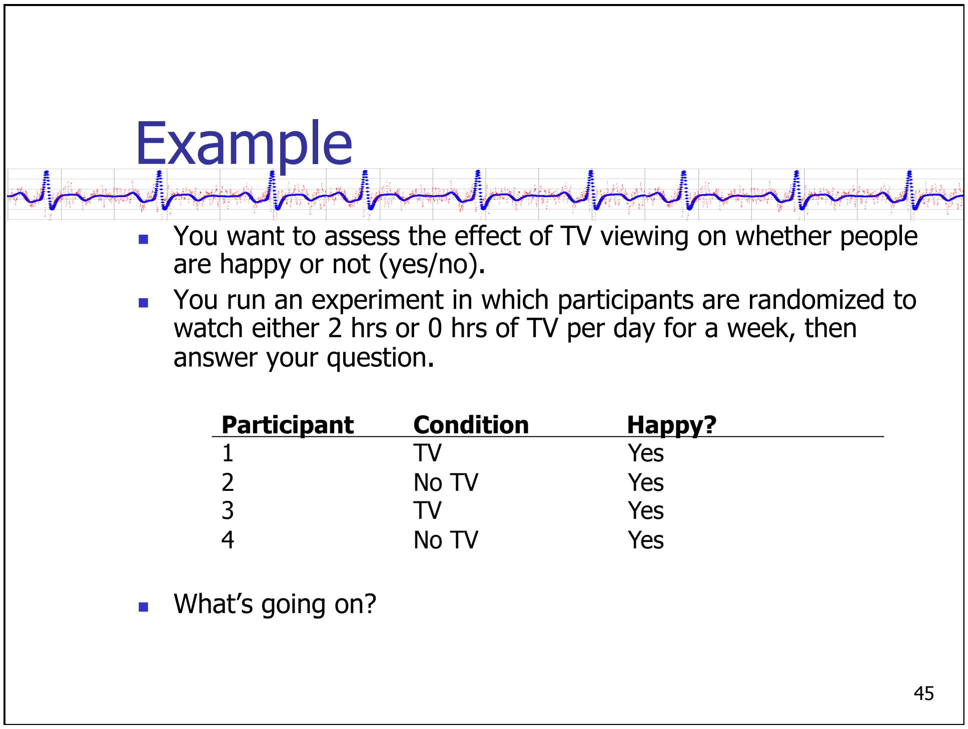
  - Histogram (later)

Factors Affecting Your Choice of a Scale of Measurement

- Information Yielded
  - A nominal scale yields the least information.
  - An ordinal scale adds more information.
  - Interval and ratio scales yield the most information.
- Statistical Tests Available
  - The statistical tests available for nominal and ordinal data (nonparametric) are less powerful than those available for interval and ratio data (parametric)
  - Use the scale that allows you to use the most powerful statistical test

Concerns with Measures

- Sensitivity
  - Is a dependent measure sensitive enough to detect the change you are interested in?
  - An insensitive measure will not detect subtle behaviors
- Range Effects
  - Occur when a dependent measure has an upper or lower limit
    - *Ceiling effect:* When a dependent measure has an upper limit
    - *Floor effect:* When a dependent measure has a lower limit.

