

2x2 intervention design (Lord's paradox)

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Dear all,

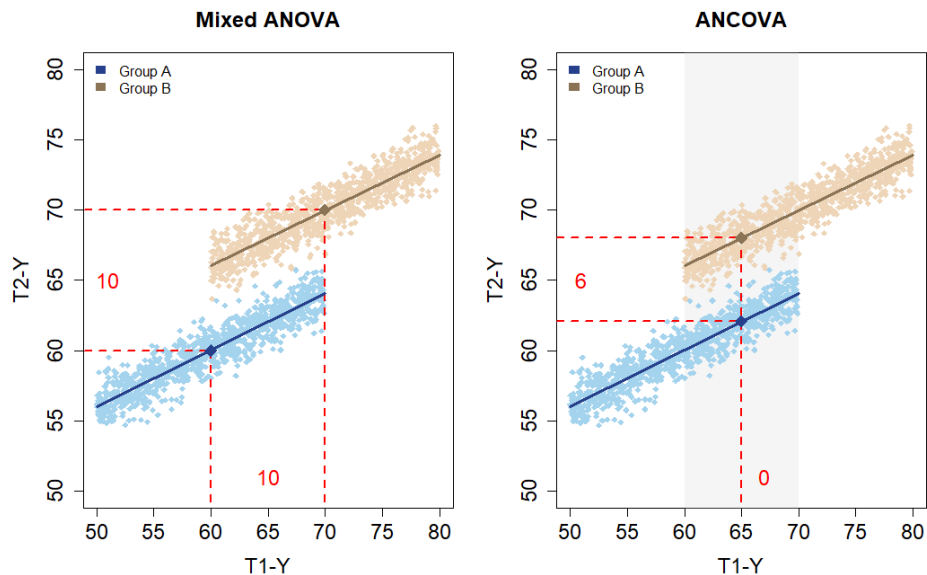
Today's message concerns the problem of a 2x2 intervention design of Group (between-subjects) by Time (within-subjects) factors. There are in fact two popular ways of analyzing such a design. The first approach is by a **mixed ANOVA**, which is more popular in psychology (in R formula notation):

```
cbind(T2, T1) ~ Group
```

This is a repeated measures ANOVA with group as BS and time as WS factor. The analyst is interested in the Group x Time interaction, which checks whether the pre-post difference for group A is different from pre-post difference in group B (regardless of baseline differences). This is an unconditional test. The second approach is by **ANCOVA**, which is more popular in medical sciences:

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T2 ~ Group + T1
```

This is a conventional regression, where the analyst is interested in the Group main effect, which checks whether there are group differences at T2 when controlling for group differences at T1 (=given that subjects had equal baseline values). This is a conditional test.



While these two analyses seem to address very similar questions, they are subtly different and may in fact contradict each other, in a scenario known as [Lord's paradox](#). The attached graph illustrates how this contradiction happens. That is, the mixed ANOVA considers all data when looking at the average group differences at T1 and T2. The ANCOVA only considers the overlapping part of the data for both groups. Both analyses are correct, depending on which hypothesis the researcher wishes to answer. However, I generally recommend to avoid the ANCOVA approach, especially when the group variable is observational and/or moderately-to-strongly correlated with the T1 measure.

Best,
Ben

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