Week 5 Lecture - Measurement

Undergraduate Research Methods in Psychology

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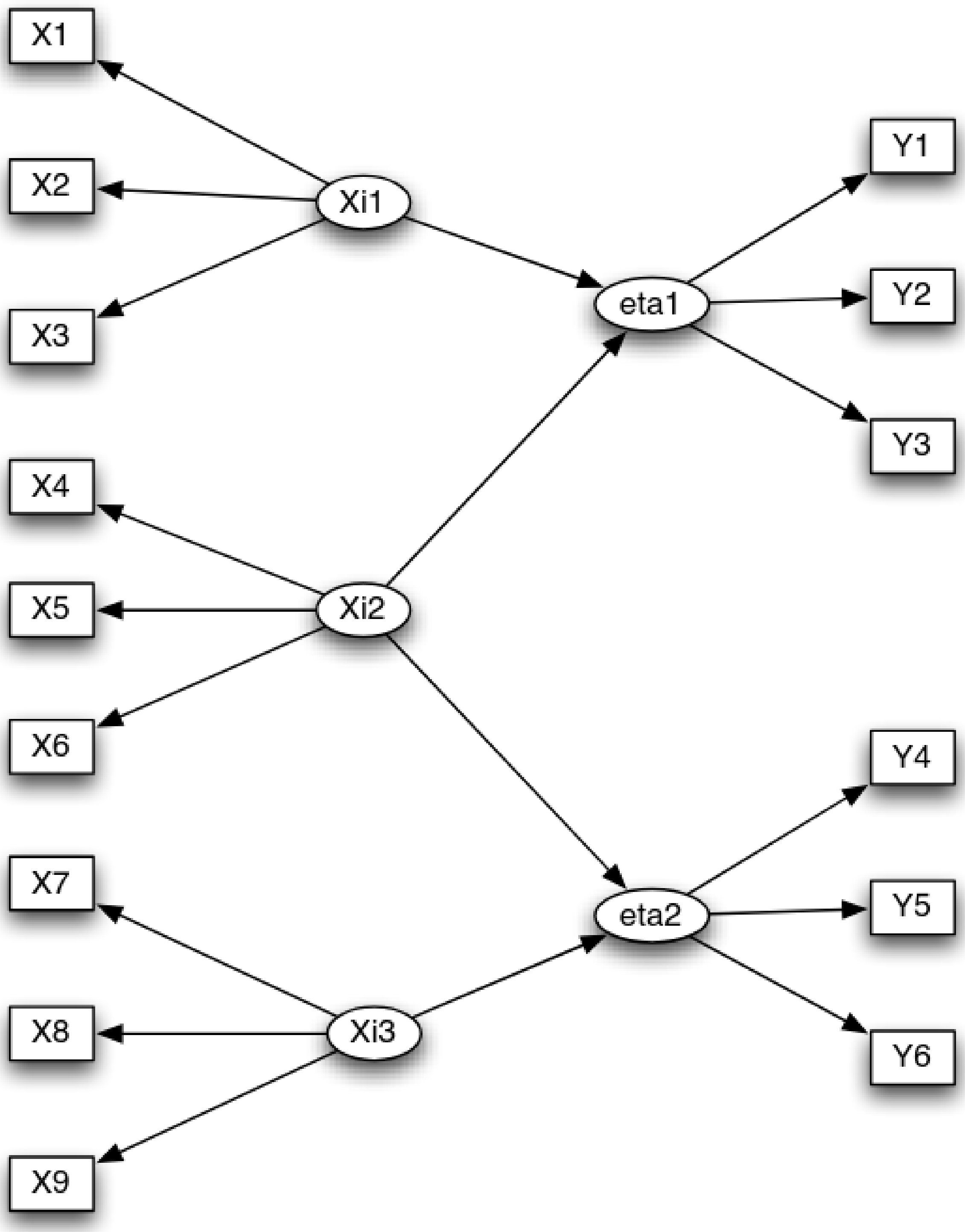
1 Chapter Overview

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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Y2
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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!

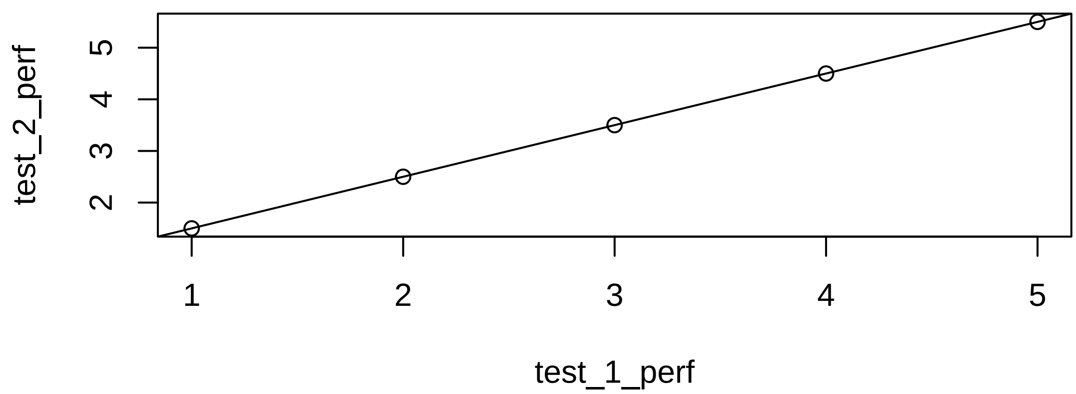
3.2 Three Types of Reliability

- 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?

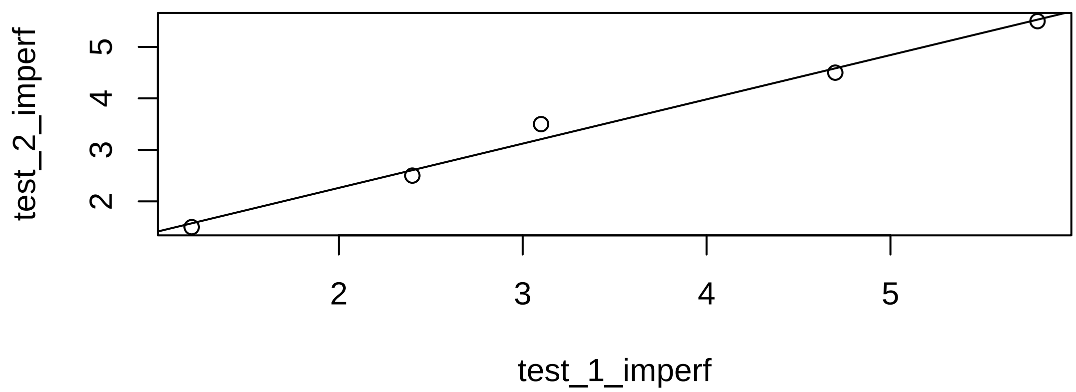
3.3 Scatterplot Visualization

- 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 ρ (rho) or Kendall's $\tau - B$ (tau-B).

3.4.1 Perfect Positive Relationship

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[1] 1
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3.4.2 Imperfect Positive Relationship

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[1] 0.9944883
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- 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 κ (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 α (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 κ 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”