**Additional file 3: Derivation of confidence intervals for the variance parameters**

The following describes how confidence intervals can be constructed for the variance parameters , and in the two-way random model. Here we consider the model stated in Eq. (1) in the main paper, but the calculations are straightforwardly extended to the setup in Section 2.2 in the main paper, where each observer performs multiple measurements on the same subject.

**Confidence interval for :**

Let denote the -distribution with degrees of freedom, the normal distribution with mean and variance , and convergence in distribution.

We have cf. Searle et al [1] that

which converges to a -distribution when . This entails that
Similarly, we obtain that

As and are independent [1], we have that

To find the asymptotic distribution of , we use the statistical delta method for the transformation (see, e.g., [2]) . This gives us

from which an approximate confidence interval can be obtained for using plug-in estimates of the variance components. Figure 2 in Additional file 2 displays results from a small simulation study on the accuracy of the approximate CI.

**Confidence interval for :**

An approximate confidence interval for is obtained by mimicking the arguments for , that is, one simply needs to interchange the role of and as well as substitute with and with .

**Confidence intervals for :**

We have cf. Searle et al [1] that

where . From this we can straightforwardly calculate an exact confidence interval for , which in turn can be transformed into an exact confidence interval for The resulting 95% confidence interval for is given by

where is the -quantile of a -distribution with degrees of freedom.

Alternatively, an approximate (symmetric) confidence interval can be constructed in a similar manner to the confidence interval for using the delta method. The resulting approximate 95% confidence interval is given by:

Figure 3 in Additional file 2 displays results from a small simulation study on the accuracy of the approximate CI.

**References**

[1] S. R. Searle, G. Casella, and C. E. McCulloch, *Variance Components*. Hoboken: John Wiley & Sons, Inc., 1992.

[2] A. W. van der Vaart, *Asymptotic statistics*. Cambridge: Cambridge University Press, 1998.