Technical Note 6.1

Error Variance and Design Considerations

In Section 6.2, we presented an informal argument for the potential advantage of the correlated-scores design relative to the independent-groups design. A more formal argument is as follows. From Appendix 5.1, the variance of the sampling distribution of the difference of two means may be written as

$$\sigma_{\bar{D}}^2 = (1/n)\left(\sigma_{Y_1}^2 + \sigma_{Y_2}^2 - 2\rho\sigma_{Y_1}\sigma_{Y_2}\right)$$

where ρ is the correlation between the conditions. Assuming homogeneous variances, the equation can be rewritten as

$$\sigma_{\bar{D}}^2 = (1/n)(2\sigma^2 - 2\rho\sigma^2) = (1/n)(2\sigma^2)(1-\rho)$$

That correlation is zero for the independent-groups design but greater than zero in both matched-pairs and repeated- measures designs. As a result, $\sigma_{\bar{D}}^2$ will be smaller in correlated-scores designs (σ_{cor}^2) than in independent-groups designs (σ_{ind}^2). In fact, $\sigma_{cor}^2 / \sigma_{ind}^2$ = 1- ρ . Therefore, correlated-scores designs will have smaller denominators and consequently larger *t* ratios than independent-group designs.