Best practice guidance for linear mixed-effects models in psychological science

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**Appendix 5: Example Tables for Reporting mixed-effect models**

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## A5: Example tables for reporting LMMs

Table were adapted from excellent examples in Stevenson et al, 2013 (Table 2), Goldhammer et al, 2014 (Table 1) and Li et al, 2014.

## **Table A5.1 Example for reporting model comparison and the model building/selection process**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sampling Units | | N total obs = 7628  N Subjects = 40; N items = 200 | | | | | | | | | | |
|  | | | | | | | | | | | | |
| **Model specification** | **Model name** | **Nested / simpler Model** | **Fixed Effects added** |  | **Random Effects** | | **Model fit** | | | | **LRT Test against nested** | |
| **Subjects** | **Items** | **AIC** | **BIC** | **LL** | **df** | **df** | **X2** |
|  | | | | | | | | | | | | |
| RE only | Null | - | - |  | intercepts | intercepts | 5241.5 | 5260.9 | -2617.8 | 3 |  |  |
|  | | | | | | | | | | | | |
| FE main effects | Main effects 1 | Null | Group + ItemVariable1 + ItemVariable2 + ItemVariable 3 |  | intercepts | intercepts | 5204.1 | 5262.1 | -2593.0 | 6 | 3 | 49.427\* |
| FE two-way interactions | Group x ItemVariable1 |  | Group x (ItemVariable1 + ItemVariable2 +  ItemVariable3) |  | “ | “ | convergence warning - item variance close to zero. Removed item intercepts. | | | |  |  |
|  | | | | | | | | | | | | |
| FE main effects | Main effects 2 |  | Group + ItemVariable1 + ItemVariable2 + ItemVariable 3 |  | intercepts | none | 5202.1 | 5253.7 | -2593 | 6 |  |  |
| Two way interactions | Group x ItemVariables | Main effects 2 | Group x (ItemVariable1 + ItemVariable2 +  ItemVariable3) |  | “ | “ | 4858.1 | 4942 | -2416.1 | 8 | 2 | 353.98\* |
| Three way interaction | ItemVariable1 x ItemVariable2 | Group x ItemVariables | + Group x (ItemVariable1 x ItemVariable2) |  | “ | “ | 4858.1 | 4954.8 | -2414.1 | 8 | 2 | 4.0182 |
| Three way interaction | ItemVariable1 x ItemVariable3 | Group x ItemVariables | + Group x (ItemVariable1 x ItemVariable3) |  | " | " | 4850.5 | 4947.3 | -2410.3 | 8 | 2 | 11.566\* |
| Three way interaction | ItemVariable2 x ItemVariable3 | Group x ItemVariables | + Group x (ItemVariable2 x ItemVariable3) |  | " | " | 4860.3 | 4957 | -2415.2 | 8 | 2 | 1.8214 |

**Table A5.1 Key:**   
  
This table provides an example format for reporting, concisely, a succession of models that are fit to the data and (in this case) compared against each other using Likelihood Ratio Tests (LRT). For this example, we have used generic terms such as ‘Group’ and ‘ItemVariable1’, ‘ItemVariable2’ rather than using names of ‘real’ variables or groups from a specific study.

**AIC** – Aikake Information Criterion  
**BIC** – Bayesian Information Criterion  
**LL** – LogLikelihood  
**df** – degrees of freedom  
**LRT** – Likeilhood Ratio Test  
**X2** – Chi-square

**Model Specification** – the current model and what it includes. In the above example this refers to the interactions that have been added. Researchers may choose the labels based on variables that have been added (e.g. subject variable X, item variable X) or a different label that summarises in some consistent way how a model is specified and how complex it is.  
  
**Model Name** – A short-hand to refer to the larger / more complex model that has been created. In the above example the model name has been derived from the addition of different variables. If researchers are testing successive nested models they may simply refer here to ‘Model 1’, ‘Model 2’, ‘Model 3’ etc.   
  
**Nested / simpler model** – the model against which the current, more complex one is being tested, using the Model Name as a label.  
  
**Fixed effects added** – which fixed effect / predictor variables have been added in order for a model comparison to take place (against the nested model).   
  
