
# Week 5 Lecture - Measurement

## Undergraduate Research Methods in Psychology

Quinton Quagliano, M.S., C.S.P

Department of Psychology

# Table of Contents

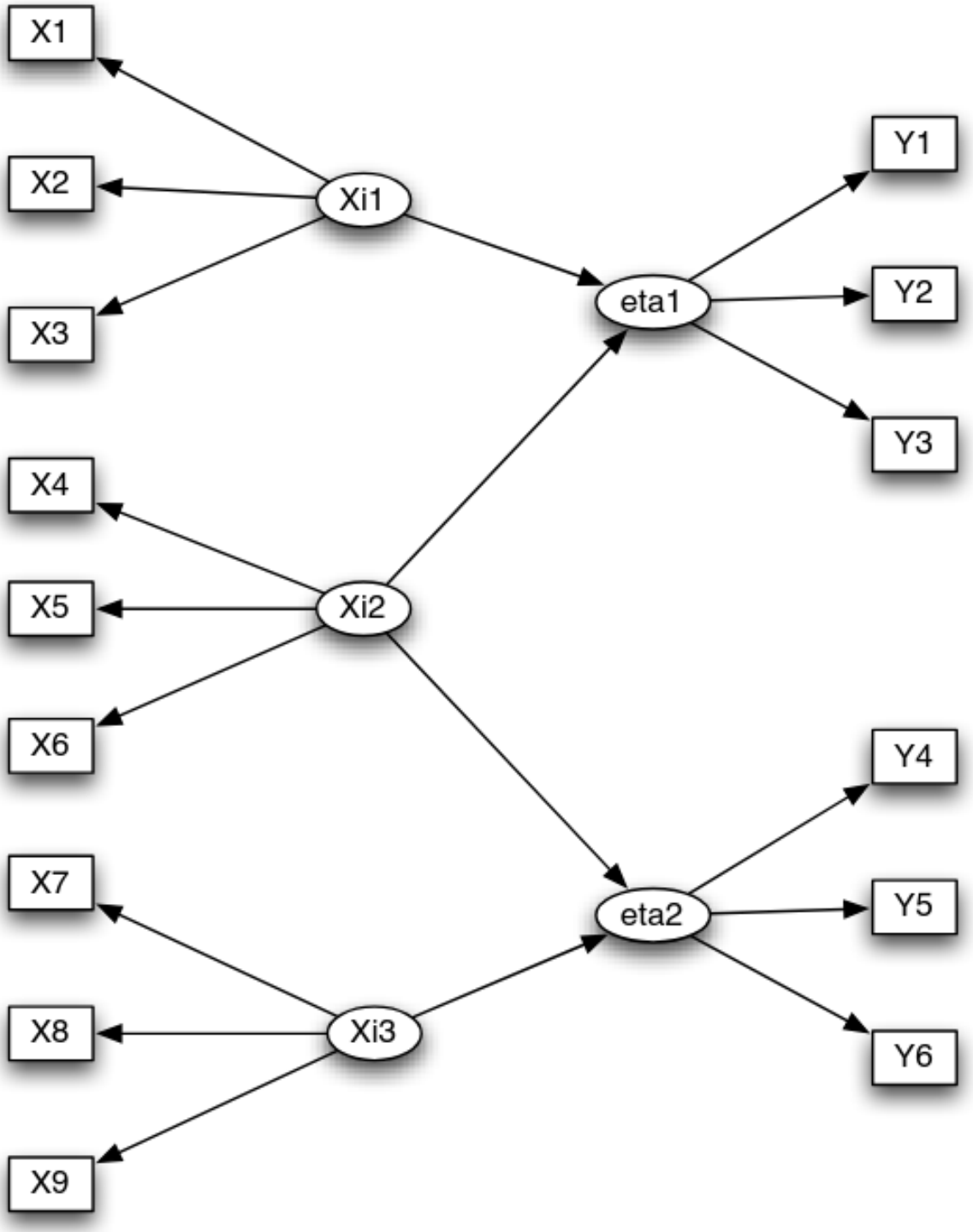
# 1 Chapter Overview

## 1.1 Introduction to Measurement

- Valid and reliable _____ is an essential part of any good quantitative research - without it, it is difficult to test for differences, associations, _____, or frequencies.
- We must be *systemic*, *rigorous*, and _____ in our measurement, and report (through our writing) thoroughly on the methods we use to capture phenomena and experiences.
- Psychological constructs are, in some ways, more difficult to measure than phenomena explored in other _____. For example:
  - A chemist is able to _____ parts of solutions with pH, graduated cylinders, etc.
  - Physicists can measure weight, mass, speed, velocity with _____ and scales
  - Biologists can measure _____ of animals or number of times a certain trait appears in a creature
  - In psychology, we cannot _____ measure cognitive traits that are *internal* to people, and even in behaviors things may be complicated…
- Remember that for _____ validity: we must make operational variables from latent/conceptual/construct variables, and we must do this well!

