A multinomial model of event-based prospective memory

Ute Johanna Bayen & Rebekah E. Smith, The University of North Carolina at Chapel Hill

Event-based prospective memory involves remembering to perform an action in response to a particular future event (e.g., give your colleague a message when you see her). In the typical laboratory paradigm to investigate event-based prospective memory, participants perform a particular action (e.g., press the Z key) when a target word appears on a computer screen during an ongoing task (e.g., a lexical decision task). We distinguish between the prospective component of the task (remembering *that* you have to do something) and the retrospective component (remembering *when* to perform the action). A current debate in the prospective-memory literature regards the question whether the processes involved in the prospective component of the task are automatic or resource-demanding. To address this issue, we have developed a multinomial processing tree model (Smith & Bayen, 2004) which is the first formal model of event-based prospective memory. The model includes a parameter *P* that measures the degree to which the prospective component of the prospective-memory task is resource-demanding, a parameter *M* for the retrospective-memory component of the task, and two parameters related to the ongoing task.

We validated the model in eight experiments which demonstrated a good fit of the model to the data and showed that experimental and individual-difference variables affected model parameters in predictable and separable ways. Manipulations of instructions to place importance either on the prospective-memory task or on the ongoing task affected parameter *P* only. Manipulations of the similarity of target and distracter events affected parameters *P* and *M*. A manipulation of the difficulty of target encoding affected parameter *M* only. Working memory span influenced parameters *P* and *M*, especially when the ongoing activity was particularly demanding. In experiments with normal young and older adults, we found age-related differences in parameter *P*, and not in *M*. A model variant postulating an automatic prospective component did not fit the data in any of the experiments. We illustrate advantages of the multinomial modeling approach over traditional design-based approaches in the prospective-memory paradigm.

"Free Listing and Latent Semantic Analysis"

Roy D'Andrade, Professor Anthropology, University of Connecticut

Despite the ease with which word associations and free listing responses can be elicited, and the apparent informativeness of such responses, this technique has not been utilized by cognitive anthropologists and other cognitive scientists. Part of the problem is that factor analyses of the stimulus words based on similarity in associations or listing terms have proven disappointing, providing approximately the same data as similarity sorting. Analysis of the content of the associations or free listing responses has been more effective, but has required coding and other labor intensive processes.

Given the potential of word association and free listing, it seems worthwhile to investigate the possibility of using the techniques of latent semantic analysis developed by Landauer and other for automated text analysis. By focusing on the structure of the responses, and by using single value decomposition as a method, it has proven possible to investigate the structure of implicit associations without depending on direct overlap in frequencies. Using various data samples, this talk will discuss the advantages and disadvantages of using latent semantic analysis for the analysis of these data, comparing latent semantic analysis to correspondence analysis and other methods of analysis.

“Cultural Consonance and Individual Adaptation in Urban Brazil”

William W. Dressler, Department of Anthropology, University of Alabama

In research in Brazil and the U.S., the hypothesis was developed and tested that cultural consonance is associated with health outcomes, including arterial blood pressure and depressive symptoms. Cultural consonance is the degree to which individuals are able to approximate in their own beliefs and behaviors the prototypes for belief and behavior encoded in shared cultural models. In previous research, it was found that individuals who had higher cultural consonance in the domains of lifestyle and social support had lower blood pressures and fewer depressive symptoms. Research recently conducted in urban Brazil replicates and extends these findings. In this research, a more extensive cultural domain analysis, employing cultural consensus analysis as the ultimate step, was carried out in order to improve the description of shared cultural models in several domains. This made possible both more sensitive measures of cultural consonance in lifestyle and social support, and measures of cultural consonance in additional domains (family life, national character, and foodways). The following findings structure this presentation: (a) cultural domain analysis using both structured ethnographic techniques and unstructured interviewing was consistent with the hypothesis of shared cultural models in the domains studied; (b) the associations of cultural consonance with arterial blood pressure and with depressive symptoms were replicated; (c) the patterns of association of cultural consonance and blood pressure and cultural consonance and depressive symptoms were different; and, (d) cultural consonance was prospectively associated with depressive symptoms, independent of other predictors, at a follow-up of 1-2 years. These results are consistent with the hypothesis that cultural consonance with shared cultural models is an important component of individual adaptation

