
How To

A PRACTICAL GUIDE TO PSYCHOMETRICS

Composites

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For more on Composites see [Combining Scores from Different Tests](#)

1. Form a composite and calculate its mean

Suppose that we have two tests of verbal fluency and we wish to combine them into a single measure in the hope that doing so will give us a more reliable and valid measure of a patient's verbal fluency, how do we set about it?

The score on the composite test, C, will simply equal the score on Test X plus the score on Test Y

The mean of the composite test C will be equal to the sum of the means of the two tests X and Y of which the composite is composed.

So if test X has a mean of 25 and test Y has a mean of 50, the mean of the composite will be 75.

If, of course we work with Z-scores (i.e. convert all scores on each test into a Z-score for that test) then the mean score on the composite will be $0 + 0 = 0$.

As it will be much easier to work with Z-scores, that is what we will do.

2. Calculate the standard deviation of the composite

Do not forget that from now on we are working with a composite on which scores equal $Z_x + Z_y$.

The easiest way to work out the variance of the composite is add all the elements in the matrix of correlations between, and the variances of, the tests involved.

So, suppose that the correlation between out two tests of verbal fluency was .6. We could make the following table – again remember that we are working with Z scores for tests X and Y.

	Test X	Test Y
Test X	Variance $Z_x = 1$	$r_{xy} = .6$
Test Y	$r_{xy} = .6$	Variance $Z_y = 1$

Adding all the values in this table will give us a total of $1 + 1 + .6 + .6 = 3.2$. This value is the variance of the composite. If we take the square root of the variance we of course get the standard deviation of the composite, which is 1.8

Thus our composite formed by adding Z-scores on Test X to the Z scores on Test Y will have a mean of 0 and a standard deviation of 1.8. So, if somebody obtained a Z score on test X of 2, and a Z score on Test Y of 1.6, their score on the composite test would be 3.6. To convert that score into a Z score on the composite test we simply use the ordinary formula for a Z score.

$$Z_{composite} = \frac{X_{composite} - M_{composite}}{\sigma_{composite}}$$

$$= \frac{3.6 - 0}{1.8} = 2$$

So the Z score on the composite Test is 2.

3. Calculate the reliability of the composite

Yet again remember our scores on Test X and Y were Z scores.

You will recall the formula for the reliability coefficient is the true variance divided by the total variance. In the present case it will be the true variance of C divided by the variance of C – which we worked out in the previous section to be 3.2, so, if we knew the true variance, we could just divide it by 3.2 and we would have the reliability of our composite. The formula would be:

$$r_{cc} = \frac{\sigma_{true_c}^2}{\sigma_c^2}$$

To calculate the true variance of our composite we can again use a table like the one for calculating the variance of the composite.

The difference is that instead of putting the variance in the diagonal cells we put the reliability coefficients. So, supposing that the reliability of Test X was .7 and of test Y was .8 the table would look as follows.

	Test X	Test Y
Test X	Reliability Test X = .7	$r_{xy} = .6$
Test Y	$r_{xy} = .6$	Reliability Test Y = .8

The true variance will be the sum of the values in this table = .7 + .6 + .6 + .8 = 2.7.

So the reliability of the composite will be

$$r_{cc} = \frac{\sigma_{true_c}^2}{\sigma_c^2} = \frac{2.7}{3.2} = .84$$

4. Calculate the correlation between the composite and another test

Suppose we wanted to correlate or new composite test of verbal fluency with some other measure, for example, IQ.

Suppose further that the correlation between Test X and IQ was .5 and between Test Y and IQ was .65.

Again we resort to a table, and again we are working in Z scores.

The formula we are going to use for the correlation coefficient is one of the variants of the basic formula.

$$r_{xy} = \frac{\text{COVariance}_{xy}}{\sigma_x \sigma_y} = \frac{\text{COVariance}_{CIQ}}{\sigma_c \sigma_{IQ}}$$

This time the Table looks like this.

	IQ	Test X	Test Y
IQ	Variance IQ = 1	Covariance Test X, IQ = $r_{XIQ} = .5$	Covariance Test Y, IQ = $r_{YIQ} = .65$
Test X		Variance X = 1	$r_{xy} = .6$
Test Y		$r_{xy} = .6$	Variance Y = 1

The covariance we need for working out will be the total of the values in the blue area, which equals $.5 + .65 = 1.15$

The variance of IQ (remember we are using Z scores) is 1 and the variance of the composite (which we worked out earlier) is the sum of the values in the yellow cells. which equals 3.2. Thus the correlation between the composite and IQ will be:

$$r_{CIQ} = \frac{1.15}{\sqrt{1}\sqrt{3.2}} = \frac{1.15}{1.8} = .64$$

5. Calculate the correlation between two composites

Once more we will work with Z-scores and once more we will use a tabular method.

Suppose we have two tests of anxiety and three of depression. We convert scores on all of these tests to Z-scores, and add the two anxiety scores to form the anxiety composite, and the three depression scores to form the depression composite.

Suppose further that the correlations between the tests are as follows

	Anx 1	Anx 2	Dep 1	Dep 2	Dep 3
Anx 1	1	.7	.5	.3	.4
Anx 2	.7	1	.6	.4	.4
Dep 1			1	.7	.8
Dep 2			.7	1	.5
Dep 3			.8	.5	1

The covariance between the composites will be the sum of the correlations of the components of the Anxiety composite with the components of the Depression composite. These are shaded yellow in the table above.

Adding them up we get a total of 2.6

The variance of the Anxiety composite will be the sum of all the values in the pink-shaded area, which is 3.4

The variance of the Depression composite will be the sum of all the values in the blue-shaded area, which is 7.0. Thus the formula for the correlation coefficient becomes:

$$\frac{\text{Covariance}_{AD}}{\sigma_A \sigma_D} = \frac{2.6}{\sqrt{3.4} \times \sqrt{7.0}} = .53$$