## 1.2 Visual Representation

- Rectangles -> Observed Variables (Our Measurements)
- Ellipses -> Latent Variables (Our Constructs)
- We want to use strategies that _____ the link between the two


X1
X2
X3
X4
X5
X6
X7
X8
X9
Xi1
Xi2
Xi3
eta1
eta2
Y1
Y2
Y3
Y4
Y5
Y6

# 2 How to Measure Something?

## 2.1 Overview

- There are many decisions to be made on how to operationalize, which will have a direct _____ on the construct validity of a study.
- There are also different mediums for measurement:
  - _____-report
  - _____
  - _____

## 2.2 Constructs vs. Observed Variables (Again)

- Expanding on what we already know from lecture 3:
  - For any construct under study, we must come up with some conceptual _____, that is, some theoretical description of a construct. This usually involves having a reasonable knowledge of _____ and theoretical work in a certain topic area
  - Then, we must link that conceptual definition to an operational measure or tool that fully _____ that meaning.
  - Note: different measures for the "same" _____ may have very different underlying conceptual definitions! Understand the _____ that your tool makes before you use it.
- Example: take the concept of "_____" - what even is intelligence?
  - Depends on whom we ask: Weschler says _____ from Binet says different from …
  - We also may ask: is cognitive intelligence different from emotional intelligence different from _____ intelligence
  - Do we take into account age? _____ level? Race? Socioeconomic background?
  - This is why having a clear literature review and background for a tool can help readers understand a _____ description which goes into the measure of choice

## 2.3 Three Types of Measure

- All three types have drawbacks and biases which will be discussed more in week 6

### 2.3.1 Self-Report

- This is a _____ completed by the person it is measuring, often requiring some amount of introspection
- *Example:* Ever been to a doctor's office and have to fill out a bunch of paperwork? We would call that self-reported _____
- This can be either through a paper form or through a _____ questionnaire
- Related: in some cases we may use what is called a _____ report which involves a third-party (e.g., parent, teacher, friend) providing their _____ of another person

### 2.3.2 Observational

- This is derived from a third party _____ a person's behavior/actions and _____ how many times a certain behavior occurs or in what manner the behavior occurs.
- What I do every day in clinic is technically an observational measure: I present a person with some task or stimuli and I *observe* their response or _____ on a test

### 2.3.3 Physiological

- This is some sort of measurement of _____ characteristics of a person, tends to be much more of a "concrete" measurement that than other two described
- A lot of physiological measures enjoy some associations with the types of measures above
  - Example: a person who reports a high level of anxiety may also show a specific pattern of _____ in the brain during an fMRI
- Examples:
  - Brain scans: CT, MRI, fMRI, PET, EEG
  - Facial movement: EMG
- Ideally, we may choose to use all 3 _____ of measures or some combination of two of them, to provide multiple operationalizations for the same construct, and they should all be _____ (correlated) with one another.

# 3 Reliability (Consistency)

## 3.1 Overview

- _____ is all about how *consistent* a certain scale or measurement is across different raters, times, and contexts.
- We want a measure to be reliable, otherwise, we have a tool that may very well tell us a _____ answer every time we take a measurement!

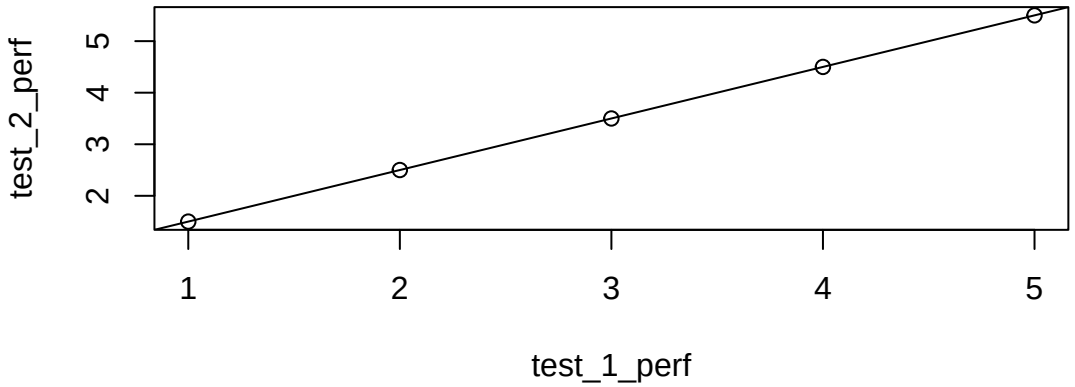
## 3.2 Three Types of Reliability

- There are generally 3 types of reliability:
  - Test-retest: Between different _____ points
  - Interrater: Between different observers/raters - how often are they rating something the _____?
  - Internal: Between items on the _____ measure - how well are related questions regarding the same construct co-varying with one another?