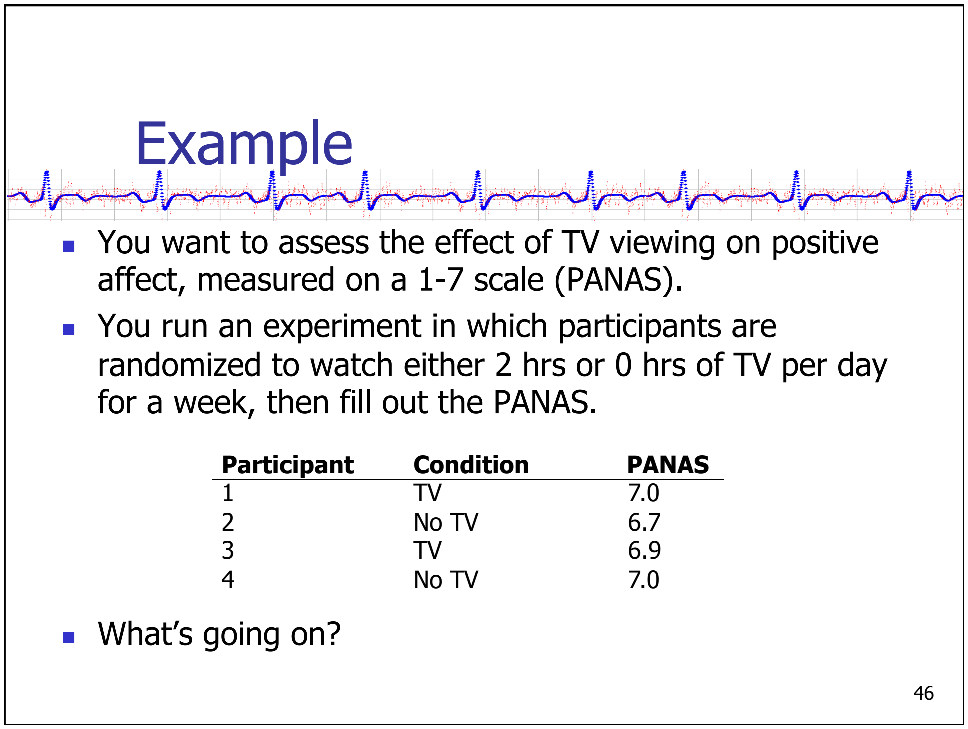


Example

- You want to assess the effect of TV viewing on whether people are happy or not (yes/no).
- You run an experiment in which participants are randomized to watch either 2 hrs or 0 hrs of TV per day for a week, then answer your question.

Participant	**Condition**	**Happy?**
1	TV	Yes
2	No TV	Yes
3	TV	Yes
4	No TV	Yes

- What's going on?

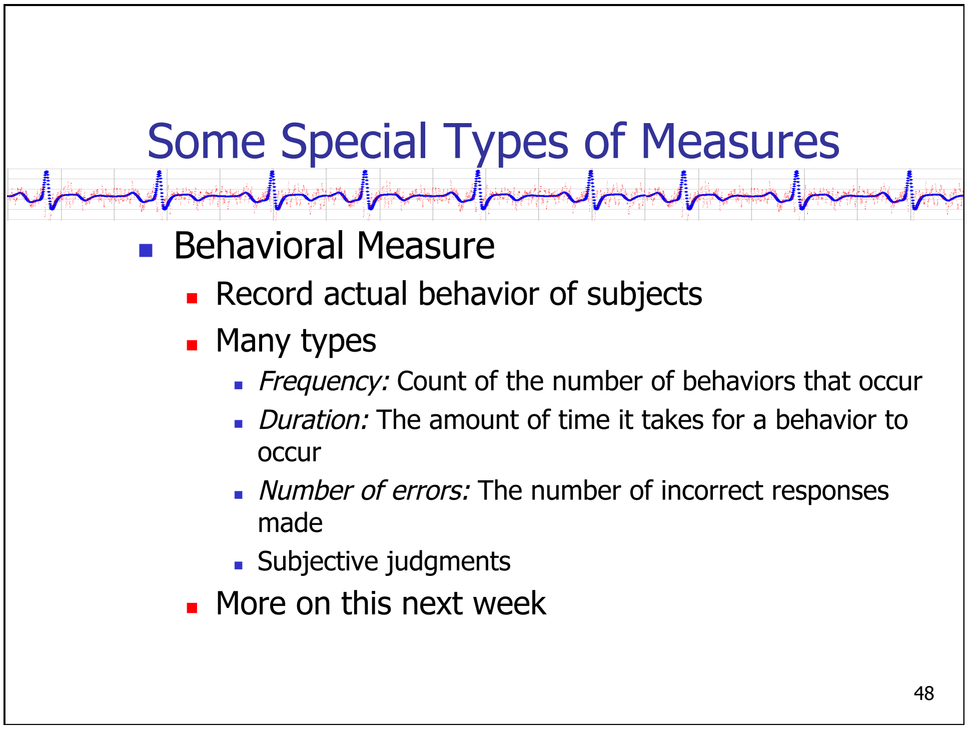


Example

- You want to assess the effect of TV viewing on positive affect, measured on a 1-7 scale (PANAS).
- You run an experiment in which participants are randomized to watch either 2 hrs or 0 hrs of TV per day for a week, then fill out the PANAS.