**Random Effects** – the random effect structure included in the model, identified by column names for the groupings added as random effects (in this case, Subjects and Items) and whether these were intercepts, or intercepts and slopes for specific fixed effects. In this example, random intercepts have been fit for subjects and items. Where these are unchanged in subsequent a models there is a “ in the table cell. For models where slopes are fit for fixed effects, authors could enter text such as ‘Slopes for ItemVariable 1’ etc.  
  
**Model Fit** – column names that provide information on aspects of model fit, depending on which variables a researcher is choosing to use (e.g. AIC, BIC, Log Likelihood, R2 etc.)  
  
**LRT Test against nested** - results of a Likelihood Ratio Test for the current model against the nested model.

## **Table A5.2 Example for reporting a ‘final’ model**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Fixed Effects | | | | | | | | |
|  | Est/Beta | SE | 95% CI | | t | | p | |
| Intercept | -1.02 | 0.32 | -1.65 - -0.39 | | -3.2 | | 0.001 | |
| Group | 1.11 | 0.47 | 0.18 - 2.03 | | 2.35 | | 0.019 | |
| Item var 1 | -0.52 | 0.05 | -0.62 - -0.42 | | -10.24 | | 0.0003 | |
| Item var 2 | 0.63 | 0.05 | 0.52 - 0.73 | | 11.67 | | 0.0004 | |
|  |  | | | | | | | |
| Group X Item var 1 | 0.79 | 0.08 | 0.64 - 0.94 | | 10.05 | | 0.0001 | |
| Group X Item var 2 | -1.16 | 0.08 | -1.32 - -1.00 | | -13.97 | | 0.00002 | |
|  |  | | | | | | | |
| Item var 1 X Item var 2 | 0.13 | 0.06 | 0.02 - 0.24 | | 2.38 | | 0.017 | |
|  |  | | | | | | | |
| Group X (Item var1 X Item var2) | 0.02 | 0.09 | -0.14 - 0.19 | | 0.27 | | 0.788 | |
|  | | | | | | | | |
| Random Effects | | | | | | | | |
|  | | | | Variance | | S.D. | | Correlation |
| Participant (Intercept) | | | | 1.88 | | 1.37 | |  |
| Items (Intercept) | | | | 1.8 | | 1.34 | |  |
| Item var 1 | Participant (Intercept) | | | | 0.27 | | 0.52 | |  |
| Item var 1 (slope) | | | | 0.12 | | 0.35 | | 0.24 |
|  | | | | | | | | |
| Model fit | | | | | | | | |
| R2 | | | | Marginal | | Conditional | | |
|  | | | | 0.34 | | 0.56 | | |
| Key: p-values for fixed effects calculated using Satterthwaites approximations. Confidence Intervals have been calculated using the Wald method. Model equation: Measure ~ (1 | Participant) + (1 | Item) + (1 + Item var 1 | Participant) + Group x (Item var1 x Item var2) | | | | | | | | |

## **Table A5.2 Legend**

An example of a table reporting a linear mixed effect model. The top of the table is similar to reporting regression, with predictors, estimates/betas, standard error (SE) and confidence intervals (95% CI), with test statistics (t) and p values (p) for the coefficients. Wherever possible, p values should be reported exactly rather than the shorthand ‘p<0.05’ or p<0.01’.  
  
For this example, we have used generic terms such as ‘Group’ and ‘Item Variable 1’, ‘Item Variable 2’ (shortened to Item Var 1 and Item Var 2) rather than using names of ‘real’ variables or groups from a specific study. This model includes three main effects (Group, Item Variable 1, Item Variable 2), three two-way interactions and one three way interaction.   
  
Random effects have been fit with intercepts for Participants, Items and intercepts and correlated slopes over Participants for one variable (Item variable 1).  
  
Random effects are reported underneath the fixed effects, with variance and SD reported for each, and correlations where appropriate (in this case, for correlated intercepts and slopes for Item variable 1).  
  
A measure of model fit is included at the bottom, note that researchers may choose alternative measures of model fit (e.g. AIC/BIC/Log Likelihoods when models are compared).  
  
Finally, the table key reports how p values and confidence intervals have been calculated, and the model equation is reported.

Additional examples of tables such as this can be found in Meteyard & Bose (2018; Tables 3 and 4 and Appendices B and C).