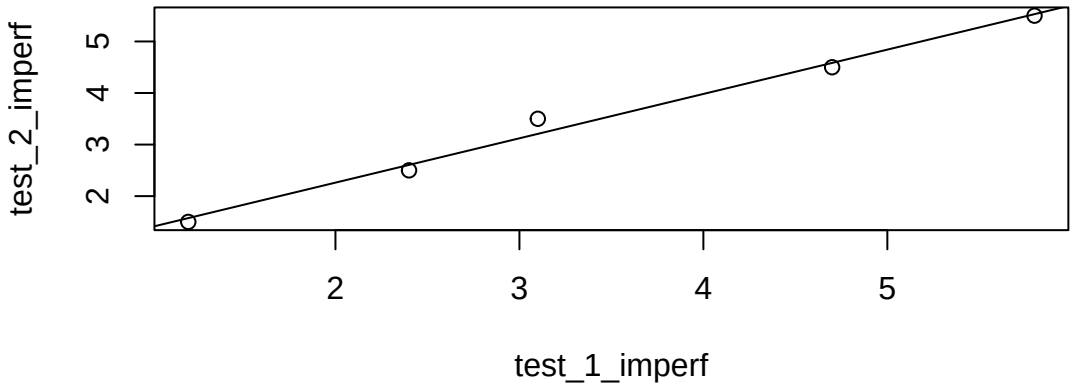
## 3.3 Scatterplot Visualization

- We may logically approach questions of reliability similar to any other claim of _____
  - In test-retest, we claim that the measure scores at two different times are _____
  - In _____, we claim that the measure scores, as recorded by each observer, are *associated* with one another
  - In internal, we claim that two or more _____ on the same measure, for the same construct, *covary* with one another
- Graphically, we may use a _____ when we have two sets of continuous data, e.g., two sets of scores of any of the above 3 types
- The more the points sit close to the line of best fit (which is usually an OLS linear regression line), the stronger the _____ between the two measures.
- In the case of reliability, we would usually like to see a positive relationship between the two sets of data, which would be represented by a line of best fit traveling up and to the _____. Put another way, as one set of data increases, the other generally does as well.

### 3.3.1 Perfect Positive Relationship




### 3.3.2 Imperfect Positive Relationship




## 3.4 Correlation Coefficient

- To mathematically _____ the direction and strength of relationship between two variables we may use $r$. The type we will be talking about now is technically called Pearson's product-moment correlation coefficient $r$.

- $r$ will always be between -1 and 1, with 0 representing _____ correlation or relationship and -1/1 representing a perfectly strong relationship between the two. In practice, you will never get exactly 0 or -1/1, but likely some number in _____.

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

- This correlation coefficient is technically only applicable to continuous data, but is _____ to ordinal data by using Spearman's $\rho$ (rho) or Kendall's $\tau - B$ (tau-B).

### 3.4.1 Perfect Positive Relationship

```
[1] 1
```

### 3.4.2 Imperfect Positive Relationship

```
[1] 0.9944883
```

- The _____ process is fairly straightforward for inter-rater or test-retest reliability -> higher $r$ = greater consistency/reliability.
- Another popular statistic for inter-rater reliability is called Cohen's $\kappa$ (kappa), but that is only _____ when raters are grouping/classifying objects or people. It's interpretation is the same as $r$.

### 3.4.3 Internal Reliability

- The simplest way to arrange this is to use a correlation _____ of all the items of a measure, and calculate the $r$ between each two items.
- In such a table, we are looking to make sure construct-related items are positive, highly _____ and that theoretical unrelated items are negative or weakly correlated.
- You may also calculate an _____ inter-item correlation which is just an average correlation across the entire matrix (only recommended if all items *should* be related)
  - Side note: I wouldn't recommend using the acronym AIC for this - most statisticians use that more often for the Akaike information criterion, used often in regression
  - We want _____ between 0.15 and 0.50 for this to be "reliable"

- Finally, you can take _____'s $\alpha$ (alpha) which is taken from the average inter-item correlation and number of items on a scale.
  - This is probably the "preferred" statistic for _____ reliability
  - Above 0.80 is good for self-reports, we want as close to 1 as possible

### 3.5 Reading About Reliability

- The most important things to know are the _____ of each value for reliability and a basic _____ of each one. You do not have to know how to calculate these values by hand (for this class), but you should be familiar with the conceptual definition of each.