“Statistical Tests for Parameterized Multinomial Models: Power Approximation and Power Optimization”

Edgar Erdfelder, Department of Psychology, University of Mannheim

Parameterized multinomial models like log-linear models, Multinomial Processing Tree (MPT) models, or Cultural Consensus Theory (CCT) models play an important role in the social sciences. Empirical applications usually start with an overall goodness-of-fit test of a base model. If the base model can be retained, special tests of significance are used to test hypotheses on parameter values (i.e., parameter fixations) or differences between parameter values (i.e., equality constraints) within or across populations. Substantive conclusions are typically based on the results of these special parameter tests. Obviously, not only the type-1 error probability α but also the type-2 error probability β may severely bias both the statistical decisions and the substantive conclusions derived from these decisions. Nevertheless, most researchers routinely employ standard levels of significance like $\alpha = .05$ or $\alpha = .01$ without making any reference to ß or its complement 1-ß, the power of the statistical test. In those few cases in which researchers have aimed at controlling $1-\beta$, they referred to the effect size conventions ("small", "medium", and "large") introduced by Jacob Cohen (1969). However, this approach is often misleading because the meaning of "small", "medium", and "large" effect sizes may differ between models, designs and statistical hypotheses.

I propose an alternative approach that allows for directly controlling the power of a test as a function of the model parameters under the null and the alternative hypothesis. As will be shown, this approach leads to better interpretable results. In addition, it is easy to apply in practice, using standard software for parameterized multinomial models and statistical power analyses. Different methods of power approximation will be described and compared by means of a Monte-Carlo study for different goodness-of-fit statistics (likelihood ratio χ^2, Pearson´s χ^2, and the Cressie-Read statistic). The final part of my talk is devoted to several techniques of maximizing the test power given a fixed overall sample size: (1) The optimal choice of a test statistic, (2) the optimal decomposition of the overall sample size in case of joint multinomial models, (3) optimization of parameter values not addressed in the statistical hypothesis, and (4) optimization of the test strategy.

GPT models: Basic theory, initial implementation, and existing issues and challenges

Xiangen Hu – Department of Psychology, The University of Memphis

General Processing Tree (GPT) model is a mathematical form of multinomial processing tree (MPT) models. This presentation will be divided into three parts.

1. **Mathematical and statistical properties of GPT models**: The basic theory of GPT models will include an overview of the theoretical results that have be obtained in prior researches. I will emphasize some extensions. For example, I will talk about the extension of GPT models to analyze categorical data such as contingency tables.
2. **Computer software packages for GPT models**: There are several computer software packages that have been created for analyzing GPT and MPT models. I will explore the features for the packages. The purpose of evaluating the existing packages is to see what else we can do to make the GPT/MPT tools available to researchers in other domains. For example, I will explore the possibilities of having components in popular software packages, such as R.
3. **Existing issues and challenges**: To end the presentation, I will raise a few issues of GPT models, such as the issue of structure identifiably for GPT models. I will also

share with the audiences the lessons learned using GPT models in analyzing data from directed forgetting experiments.