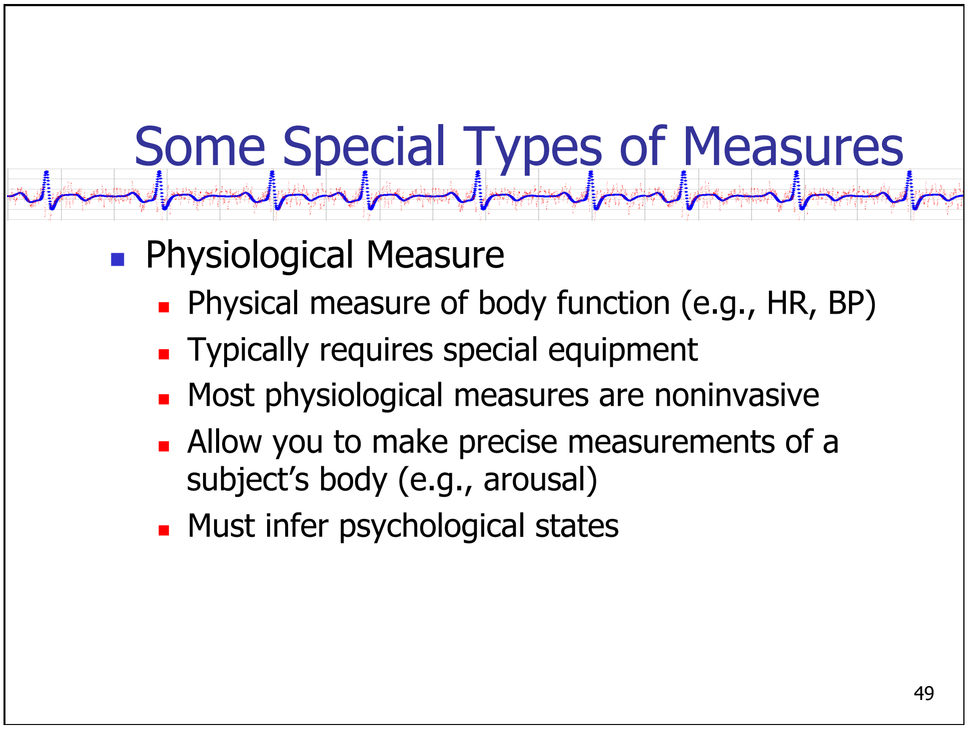
Participant	**Condition**	**PANAS**
1	TV	7.0
2	No TV	6.7
3	TV	6.9
4	No TV	7.0

- What's going on?