## 4 Measurement Validity (Accuracy)

### 4.1 Overview

- This is where our _____ get confusing, because we already talked about the 4 validities for investigating claims. For the sake of clarity I will use the terms *"claim validity"* and *"measurement validity"* to separate the two terms.
- Essentially, _____ validity is the second major component of construct validity, alongside measurement reliability. They both are individual steps in establishing construct validity.
- A "good" measure (i.e., one with good construct validity) will have evidence of _____ the following measurement validities, usually across different studies

### 4.2 Measurement Validity

- Validity is all concerned with how well we represent the construct with an _____ tool. It is multifaceted and often quite complicated - usually the measurement validity of any given tool has to be well-established across _____ studies.
- But remember, just like any claim or evidence, we never *prove* something as completely and flawlessly valid - rather the _____ of evidence is for or against its validity.

## 4.3 Face & Content Validity

- Both of these are more _____ validities which relate to whether it *seems* like a certain measurement captures the concept well. However, they are a little _____ and tend to be more valued when a measurement scale is first proposed, vs. less so when a scale is more established.
- **Face validity** is largely just an assessment of "well, does it seem like this would work?" - may be _____ by the general public or by experts in a domain
- **Content validity** asks whether it appears a measurement would capture *all* components of a theoretical construct. This is usually _____ assessed by domain experts which have a strong knowledge of the theory underlying a certain construct.
- For a more empirical, albeit subjective approach, some studies will gather a panel of experts, calculating $r$ or $\kappa$ for a measurement or the individual items of a measure across the experts. This could be taken as evidence of somewhat decent expert _____ on a tool, but it strays close to an appeal to authority (i.e., the expertise of the judges). For more than 2 judges we would use extensions of those statistics that are applicable to multivariate data (e.g., multivariate regression, G-study, D-study, etc.)

## 4.4 Criterion Validity

- **Criterion validity** focuses on whether a measurement is positively _____ with behaviors that are also said to be representative of the construct. Now those selected _____ are also a subjective choice - but this measurement validity can help establish that a measure is related to what behaviors we normally associate with a trait.

### 4.4.1 Correlative Methods (for Continuous Behavior)

- Once again, we are able to use _____ methods and scatterplots, like those previous discussed.
  - In the scatterplot, we would place the _____ or magnitude of behavior on one axis and the measure on the other axis.
  - A strong, positive relationship between the two would be _____ of good criterion validity
- For example, consider we are developing a collateral-report measure for temper in children where a parent reports how often a child engages in disruptive behavior. Now, we sit in a classroom with the child and measure the number of _____

they engage in disruptive behavior. A higher score on the measure should be associated with a higher number of occurrences of disruptive behavior.

### 4.4.2 Known Groups Methods (for Categorical Behavior Groups)

- We can also assess whether a measure is able to discern differences between some *known-groups* by some _____ standard.
  - This means that, prior to testing the new measure, we must have some "source of truth" for whether a person belongs to a certain group.
- Example: We have two groups of people, those diagnosed with schizophrenia and those not diagnosed with schizophrenia. We have a continuous measure designed to detect psychotic disorders. Are those individuals with schizophrenia and those without scoring different on this measure?
- In this method, we could use between-groups _____, such as t-tests and ANOVA to decide whether scores on the measure are significantly different between the known-group members.
  - In modern research, you are more likely to see techniques like logistic regression, receiver operating characteristic (ROC), and area-under-the-curve (AUC) analysis - as these methods are able to detect appropriate "cut-off" scores for the measure that discriminate between the two groups with ideal sensitivity (detection of true positives) and specificity (detection of true negatives)

## 4.5 Convergent & Divergent Validity

- We can also determine how a new measure relates to existing measures for the same/different _____. Ideally, we want a new measure to strongly correlate with measures for the same construct (convergence) and have little to no relationship with measures for other constructs (divergence).
- Just like the other measurement validities, correlation is our analysis of choice for these

### 4.5.1 Convergence with Related Measures

- For a valid measure, we want *high convergence (i.e., strong positive correlation)* with tools that are meant to measure the *same* construct.

### 4.5.2 Divergence with Unrelated Measures

- For a valid measure, we want *high divergence (i.e., no/negative correlation)* with

tools that are meant to measure a *different* construct.

## 4.6 Relationship Between Reliability and Validity

- Measurement validity and reliability are **not** _____ terms, though they are related.
  - Reliability is a core necessity for a tool to be considered valid, but just because something is reliable, does not make it valid.
  - "A valid tool is reliable"
  - "A reliable tool is not necessarily valid"