"Bayesian Cultural Consensus Theory"

George Karabatsos, Department of Educational Psychology, Illinois University

A Cultural Consensus Theory (CCT) model provides a device to infer the beliefs of a cultural group of respondents from a set of questionnaire data, using answer key parameters that describe the culturally-correct response to each and every questionnaire item, and parameters that describe differences between respondents according to ability. Parameters of respondent response-bias, and item difficulty may also be included in the model. This presentation discusses a general Bayesian approach for performing statistical inference with Cultural Consensus Theory (CCT) models, which includes methods of model estimation, model testing, and model selection (Karabatsos & Batchelder, 2003, *Psychometrika*). Specifically, the approach: 1) provides a particular Markov Chain Monte Carlo algorithm that provides the basis for estimating the posterior distribution of the parameters of a CCT model (the answer key parameter, respondent ability parameters, and possibly response-bias parameters and item difficulty parameters), 2) includes methods for providing global or detailed tests of fit of a CCT model through posterior-predictive p-values, and 3) employs the Deviance Information Criterion for the task of model selection, in order to determine which model, of a set of CCT models with different parameterizations, implies a predictive distribution that is closest (in Kullback-Liebler distance) to the (unknown) true sampling distribution of the item responses. This entire Bayes framework is illustrated through analyses of real data sets, where one of the applications involves placing order-constraints on the ability parameters of the CCT model. A simulation study demonstrates that estimates of the answer key parameters can be quite accurate even for a respondent sample size as low as 3. Finally, in looking towards the future, I will discuss possible Bayesian hierarchical formulations of CCT models, either in order to handle situations where there is more than one cultural group in the respondent sample, to handle any dependence that may exist between item (or person) parameters, and/or to define Bayesian non-parametric versions of CCT models through Dirichlet-Process (hyper-) priors. Of course, the Bayesian inference framework for model estimation, model testing, and model selection, is easily extended to the hierarchical versions of CCT models.

"Hierarchical Multinomial Processing Tree Models: A Latent-Class Approach"

Christoph Klauer, Institut of Psychology, Bonn University

Multinomial processing tree models are widely used in many areas of psychology. Their application relies on the assumption of parameter homogeneity, that is, on the assumption that participants do not differ in their parameter values. Tests for parameter homogeneity are proposed that can be routinely used as part of multinomial model analyses to defend the assumption. If parameter homogeneity is found to be violated, a new family of models, termed latent-class multinomial processing tree models, can be applied that accommodates parameter heterogeneity and correlated parameters, yet preserves most of the advantages of the traditional multinomial method. Estimation, goodness-of-fit tests and tests of other hypotheses of interest are considered for the new family of models.

The CCM as a tool for analyzing cultural processes

Douglas L. Medin – Department of Psychology, Northwestern University

This talk will focus on applications of the cultural consensus model to within and across cultural comparisons. The CCM is not a theory of culture but it is a very effective tool for cultural analysis. The talk describes within and across group comparisons of folk ecological models from ongoing studies in Guatemala (with Q'eqchi' Maya, Itza' Maya and Ladinos) and in Wisconsin (with Native American and European American fishing experts).

"Clinical Aplications of Multinomial ProcessingTtree Models"

David Riefer, Department of Psychology, University of California at Riverside

Multinomial processing tree (MPT) models are a well-studied class of mathematical models that can be used as measurement tools to study cognitive processes. A recent trend in this field is the use of MPT modeling to study cognitive deficits in clinical populations. This talk provides a comprehensive review of the these applications, including MPT models for measuring storage and retrieval, source monitoring, process dissociation, and other cognitive processes. These models have been used to measure cognitive deficits associated with schizophrenia, Alzheimer's disease, developmental dyslexia, dementia, amnesia, and other forms of cognitive dysfunction. However, using MPT modeling to study clinical groups raises a number of special methodological issues, including problems of individual differences, sample size, and covariates. Possible strategies are discussed for addressing these problems, including the use of computer simulations and a technique called hierarchical modeling. In addition, the issue of individual differences is illustrated with a concrete example --- an experiment examining storage and retrieval deficits in schizophrenics and organic alcoholics. This example demonstrates that when parameter estimates are computed for each participant individually, a number of additional statistical analyses can be conducted, including measures of effect size and correlation between the parameter estimates. These types of traditional statistics are hard to compute when MPT models are applied to group data, but are easy to use when estimates are obtained for each individual. This approach can be informative when using MPT models to assess cognitive deficits in clinical populations.