 LEVELS OF MEASUREMENT

We use numbers in many different ways, they are symbols that can be used in a very vague way or in a very precise manner. When we collect data it is very important that we know what kind of number we have collected, because this will partly determine what kind of statistical analysis or treatment we can carry out on our data. As all numbers describe or measure something (usually a variable) we can say that various kinds of numbers achieve a certain level of measurement. Our measurements might be crude or they might be a little more precise or they could be extremely fine in the kind of discrimination they make. There are four levels of measurement, listed in order of precision:

- **Nominal**
- **Ordinal**
- **Interval**
- **Ratio**

Each different level has its own characteristics and each has certain arithmetical operations (e.g. calculate means) that you can or cannot do - these are determined by the characteristics of the numbers. If you do an arithmetical operation that you should not do because of the characteristics of the number you will come out at the end with a number that sounds sensible but in fact means nothing at all. For example, if you consider a football team, each player has a number on his back. If you were to add up each of those numbers and take a mean, you would come out with a number at the end, but it would be nonsense: what sense is there in saying that the mean of a football team is, say, 6?

- **Nominal Scale**
  Nominal means “in name only” and at this level of measurement numbers are simply used to classify things. They say something about the underlying phenomenon, but not much. In fact, instead of numbers you could use other symbols such as letters of the alphabet, word descriptions, even pictures. Numbers are often used though because they provide a handy shorthand for other descriptions that might take up more space. Using the football team example from above (let’s call them Psychos United), it’s much easier to put a number on a footballer’s back than it would be to print a description of the position in the team that he occupies: imagine having to print “the player that stands half way down the field on the left-hand side” instead of a single digit. Therefore, the numbers used on the Psychos United team’s shirt are simply used to categorise each player, they are a nominal level of measurement. Other examples of a nominal level of measurement are blood groups, types of beer, psychiatric classification systems, Chinese take-aways, convict numbers, bus routes. Any or all of these could be replaced by numbers (e.g. you could call Tetley bitter...
number 103!) and provided everyone had agreed on this system and knew what each number stood for there would be no loss of information.

**Properties and Restrictions of the Nominal scale**
The only thing that the nominal scale represents is equivalence: it can tell you whether to put a particular data point into a particular category because it is the same as another data point. To go back to Psychos United, we know that someone who has the number 5 on his back should go at a certain position because that is agreed on at least a national level and we can say that our number 5 plays in the same position as the number 5 from another team: they have equivalence. This means that we can use the arithmetical sign for equals (=), but very little else. The results of adding, multiplying, dividing nominal numbers is quite meaningless: for example, would it interest you to know that the sums of squares (\(\Sigma x^2\)) for a football team is 506? This would represent precisely nothing! All you can do with a nominal scale of measurement is count how many data points/people fall into a particular category; you can count frequencies. For example, you might be interested to find out how many smokers have a cough compared to non-smokers. You could call your smokers with a cough “1”, those without “2”, non-smokers with a cough “3” and non-smokers without “4”, using a nominal scale of measurement. You could then count how many people fell into each category, but that is all you could do with those numbers.

**Statistical Testing with Nominal level of measurement**
There are only two statistical tests that you can use to analyse these frequencies that you get from a nominal level of measurement: sign test and chi-square (\(\chi^2\)). You would use a sign test if you had designed your study using a repeated measures design and a \(\chi^2\) if you had designed your study using an independent groups design. For example, if you had a study that examined the number of smokers who had a cough when they smoked compared to when they gave up smoking that would be a repeated measures design and you would use a sign test to analyse your data; however, if you were comparing a group of smokers with a groups of non-smokers then you would use a \(\chi^2\).