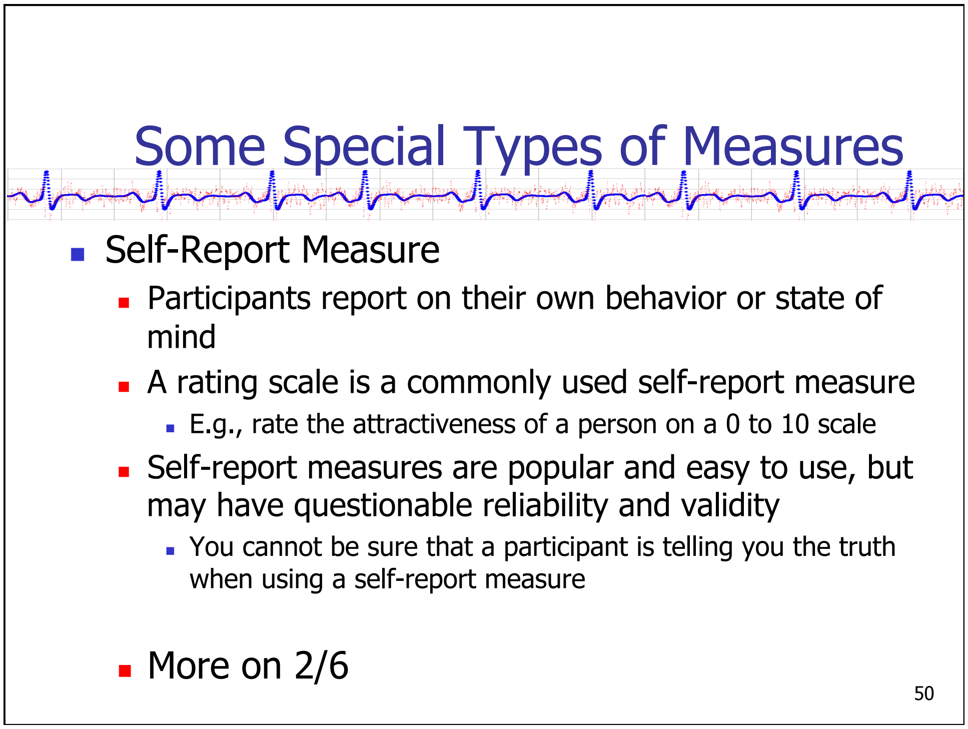
Some Special Types of Measures

- Behavioral Measure
  - Record actual behavior of subjects
  - Many types
    - *Frequency:* Count of the number of behaviors that occur
    - *Duration:* The amount of time it takes for a behavior to occur
    - *Number of errors:* The number of incorrect responses made
    - Subjective judgments
  - More on this next week



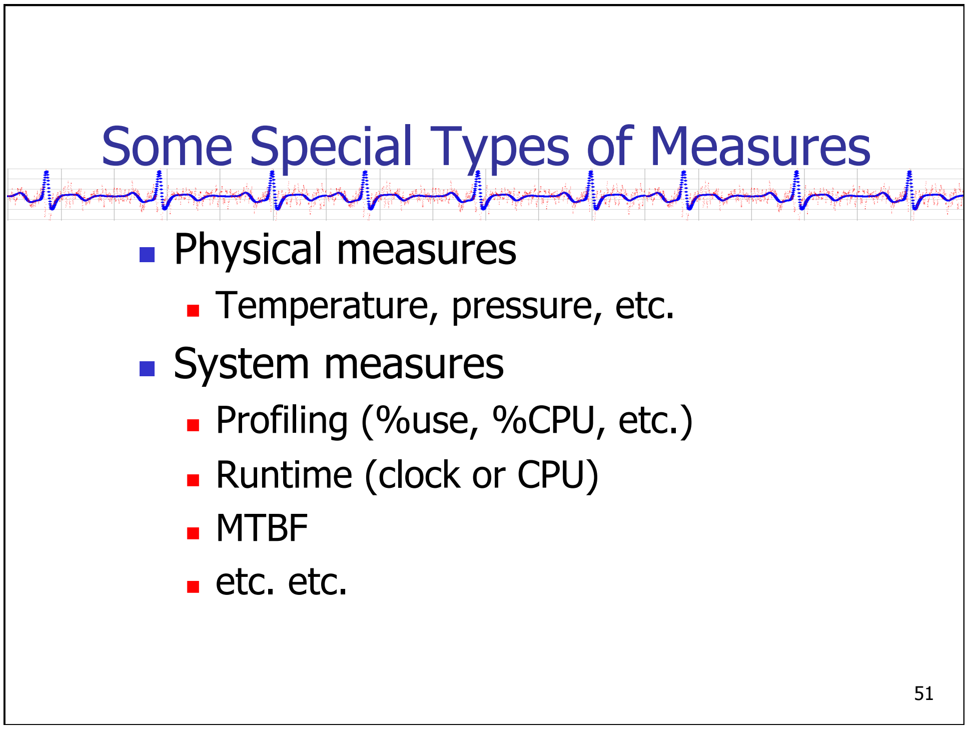
Some Special Types of Measures

- Physiological Measure
  - Physical measure of body function (e.g., HR, BP)
  - Typically requires special equipment
  - Most physiological measures are noninvasive
  - Allow you to make precise measurements of a subject’s body (e.g., arousal)
  - Must infer psychological states



