Levels (or Scales) of Measurement

Measurement is a process whereby values (scores) are assigned to properties of people, places, things, or events. You might rate preferences of perfumes or TV show. You may collect data about marital status or gender, or count the number of times people report feeling depressed. These different measures all have different properties, which in turn, lead to different sorts of appropriate statistical tests. The level of measurement refers to the amount of information the measurement procedure can convey about the actual quantity of the variable present and about the differences individuals with different scores.

Four Properties of the Real Number system

1. Identity, where each number serves as a label for a different numerical value;
2. Order (or ranking), where the numbers can be placed in order based on magnitude;
3. Equal Intervals, where an equal difference in the numbers always represents an equal amount of change in the magnitude;
4. A True Zero Point, where the number zero always means zero amount, or complete absence of the variable.

- Nominal scale: based on categories or names, and tells us nothing about magnitude.
- Ordinal scale: a rank-order scale that reflects differences in magnitude, but the intervals between values may not be equal and there is no absolute zero.
- Interval scale: also measures magnitude and has equal intervals between values, but the scale has no absolute zero.
- Ratio scale: Has equal intervals between all its values and an absolute zero point.

Nominal Scale

The nominal scale is the most basic. It seeks to name things, to categorize or classify them. Nominal scales satisfy only the property of identity.

Examples are gender, job title, religion, marital status, etc. Numbers can also be used to identify or categorize, such as the numbers of players on the football team. The numbers themselves do not indicate magnitude, and it would make no sense to try to add or multiply the numbers on football jerseys.

Ordinal Scale

The ordinal scale of measurement deals with order or ranking. Common examples are the grades of A, B, C, D,and F; the "top 20" ratings for sports teams; the "top 40" ratings for music. While an ordinal scale allows us to know which category is larger, higher, or better, it does not allow us to say anything about the interval between the rankings, or how much better one team or song is than another. The only mathematical operation allowed on ordinal data is ranking.

Interval Scale

The interval scale of measurement tells us about the rank order and about the intervals between the numbers. On an interval scale, a difference of 1 point always means the same thing. Temperatures measured with either the Celsius or Fahrenheit scales provide scores on an interval scale. However, these thermometers do not have true zero points: a temperature of 0° does not mean the absence of heat. The mathematical operations allowed are addition and subtraction, but never multiplication or division. 80° is not twice as hot as 40°.

Ratio Scale

The "highest" level of measurement, the ratio scale has all of the properties of the real number system. In addition to identify, order, and equal intervals, ratio scales have a true or absolute zero point. Our standard measures of time, distance, volume, height, and weight all use ratio scales.

Mathematical operations allowed: (all) Addition, subtraction, multiplication, division.

Why should we care?

One reason why it is important to understand these different scales of measurement is so we can select the most powerful statistical test we can for our data analysis. Statistical tests are divided into two types: parametric and nonparametric tests. Parametric tests are more powerful [rejecting the null hypothesis when it is false: $1-\beta$], but because they include particular mathematical operations on the values, they can be used only with interval or ratio data. Ordinal and nominal data require the use of non-parametric statistical tests.

Parametric tests usually require:

- Normally distributed data from each treatment condition;
- Approximately equal variability across treatments;
- Interval or ratio data;
- Independence of measures.

Parametric:	Nonparametric:
• Z-test • *t*-test (for independent groups, matched groups or within subjects) • One-way ANOVA • Two-way ANOVA • Binomial test • Analysis of Covariance	• Chi square test • Wilcoxon test • Mann-Whitney U test • Kruskal-Wallis test • Friedman test • Cochran's Q test • Factor analysis