

Manuscript Review

Journal: PeerJ

Manuscript: 5396

Title: A practical guide and power analysis for GLMMs: Detecting among treatment variation in random effects

Overall Comments

This manuscript presents information on two aspects of generalized linear mixed models not well appreciated in the ecological, evolutionary, or behavioral literature. The first is a way to compare within- and among-group variation using GLMMs. This is particularly useful in behavioral and evolutionary studies; situations they describe well. The second part of the paper is a description and example of how to conduct a power analysis for designing complex experiments with repeated samples of individuals within groups or treatments. This is a very common experimental design. I have talked with other colleagues about this issue in the past without much consensus on how to best allocate effort/subjects/treatments/groups. I’ve previously conducted clunky simulations to assess power, but this paper would have been very useful.

This paper provides valuable information regarding the optimal balance of repeated sampling of individuals and the total number of individuals. While the results are not fully generalizable because of the other factors that influence ability to detect change (effect sizes and variances), the methods are generalizable and sufficient information is provided such that a reader could easily perform their own power analyses.

Many of the findings are intuitive and not surprising. They may even be trite for statisticians. However, for many practicing EEB scientists the manuscript provides some useful general recommendations, but most importantly a framework for systematically considering and simulating variation within and among individuals across treatments. This is valuable in many fields and for a variety of applications. The critical power detection and relative effect sizes and variances, along with sampling limitations, will always necessitate problem-specific power analyses. However this manuscript and associated supplements provide a readable, instructional way forward for graduate students and typical researchers. It also provides (slightly disheartening) information regarding the large amount of sampling and subjects required to detect difference in variance components among groups or treatments.

There are some assumptions required for these analyses. They are all reasonable for some systems and, most importantly, they are well described and acknowledged. Individual readers can decide whether their system sufficient meets these assumptions. In the *Further Considerations* section the authors describe additional complications and potential applications. Although these were beyond the scope of this manuscript, it seems reasonable that a reader could adapt their power analyses to address things like covariance between various terms. This would provide an interesting program for an entrepreneuring graduate student to explore further.

Introduction

The introduction is exceptionally well written. It lays out need for the paper (problem) and relevant literature in organized, easy-to-understand language. this can be a challenge for technical (mathematically and computationally) papers but the authors do an admirable job. This is critical in a manuscript intended for a general EEB audience.

The only place where more elaborate might be useful is on lines 57–61. Describing in real-world terms what the Bernoulli observations are in contrast to sampling occasions and individuals could be helpful for some readers (“for example, number of times a behavior was displayed during observation period j for individual i ”). This becomes more clear in the final paragraph of the introduction but is worth including earlier as 1 sentence or even parenthetically.

Methods

I like the layout and description of equations 1–4. My only comment is to consider adding the term “fixed effects” to $\beta_{0k} + \beta_{1k}X_{ij}$ to correspond to the output the *lme4* which many of the readers will be familiar with and which is used in this paper.

L127–128: I am not sure if all readers will understand what is meant by the “variation in individuals’ average behavior in the mean-centered environment”. It might be worth rewording or providing a more colloquial description as a next sentence. I do really appreciate the real-world example that ends the paragraph.

It is unclear whether the linear mixed model section is needed or if the information could easily be merged with the binomial GLMM section. The GLMM model is not much different, so I’m not sure if it’s really valuable having it as 2 sections and introducing LMM separately from GLMM. However, the manuscript flows very nicely as is, so I wouldn’t advocate for merging them unless there was another reason to do so.

I appreciate the well laid out description of handling overdispersion L195–201). This has been an issue with mixed models and there has been relatively little in the ecological literature describing the logic behind it (but see Harrison 2014 PeerJ). It is also great to see this term used informatively rather than just as a nuisance parameter when the binomial (or similarly Poisson) distribution just doesn’t fit.

L223–224: It would be useful to further describe how these values are “biologically relevant”. Maybe some indication of studies with similar probabilities and variances.

Discussion

It would be worth adding how one would test for differences among more than 2 treatments (as opposed to the LRT) in the final paragraph ~L500.

Conclusions

This was fine but was somewhat redundant, although not completely, and didn’t really feel like conclusions. The note regarding power not ensuring accuracy or precision was good (and first time it was mentioned).

Figures

Figure 1: It would be beneficial to include the terms from the equations relevant to plots A, B, and C (i.e. $\sigma_{0k}^2, \sigma_{1k}^2, \sigma_{\epsilon k}^2$).

Additional Comments

I am not aware of peerj’s policy regarding the number of in-text citations together. Some journals suggest or require e.g. then a max of 3 citations. In this manuscript there are sometimes 7+ citations at once. As a non-print journal I hope this is acceptable because in a “how to” article like this it is valuable for many readers to have many citations to refer to as they learn and try to integrate this new information with their existing knowledge.

Given the ease of markdown, Rmarkdown (RStudio), and basic text editors, it seems unnecessary to have pasted code with > and + symbols. It prevents code from easily being pasted back into R scripts. That being said, Supplement 1 is a helpful and necessary part of the paper.

L239: Awkward wording with multiple “did not” statements in succession. Consider rephrasing.

The need for a “recent version” of lme4 is mentioned in the main text and in the supplement. This is vague. A version number should be indicated (e.g. >1.1–7). Even if the authors do not remember the earliest version that the tools were included in and can’t find it on git, the version used in the analysis should be indicated in the text as the minimum one to use.