Some Special Types of Measures

- Self-Report Measure
  - Participants report on their own behavior or state of mind
  - A rating scale is a commonly used self-report measure
    - E.g., rate the attractiveness of a person on a 0 to 10 scale
  - Self-report measures are popular and easy to use, but may have questionable reliability and validity
    - You cannot be sure that a participant is telling you the truth when using a self-report measure
  - More on 2/6



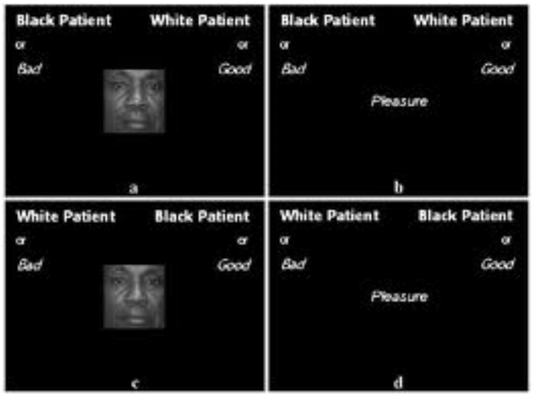
Some Special Types of Measures

- Physical measures
  - Temperature, pressure, etc.
- System measures
  - Profiling (%use, %CPU, etc.)
  - Runtime (clock or CPU)
  - MTBF
  - etc. etc.

Implicit Measures

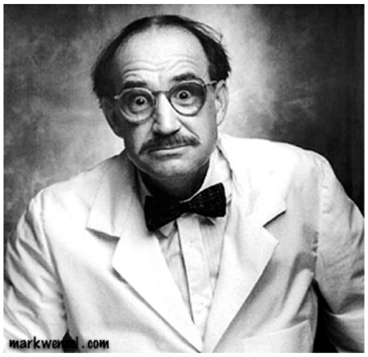
subject is unconscious of measurement

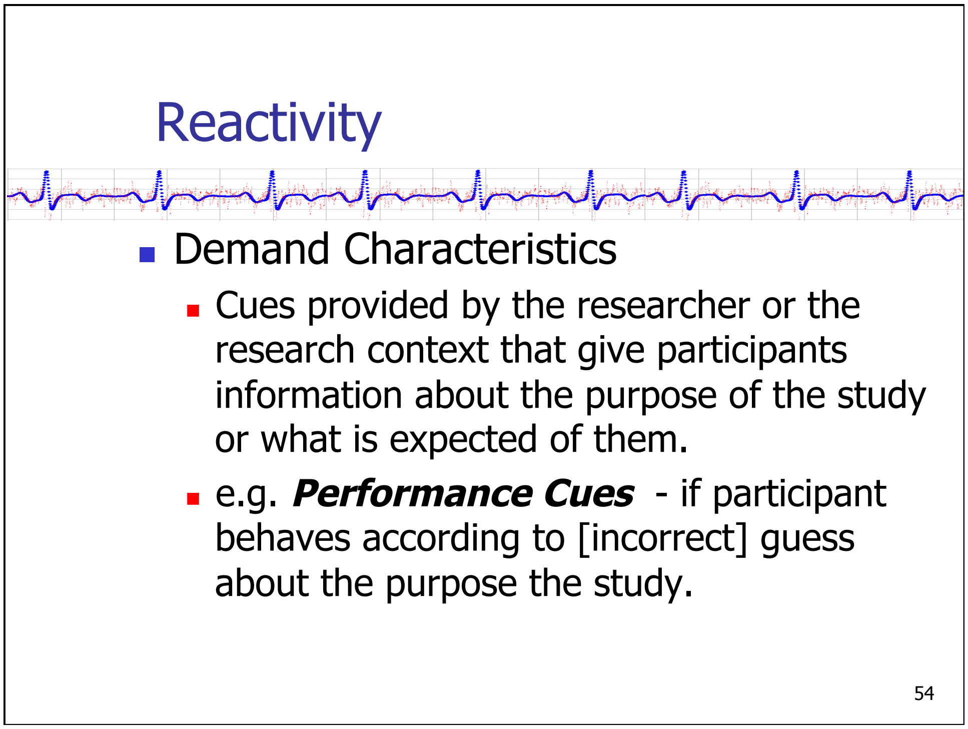
- Uses rapid, unconscious categorization task to tease out biases.
- Assume quicker reaction times are associated with stronger concept associations.



