In Module 9, we will review repeated measures models where observations are clustered within people.

The data used in this module are used as an example in Hoffman and Rovine (2007). The article and supporting materials can be found here: <http://www.lesahoffman.com/Research/MLM.html>

For this data demo the variables of interest are: The log of reaction time for participants to detect a change during a picture viewing task. Repeated trials are nested within persons. The pictures varied on two dimensions: how meaningful driving was to the picture (meaning) and how salient the change was in the picture (salient). For this analysis we will focus on the variables centered from the midpoint of the rating (3). One of the primary research questions was how age related to reaction time, given those differences in pictures. Participants were sampled in age categories: younger (oldage = 0, 40 and under) and older (oldage = 1, above 40).

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| **Descriptive Statistics** | | | | | |
|  | N | Minimum | Maximum | Mean | Std. Deviation |
| sex (0=male, 1=female) | 7803 | 0 | 1 | .60 | .490 |
| age | 7803 | 18 | 86 | 40.57 | 27.326 |
| oldage (0=no, 1=yes) | 7803 | .00 | 1.00 | .3725 | .48351 |
| yrs65 (years over 65, 0=65) | 7803 | -2.00 | 21.00 | 3.9869 | 6.10941 |
| salience (1-5) | 7803 | 1 | 5 | 3.02 | 1.094 |
| meaning (0-5) | 7803 | 0 | 5 | 2.65 | 1.887 |
| c\_mean (centered meaning, 0=3) | 7803 | -3.00 | 2.00 | -.3529 | 1.88737 |
| c\_sal (centered salience, 0=3) | 7803 | -2.00 | 2.00 | .0196 | 1.09355 |
| lg\_rt (Natural Log RT in Seconds) | 7646 | .14 | 4.09 | 1.6121 | .82846 |
| Valid N (listwise) | 7646 |  |  |  |  |

1. Load in the data and the libraries we will use for this module: lme4, lmerTest, and performance.
2. Run null model with lg\_rt as the outcome and person as the clustering variable, ML as the estimator
3. What is one reason to use ML instead of REML?
4. Calculate and interpret the ICC.
5. Let’s build the L1 model first, what are the L1 predictors? What would an interaction between the predictors represent?
6. Write out the equation for a model with L1 predictors (no interaction), do not include random slope effects, run the model
7. Interpret the parameters and their significance, what do they represent?
8. Conduct a deviance test comparing the null model to the model with predictors, does the model have significantly less deviance?
9. How much was the L1 variance reduced by adding the L1 predictors?
10. Write out a model with a random slope effect for meaning and salience, what do these random effects represent?
11. Run this model with the variances only, no covariances. What is a reason for running this model first?
12. This will cause an estimation error, what looks like the problem?
13. Rerun the model with one less random effect
14. Should we retain the last random slope? Conduct a deviance test and examine the significance.
15. Given the random effects we are retaining, how should we consider adding in L2 predictors? What are L2 predictors in our dataset?
16. Write out a model with dichotomous age and gender as L2 predictors of the intercept
17. Evaluate the significance of those predictors via their standard error. Remove the nonsignificant predictor and rerun, then carry out a deviance test.
18. How much variance in L2 intercept variance was reduced by the addition of age?
19. Run a model with age as a predictor of the slope for meaning predicting reaction time (a cross-level interaction). Do not estimate the variance (i.e., random effect).
20. Interpret the cross-level effect, what does it represent?