Linear Model and Assumptions

1. Statistical model – the understanding that F is a probability density function (i.e. the curve depending on DF) and F is “random” in the sense that it could take on many different values based on the experiment.
   1. Linear Model
      1. Each person’s individual score = mean for that group + Error (how far they deviate from the mean)
      2. But you can also add in the deviation from the other groups: each person’s score = grand mean + treatment effect + error
         1. Treatment effect is group mean’s different from grand mean
      3. This regression is a linear model – aka several things are combined linearly (i.e. not quadratic) to create a score.
      4. The advantage of a linear model is that makes the null hypothesis that the treatment effect = 0
   2. Experimental error – assumptions in experiment about the error variable
      1. Random sampling assumptions – these should be solved by random sampling…
         1. Independence – each subject’s error term is separate from each other.
         2. Identical distribution – distribution of the errors is the same within in each group
      2. Identical distribution – distribution of errors is the same for all treatment conditions
         1. Homogeneity – equal variances for each group
         2. Normal distribution
   3. Violations of assumptions
      1. Robust – thankfully the F test is robust to the violation of assumptions
2. Sampling bias and loss of subjects
   1. Exclusion of subjects from experiment
      1. When you do not random sample that means you’ve gotten data from the population unevenly – therefore things like outliers might be a potential issue
   2. Subject loss
      1. Used to be a big deal because the calculations were complex (now no big deal with SPSS)
      2. Why lose?
         1. Don’t complete study
         2. Cannot perform the task
         3. Attrition
         4. Computer malfunction
      3. Back to MCAR and MNAR
         1. MCAR – ignorable loss of subjects – loss that is not related to the random assignment of groups
         2. MNAR – not ignorable – reason data is lost is related to the score they would have gotten
   3. Solutions
      1. Different experimental design
      2. Dropping subjects from other group randomly to have even number of loss
3. Violations of assumptions
   1. All these are tested with fancy monte carlos!
      1. Positive bias tests are liberal = more likely to type 1 error
      2. Negative bias tests are conservative = less likely to type 1 error
   2. Independence of scores
      1. Can happen when you are testing a homogenous population, equipment starts to malfunction (mud on scale)
      2. Mostly you have to fix this with the experiment
      3. Interestingly sample size increases problem – leans you toward not rejecting null.
   3. Identical error distributions
      1. Large errors are usually do to individual differences – so maybe you sampled two different populations? You can add that variable as a control.
   4. Normal distribution
      1. Must be unimodal
      2. Symmetrical
      3. Moderate spread (mesokurtic)
      4. Check with a picture! (BTW that normal curve check we do with data screening IS the error terms)
      5. Central limit theorem – increases in sample size make a distribution more normal.
   5. Outlier discussion – we talked about this before
   6. What to do? Nonparametric alternatives
      1. Kruskal Wallis
      2. Mann-Whitney U
      3. Wilcoxon rank sum test
   7. Homogeneity
      1. Real problem with unequal and small sample sizes
      2. Causes
         1. Differences in subject variable populations – wider variances in spatial tasks for girls than guys
         2. Experimental manipulations may cause an increase in variance as well as the mean.
         3. Some DVs like RTs can have very high scores, which will increase the variance
4. Dealing with Heterogeneity
   1. Look at Levene’s test – looks at deviations from means for each group, calculates that probability (it’s an ANOVA on variance!)
      1. DO not want to reject this value.
   2. What to do?!
      1. Use a more stringent alpha – heterogeneity increases Type 1 to decrease move the alpha down.
      2. Transform the data – square root or log transform the data
         1. Helps with skew and kurtosis
         2. Lots of people don’t like this because it means you are interpreting statistics (mean sd) from a transformed score and what does that even mean?!
         3. Does help with response times
      3. Switch test types
      4. Switch to single df tests – pairwise comparisons deal with heterogeneity better.