Reactivity in Psychological Research

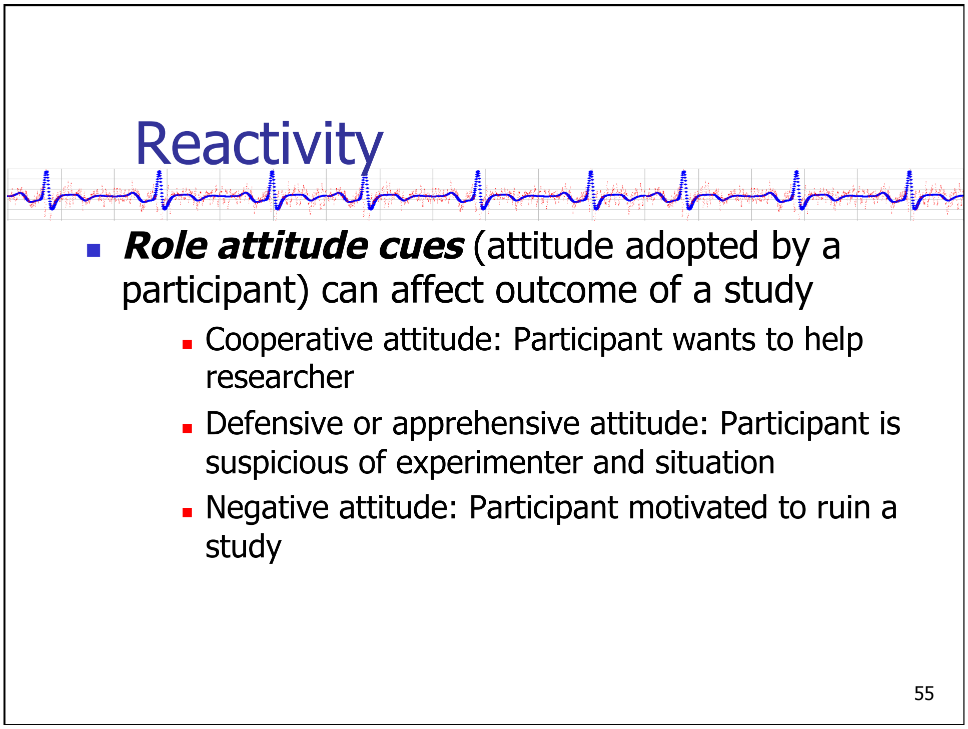
- A psychological study is a social situation
- A participant's social history can affect how he or she responds to a study
- You should not assume that your participant is a passive recipient of the parameters of your study
- Simply observing someone changes his or her behavior





