

# Statistics for Psychology

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Much of psychological research involves measuring observations of particular characteristics of either a *population*, or a *sample* taken from a population. These measurements yield a set of values or *scores*, and this set represents the findings of the research, or *data*. Often, it is impractical to completely measure the characteristics of a given population, known as *parameters*, directly. Thus, psychologists often focus on the characteristics of samples taken from a population. These characteristics are called *statistics*. The psychologist then uses these sample statistics to make inferences about population parameters.

In this section we will focus on a type of statistics known as *descriptive statistics*. We will begin with an examination of three methods of describing a set of data using scores that seem to be typical of those found in the set. We will then look at three methods of describing how scores within the set vary from these typical scores.

## Descriptive Statistics

**Descriptive statistics** is the name given to procedures used to collect, classify, summarize, and present data. The methods used by psychologists to collect, classify, and present data are beyond the scope of this discussion. For the remainder of this section, we will be focusing on statistical methods used to summarize psychological research data.

## Measures of Central Tendency

Often, data tends to group itself around some central value. This value may, in turn, be used to describe or represent the data set as a whole. Methods of determining these central values are called measures of central tendency. There are three main measures of central tendency used by psychologists. They are the *mean*, the *median*, and the *mode*.

### Mean

When people talk about averages, they're often referring to the **mean**, which is the arithmetic average of a set of scores. You have probably calculated the mean of a set of Psychology score many times in the past. Every time you sum a set of scores and divide that sum by the total number of scores you have calculated the arithmetic mean of those scores.

As you probably know from experience, the mean can be affected by extreme scores. For example, if a student were to receive five test marks over 90% and one test mark less than 20%, (let us say marks of 98%, 96%, 94%, 94%, 92%, and 18%), the mean of the test scores would be  $(98 + 96 + 94 + 94 + 92 + 18) / 6 = 82$ . Obviously, the mean in this case has been pulled in the direction of the score of under 20%. For this reason, the mean can be very misleading description of a set of scores with a heavily skewed distribution.

## Median

The **median** is the middle score in a set of scores that have been ranked in numerical order. In cases where there are an even number of scores, the median lies between the two middle scores, and is given the value of the midpoint between those scores. Of course, if the middle two scores in an even number of scores are the same, the median has the same value as the two scores themselves. There is no formula for quickly calculating the median without doing some initial data analysis. Typically, when dealing with large data sets, researchers construct a *frequency distribution* representing all the scores in the data set. This allows them to use a formula to calculate each measure of central tendency using the information provided by the frequency distribution.

Unlike the mean, the median is a good measure of central tendency to use when describing a heavily skewed set of scores. Returning to our example from above, our student's median test score would be 94%, which is a much better indication of the student's overall performance. Thus, the median is a better representation of the scores within a skewed data set than is the mean. In fact, the median is the best method of central tendency to use when describing skewed data.

## Mode

The **mode** is simply the most frequently occurring score in a data set. Returning once again to the test scores of our sample student, the mode for this data set is would be 94%, as it occurs twice within the data set. If two scores occur equally often within a data set, the set has two modes and is termed *bimodal*. Any data set that has two or more modes can be referred to as *multimodal*.

Like the median, there is no formula for calculating the mode without conducting at least some preliminary data analysis. For small data sets the mode may simply be determined by comparing the number of times the most popular scores appear in the set.

## Measures of Variability

Almost all data sets demonstrate some degree of *variability*. In other words, data sets usually contain scores which differ from one another. Only under very rare circumstances do researchers encounter data sets which have no variability. Needless to say, of the few sets of data which demonstrate no variability, fewer still will be of any interest to psychological researchers. The truly interesting observations are those of characteristics which vary within a population or sample.

This variability cannot be captured or shown by measures of central tendency. For example, if two data sets have the same mean, there is no guarantee that the two sets are very similar at all. What is needed are *measures of variability* which allow the researcher to determine the degree of variation within a population or sample, and thus to determine just how representative a particular score is of the data set as a whole. This in turn allows the researcher to determine the scope and validity of any generalizations he or she wishes to make based on his or her observations. The measures of variability used by researchers include the *range*, the *variance*, and the *standard deviation*.

## Range

The **range** is simply the difference between the highest and lowest scores in a distribution, and is found by subtracting the lowest score from the highest score. This measure of variability gives the researcher only a limited amount of information, as data sets which are skewed towards a low score can have the same range as data sets which are skewed towards a high score, or those which cluster around some central score. The range is, however, useful as a rough guide to the variability demonstrated by a data set, as it tells the researcher how a particular score compares to the highest and lowest scores within a data set. For example, a student might find it useful to know whether his or her score was near the best or worst on an exam.

## Variance

A more informative measure of variability is the **variance**, which represents the degree to which scores tend to vary from their mean. This tends to be more informative because, unlike the range, the variance takes into account every score in the data set. Technically speaking, the variance is the average of the squared deviations from the mean.

To calculate the variance for a set of quiz scores:

1. Find the mean score.
2. Find the *deviation* of each raw score from the mean. To do this,
3. Subtract the mean from each raw score. (Note that deviation scores will be negative for scores that are below the mean.) To check your calculations sum the deviation scores. This sum should be equal to zero.
4. Square the deviation scores. By squaring the scores, negative scores are made positive and extreme scores are given relatively more weight.
5. Find the sum of the squared deviation scores.
6. Divide the sum by the number of scores. This yields the average of the squared deviations from the mean, or the variance.

## Standard Deviation

More informative still is the **standard deviation**, which is simply the square root of the variance. You may be asking yourself 'Why not simply use the variance?' One reason is that, unlike the variance, the standard deviation is in the same units as the raw scores themselves. This is what makes the standard deviation more meaningful. For example, it would make more sense to discuss the variability of a set of IQ scores in IQ points than in squared IQ points.

## Statistics for Psychology

### \* Research Characteristics of Population \*

characteristics of Pop. = **Parameters**

Often use **Samples** from Pop.

characteristics of Sample = **Statistics**

Research findings are **Data**

### Descriptive Statistics

~ Procedures to collect, classify, **Summarize**, and present data

↓  
Focus of chapter

↓  
measures of central  
tendency

↓  
measures of  
variability

### Measures of Central Tendency

~ measures of scores typical of those found in set → scores **tend** toward them

~ 3 of them

↳ mean, median, mode

① Mean = average =  $\frac{\text{sum of scores}}{\text{total \# of scores}}$  (arithmetic average)

- affected by extreme scores
- misleading desc. of skewed data sets.

② Median = middle score = (no formula)

- if even # of scores, is midpoint
- best for skewed data

③ Mode = most common score = (no formula)

- 2 modes → bimodal
- 2 + modes → multimodal

### Measures of Variability

↳ measures degree to which scores vary from one another or from typical score

\*\* The research is mostly concerned with characteristics that vary because they're most interesting \*\*

### Measures of Variability

↳ degree of variation within pop. or sample

↳ how representative a score is

\* ↳ scope & validity of generalizations \*

- 3 of them → range, variance, standard deviation

① Range = difference between =  $\boxed{\text{highest} - \text{lowest}}$   
highest + lowest scores

- limited amount of information
- rough guide to variability of set

② Variance = degree to which scores vary from mean

$$\boxed{= \frac{\text{sum of (each score - the mean)}^2}{n \text{ of scores}}}$$

- more informative
- takes into account every score

③ Standard Deviation = same units as raw scores

$$\boxed{= \sqrt{\text{variance}}}$$

- even more informative
- same units as raw scores