Lab 6

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Complex experimental designs

- With complex experimental designs, the issue of power can be extremely painful, and can result in requirement of collecting huge samples
- Three-way ANOVA, e.g. affect: 2 (positive vs. negative) x fatigue: 2 (low vs. high) x self-esteem: 2 (low vs. high), result in 8 groups of combinations
- Assuming average effect size in psychology (r = 0.21) and power of at least 0.80 one would require a sample size of at least 336 participants

Complex experimental designs

- One way to this issue was ANCOVA
- The other way is to perform experiment in within subjects design, i.e. to repeat measurements with the same person under different conditions
- With the same design and conditions as above, but within subjects one would require a sample size of at least 22 participants (insted of 336)!!!
- This is a great advantage.
- Can you point drawbacks of this solution?

Repeated measures ANOVA

- With repeated measures ANOVA you can compare measurements obtained from the same participants, e.g. performance under positive vs. negative mood
- However you should adjust for the potential individual differences, e.g. in performance

$y_{ij} = \mu + \alpha_i + \alpha_j + \epsilon_{ij}$

where α_i - devation from the grand mean of person i and α_j - deviation of the mean of condition j from the grand mean

- See Andy Field's chapter on repeated measures design for an excelent introduction to the computation

Assumptions in repeated measures

- Covariance of repeated measures should be approximately a multiple of compund symmetry matrix

$\begin{vmatrix} 1 & \rho & \rho \\ \rho & 1 & \rho \\ \rho & \rho & 1 \end{vmatrix}$

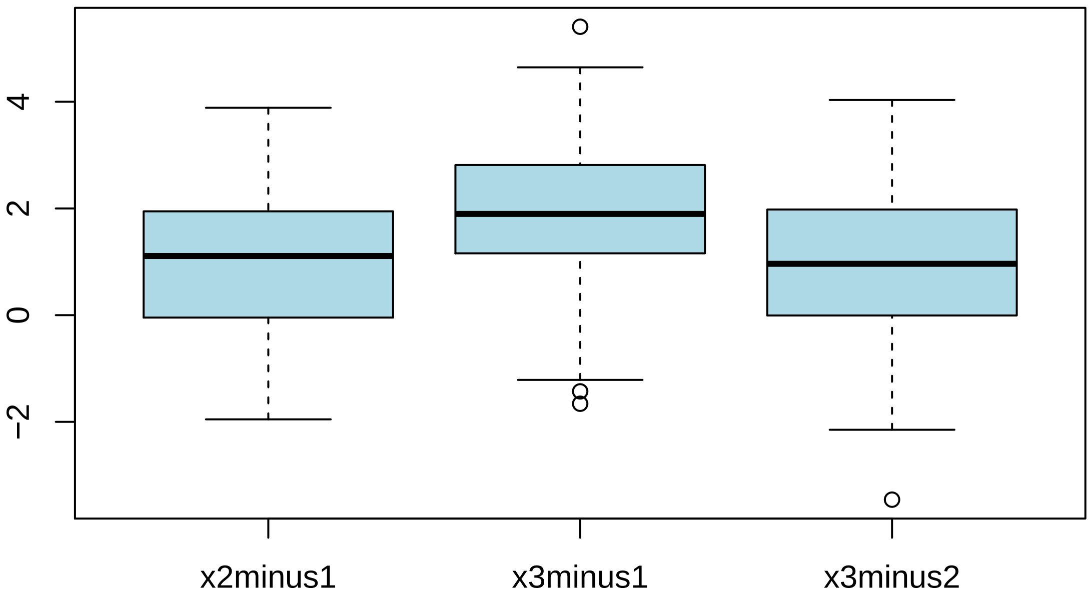
- eg.

$\begin{vmatrix} 2.1 & 1.2 & 1.2 \\ 1.2 & 2.1 & 1.2 \\ 1.2 & 1.2 & 2.1 \end{vmatrix}$

Assumptions in repeated measures

- Assumption of compound symmetry is sufficient, but not necessary
- Usually it is good if repeated measures show sphericity, i.e. variances of all of the differences between measurements are rougly equal

Assumptions in repeated measures



- Note that with only 2 repeated measures, there is only one difference, hence the assumption of sphericity is not necessary

Mauchly's (1940) test for sphericity

- To check for sphericity one should perform Mauchly's test

$W = \frac{\prod \lambda_{\updownarrow}}{[\frac{1}{A-1}\sum \lambda_{\updownarrow}]^{A-1}}$

- Where $\lambda_{\updownarrow}$ are eigenvalues of covariance matrix - don't worry if you don't know matrix algebra, you will usually be interested only in the final value
- This statistic varies between 0 and 1, and reaches 1 when the matrix is spherical
- Value close to 0 (statistically significant) means that assumption of sphericity does not hold

Repeated measures with non-spherical covariance matrix

- If the sphericity assumption is not valid, then the F test becomes to liberal (i.e. the proportion of rejections of the null hypothesis is larger the α level when the null hypothesis is true)
- In order to minimize this problem a number of correction of degrees of freedom have been proposed, see paper of Herve Abdi in lab__texts folder if you are interested in technical details

Repeated measures with non-spherical covariance matrix

- The 2 most frequently used corrections are: Greenhouse-Geisser, $\hat{\epsilon}$ and Huynh-Feldt, $\tilde{\epsilon}$

- Both of these corrections vary from lower bound (with extreme sphericity) to 1 (no sphericity), with lower bound: $\frac{1}{k-1}$ where k - number of repeated measurements
- Lower bound correction is the most extreme option
- Less extreme is GG, however when GG estimate is more than 0.75, the correction can be too conservative
- In such instance one should use HF correction

Other ways to deal with non-sphericity

- Use multivariate tests, which do not make the assumption of sphericity
- Use hierarchical linear models - the best and the most flexible option, but quite hard to learn (I will try to cover some of the basics during labs on regression analysis)