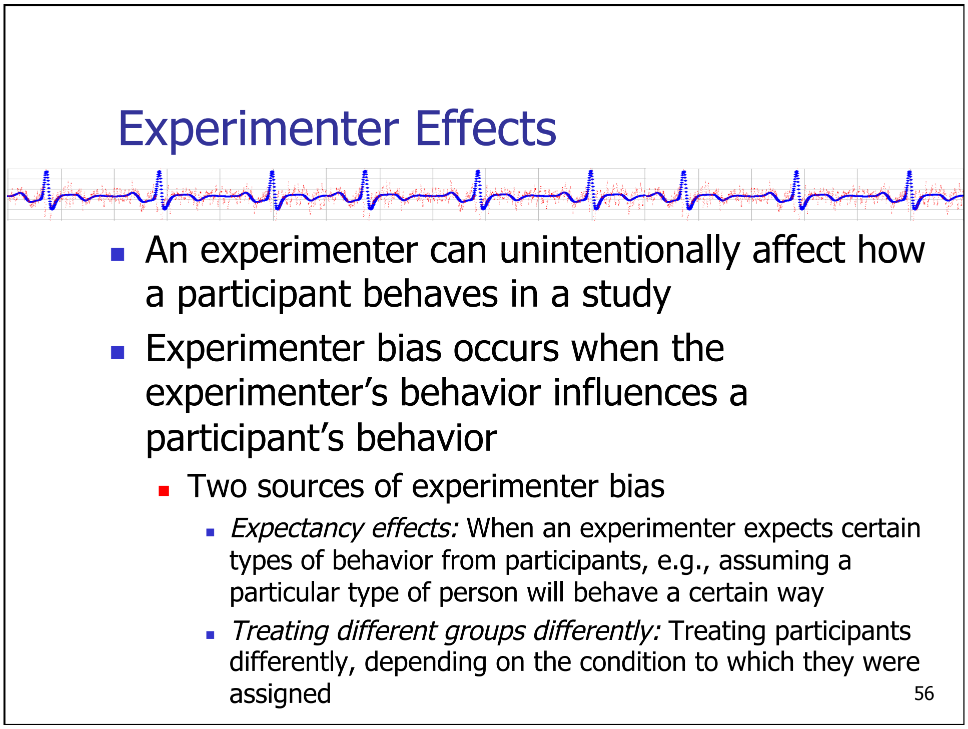
Reactivity

- Demand Characteristics
  - Cues provided by the researcher or the research context that give participants information about the purpose of the study or what is expected of them.
  - e.g. ***Performance Cues*** - if participant behaves according to [incorrect] guess about the purpose the study.



