Bivariate Correlation

The Pearson correlation coefficient (r) is a measure of how closely related two variables are, both of which must be measured at the interval/ratio level. This relationship is assumed to be linear, and the correlation is a measure of how tightly clustered data points are about a correlation line. Correlation ranges from –1.0 (perfect negative relationship) to 1.0 (perfect positive relationship). A correlation of 0.0 indicates no discernable linear relationship. Below are some graphical representations of sample correlations:

- **A**: weight in kilograms
  - weight in lbs.
  - $r = 1.0$

- **B**: weight
  - $r = 1.0$

- **C**: TV viewing
  - intelligence
  - $r = 0.0$

- **D**: TV viewing
  - $r = -1.0$

- **E**: TV viewing
  - $r = -1.0$

- **F**: age
  - $r \approx 0.0$

- **G**: weight
  - radio listening
  - number pay channels
  - $r \approx .65$
  - $r \approx -.40$
  - $r \approx .40$

- **H**: height
  - age

- **I**: income
Note that the slope of the line does not indicate the correlation; the closeness of the data points to the line is what determines the size of the $r$. The greater the absolute value of $r$, the more closely related the two variables.

Also note that a very strong nonlinear relationship (e.g., above, age and TV viewing) will not usually show a very strong correlation! That doesn’t mean there is not a relationship, just not a linear one. This inability of the Pearson correlation coefficient to discern nonlinear relationships is perhaps its greatest shortcoming, and should be remembered when interpreting correlational results.

A correlation may be tested for its statistical significance by consulting an $r$ table. For example, suppose we found a relationship between grade point average and hours per week of partying of $r = .55$. If our $n$ was 25, the critical value in the table at df = 23 and $p = .05$ is .396. Since our $r$ exceeds this, it is statistically significant at the .05 level. We are 95% certain that grade point average and partying are positively related in the population (the more one parties, the greater one’s grade point average; or, the greater one’s grade point average, the more one parties). More typically, SPSS or another statistical package will test our statistic, and give us a $p$ (significance) level. If we achieve a $p$ smaller than .05, we have, once again, met the typical .05 criterion. If we obtain a higher $p$--.23, for example--we are only 77% certain that our variables are related in the population.

Another bit of information that can be derived from the correlation is the amount of shared variance. $r^2$ is called the coefficient of determination, and represents the proportion of the variance of x that is shared by y, and correspondingly the proportion of the variance of y that is shared by x. Thus, if we have an $r$ of .30, $r^2 = .09$ – that is, 9% of the variance is shared. If we have an $r$ of .90, $r^2 = .81$ – 81% of the variance is shared.

For the record, one common formula for $r$ (there are several) is:

$$r_{xy} = \frac{\sum xy}{\sqrt{\sum(x^2)\sum(y^2)}}$$

$x =$ individual deviation score

$(X \text{- mean}_x)$

$y =$ individual deviation score

$(Y \text{- mean}_y)$