In much scientific work we are interested in either describing the distributions of and/or relationships among abstract constructs: e.g.,

- Political conservatism
- Intelligence
- Neuroticism
- Aggression

However, in most cases these constructs are abstractions that can often not be directly observed.
Measurement

- Note that the degree to which the operationalization of the abstract concept actually reflects or mirrors the construct is the degree to which the operationalization can be said to be **valid**.
- The value of scientific research is completely dependent upon the degree to which the operationalizations are successful or valid.

Concepts and Constructs

- **Concept**: “An abstraction formed by generalization from particulars”
  - Abstract hard to define
  - E.g. intelligence
- **Construct**: A concept with scientific purpose
  - Can be measured and studied.
  - E.g. IQ

Measurement

- Statistical analyses depend upon the measurement characteristics of the data.
- **Measurement** is a process of assigning numbers to constructs following a set of rules.
- We normally measure variables into one of four different levels of measurement:
  - Nominal
  - Ordinal
  - Interval
  - Ratio
Measurement

- **Nominal Measurement:**
  - This refers to the simple act of assigning different labels to different categories of a variable
  - Nominal → Naming
  - Only supplies one piece of information
  - E.g., an ethnicity variable
    - 1 = White
    - 2 = Asian
    - 3 = Middle-eastern
    - 4 = Latino
    - 5 = Black

Ordinal measurement

- Here numbers not only imply different categories of a variable, but also information concerning the “more-ness or less-ness” of that variable.
- Ordinal
- Consider the variable “subjective temperature”
  - 1 = Cold
  - 2 = Comfortable
  - 3 = Hot

Ordinal Measurement

- Where Numbers Representative Relative Size Only

Contains 2 pieces of information
Measurement

- **Interval Scale Measurement**
  - In interval scale measurement there are three kinds of information conveyed by the numbers assigned to represent a variable:
    1. Different numbers which represent different categories or values of that variable
    2. Numbers also represent “more or less-ness” of that variable
    3. Where equal intervals with respect to the operationalization correspond to equal intervals with respect to the abstraction being measured.

**Interval Measurement:**

- Where Equal Differences Between Numbers Represent Equal Differences in Size

<table>
<thead>
<tr>
<th>Numbers representing Size</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diff in numbers</td>
<td>2-1=1</td>
<td>3-2=1</td>
<td></td>
</tr>
<tr>
<td>Diff in size</td>
<td>Size C – Size B = Size X</td>
<td>Size D – Size C = Size X</td>
<td></td>
</tr>
</tbody>
</table>

**Diagram:**

- Interval scale measurement

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**Legend:**

- Abstraction
- Operationalization or measure
Measurement

- **Ratio Scale Measurement**
  - In ratio scale measurement there are four kinds of information conveyed by the numbers assigned to represent a variable:
    - Different numbers which represent different categories or values of that variable
    - Numbers which represent “more or less-ness” of that variable
    - Where equal intervals which respect to the operationalization correspond to equal intervals with respect to the abstraction being measured.
    - Where there is a meaningful 0-point and therefore meaningful ratios among measurements.
**Measurement**

- **Ratio Scale Measurement**
  - If we have a true ratio scale, where 0 represents an complete absence of the variable in question, then we form a meaningful ratio among the scale values such as:
    
    \[
    \frac{4}{2} = 2
    \]
  - However, if 0 is not a true absence of the variable, then the ratio \(4/2 = 2\) is not meaningful.

**Variables and Constants**

- **Variable:** any condition, event, characteristic or attribute that can take on different values at different times or with different people.
  - Age of people
  - Temperature
  - Intelligence
  - Xenophobia

- **Constant:**
  - One value in a given context.
  - Does not change or vary.

**Independent and Dependent Variables**

- **Independent variable**
  - We are referring to a variable that the experimenter has some direct control over and can manipulate
  - In Experiments IVs are the “cause”
  - In non-experiments IVs are the “influence”
  - i.e., \(X \rightarrow Y\)

- **Dependent Variables**
  - The variable being influenced/predicted
  - The outcome variable
Discrete & Continuous Variables

- Discrete variables: can only take on a finite or restricted set of values.
  - Can only take on whole values (think digital)
  - E.g., number of children per family, Number of students taking 100A

- Continuous variables: can take an infinite number of values
  - E.g., Temperature (10.3 C, 10.24 C, 15.212 C), Weight (102.2lbs., 116.56 lbs.)
  - The difference often limited only by precision

Random Sampling

- Random Selection
  - Participants are chosen into the study at random

- Random Assignment
  - Once selected, participants are randomly placed into treatment groups

Intro to Notation

- It's all greek (well mostly), get used to it!
- Capital letters refer to variables (e.g. X, Y)
- Lower Case Letters with subscripts – are individual values (e.g. x_i)
- Σ - summation e.g. \( \sum x \cdot \sum x \cdot \sum x \)
- \((\Sigma X)^2\) vs. \(\Sigma X^2\)
- Rules
  1. \(\Sigma (X - Y) = \Sigma X - \Sigma Y\)
  2. \(\Sigma CX = C \Sigma X\)
  3. \(\Sigma (X + C) = \Sigma X + NC\)