

Date of submission:
Project title:

2



*usually this would be the university in which the first supervisor is based.

Summary of proposed project (approximately 200 words):

A limitation of current ERP studies is a reliance on analysis of participants' responses averaged across trials. Because by-item variance is not accounted for in these analyses, experiments must include large numbers of observations (typically around 30-50, but with a standard minimum of ~16 per condition, per participant). In practice, this feature of ERPs represents a limit to their use; if the data recorded from a given participant does not include enough 'clean' observations per cell it is discarded wholesale. This can make data collection wasteful, or at worst, it can simply prevent particular paradigms or populations being studied. The current proposal addresses this problem by developing item-based ERP analyses.

The aim of the current project is to develop analysis techniques for ERPs based on mixed effects models, using the freely available R statistical programming language (a user-developed and extremely powerful statistical framework) together with available libraries (e.g., Bates et al., 2008). In practice, many experiments include items that either comprise a bounded set (letters of the alphabet) or a sample from an infinite population (sentences in a language). Using mixed-effects modelling approaches (Bagiella et al., 2000; Baayen et al., in press), items can be included as fixed or random effects in a model, at the same time as participants are included as random effects. These approaches have the additional advantage that they are highly effective when analysing unbalanced data, and cope well with covariance (e.g., due to high-density electrode arrays, traditionally requiring a correction for non-sphericity). The project will result in a set of R scripts and an analysis protocol that can be used to develop and analyse experiments where fewer ERPs can be measured per participant, or where issues in recording may prevent the collection of balanced data sets (as is likely in some clinical populations).

As a test case, we will collect data based on previously published work (Collard et al., 2008; Corley et al., 2007) using paradigms that are known to suffer from trial-number problems. In these studies we will investigate the memory processes underlying the encoding, and recognition, of words in spoken sentences. Because these studies rely on participants' memory performance they are by their nature subject to low (and unbalanced) numbers of observations, and will therefore provide an ideal dataset for the development of analysis techniques that should be of considerable benefit to the wider SINAPSE community.

Key references (up to five):

1. Collard, P., Corley, M., MacGregor, L. J., & Donaldson, D. I. (2008). Attention orienting effects of hesitations in speech: Evidence from ERPs. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 34, 696-702.
2. Corley, M., MacGregor, L. J., & Donaldson, D. I. (2007). It's the way that you, er, say it: Hesitations in speech affect language comprehension. *Cognition*, 105, 658-668.
3. Bagiella, E., Sloan, R. P., & Heitjan, D. F. (2000). Mixed-effects models in psychophysiology. *Psychophysiology*, 37, 13-20.
4. Bates, D. M., Maechler, M., & Dai, B. (2008). lme4: Linear mixed-effects models using S4 classes. Available from <http://lme4.r-forge.r-project.org/>
5. Baayen, R. H., Davidson, D. J., & Bates, D. M. (in press). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language*.

In what way does this PhD proposal meet the SINAPSE criteria as described in the call for proposals? (100 words)

Date of submission:
Project title:

3



This proposal is directly aimed at improving EEG/ERP methodology and providing the tools to design and analyse ERP experiments in circumstances that have been traditionally out-with the scope of ERP studies. In particular, studies that require complex stimulus sets, or where many repeated observations are difficult to collect (such as in some patient groups) would benefit from the development of item-based analysis. If successful, the project should extend the range of topics and populations that can be studied using ERPs, and provide new approaches for researchers across Scotland. The proposal will also strengthen research links between the Departments of Psychology in Stirling and Edinburgh; this is particularly beneficial given that Edinburgh is currently in the process of setting up an ERP laboratory. The collaboration is therefore particularly timely.

Please state the name of the local SINAPSE Centre Lead with whom you have discussed this project (Leads are listed on the Call for Proposals, applications submitted without prior discussion will not be considered.):

Prof