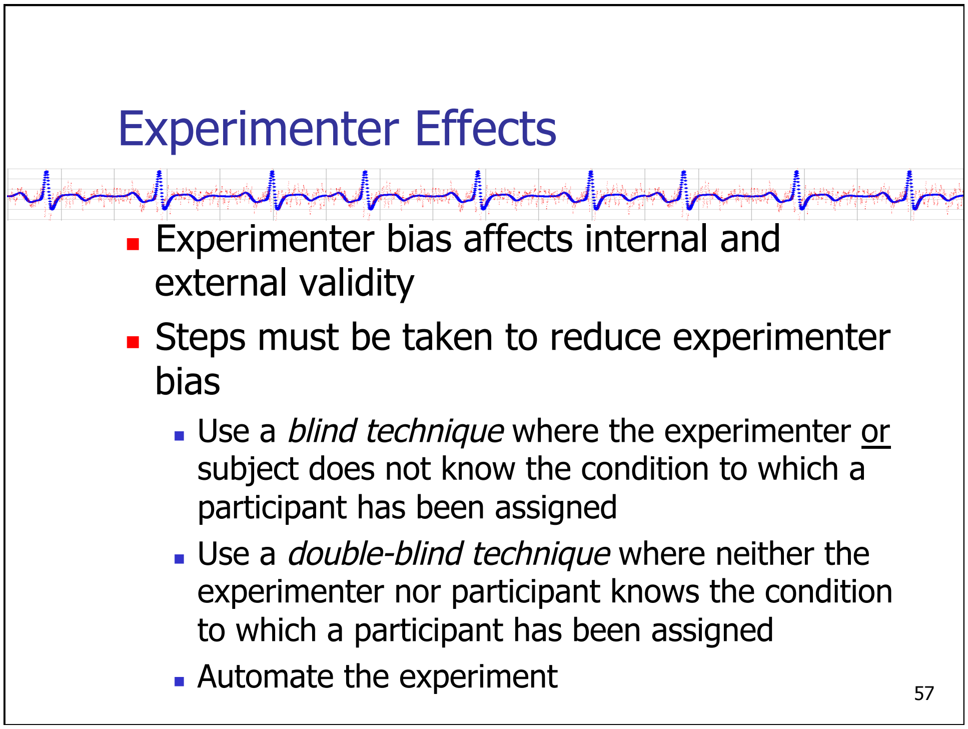
Reactivity

- ***Role attitude cues*** (attitude adopted by a participant) can affect outcome of a study
  - Cooperative attitude: Participant wants to help researcher
  - Defensive or apprehensive attitude: Participant is suspicious of experimenter and situation
  - Negative attitude: Participant motivated to ruin a study



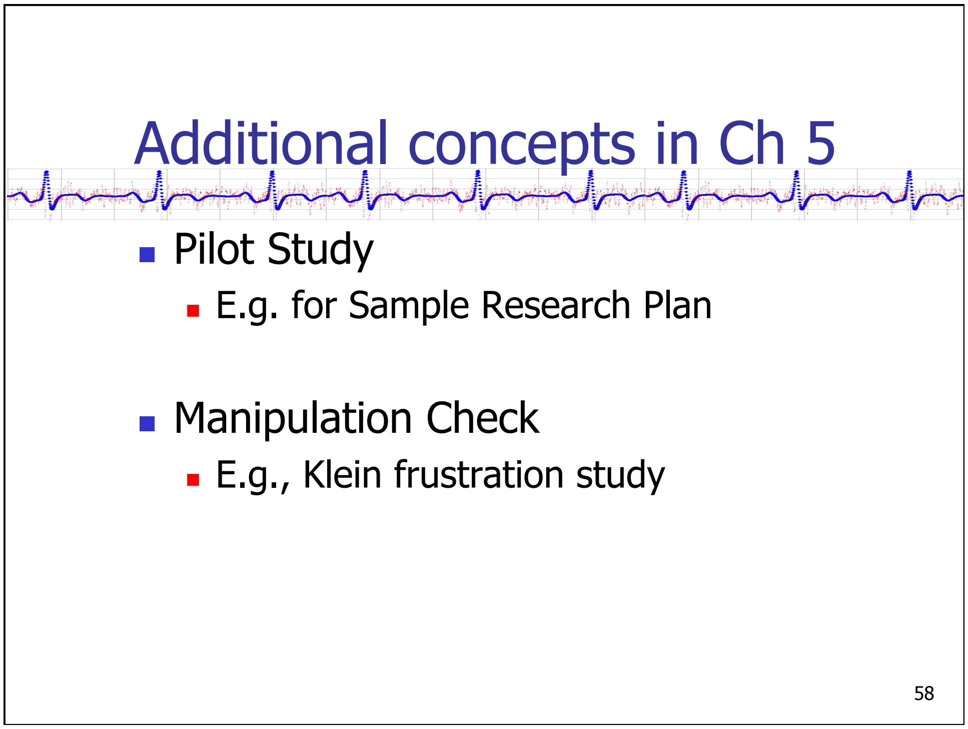
Experimenter Effects

- An experimenter can unintentionally affect how a participant behaves in a study
- Experimenter bias occurs when the experimenter’s behavior influences a participant’s behavior
  - Two sources of experimenter bias
    - *Expectancy effects:* When an experimenter expects certain types of behavior from participants, e.g., assuming a particular type of person will behave a certain way
    - *Treating different groups differently:* Treating participants differently, depending on the condition to which they were assigned



Experimenter Effects

- Experimenter bias affects internal and external validity
- Steps must be taken to reduce experimenter bias
  - Use a *blind technique* where the experimenter or subject does not know the condition to which a participant has been assigned
  - Use a *double-blind technique* where neither the experimenter nor participant knows the condition to which a participant has been assigned
  - Automate the experiment



Additional concepts in Ch 5

- Pilot Study
  - E.g. for Sample Research Plan
- Manipulation Check
  - E.g., Klein frustration study