Introduction: There are 4 types of scales, based on the extent to which scale values have the arithmetic properties of true numbers. The arithmetic properties are *order*, *equal intervals*, and a *true zero point*. From the least to the most mathematical, the scale types are *nominal*, *ordinal*, *interval*, and *ratio*. Nominal scales have *no* arithmetic properties. Ratio scales have all three of the arithmetic properties. Ordinal and interval scales fall in between nominal and ratio scales.

1. Nominal scales do not measure quantity, only type. Nominal scales classify members of a population into 2 or more categories. The categories must be mutually exclusive and exhaustive, i.e., each and every member of the population must be capable of being classified into one, and only one category. Nominal scales have no arithmetic properties. No category is greater or lesser than any other category. The category values are simply names (hence the term nominal). The only mathematical statements that can be made about nominal data consist of relative comparisons between the number of population members in each category, called proportions. Some examples of nominal scales are respondent's sex, respondent's religious affiliation, respondent's political party affiliation, respondent's ethnicity, or respondent's college major.

2. Ordinal scales "order" members of a population into ranks, from most to least, or least to most. Rank values do not possess the arithmetic property of equal intervals or true zero points. This means that, with ordinal data, we know only that one member of a population has either more or less of some quality than another member, but we do not know just how much more or less. For example, we can not say how much better the best tennis player is than the 2nd best player, or the 3rd best player is than the 4th best player. In order to know just how much better one rank is than another would require equal intervals between ranks in order to perform addition and subtraction. Also, we can not say that the 2nd best tennis player is twice as good as the 4th best tennis player. This would require a true zero rank in order

to perform multiplication and division. Some examples of ordinal scales are ranking of beauty contest winners, sports rankings of players and teams, or ranking of respondent's preferences for different flavors of ice cream.

3. Interval scales have the property of order, and also the property of equal intervals. Each interval on an interval scale is equal to every other interval on the scale. Hence, addition and subtraction are valid arithmetic operations for interval data. However, interval scales do not have a true zero point. Therefore, multiplication and division are not valid using interval data. Some interval scales, such as the centigrade temperature scale, have zero points, but they are arbitrary zero points. Arbitrary zero points do *not* mean the absence of the quality. For example, 0° centigrade does not mean an absence of heat. Because of the arbitrary meaning of 0° centigrade, 8° is not twice as warm as 4°. Absolute zero centigrade is -276°. There are few interval scales used in the social sciences. In the 1950's, social psychologists devised a method of constructing interval scales for measuring attitudes. The method is cumbersome, and not without questionable assumptions. Some examples of commonly used interval scales in our daily lives are the centigrade and Fahrenheit temperature scales, clothing sizes, and the common clock and calendar.

4. Ratio scales get their name from the fact that ratios can be calculated using ratio data. However, do not confuse the meaning of *ratio* with *ratio scale*. They are not identical terms. Ratio scales have all the arithmetic properties of interval scales, plus a true zero point. Therefore, ratio data can be treated as true numbers, permitting addition and subtraction, and multiplication and division. Ratio scales are used frequently in the social sciences, and in every-day life. Some examples of ratio scales are respondent's yearly income, respondent's age, height, or weight, and the number of individuals living in respondent's household.