Australian Mathmatical Psychology Conference 2018

14th-15th February

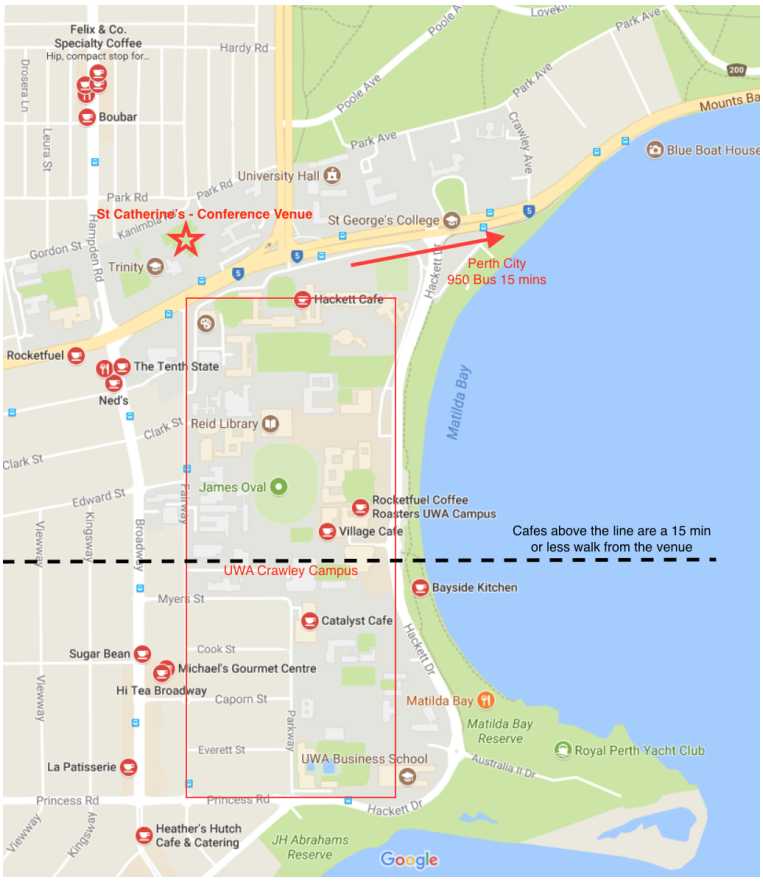
Perth, Australia

Welcome

The University of Western Australia is delighted to host the 2018 Australian Mathematical Psychology Conference in Perth, Western Australia. The conference runs from February 14th–15th 2018, with pre-conference workshops on the 13th February.

Venue Information

All sessions will be held at The St Catherine's college, a short walk from the UWA campus in Crawley. There will be morning and afternoon tea and a continuous supply of tea and coffee at the venue - included in the registration price. There are plenty of options for lunch and coffee a short walk from the venue.

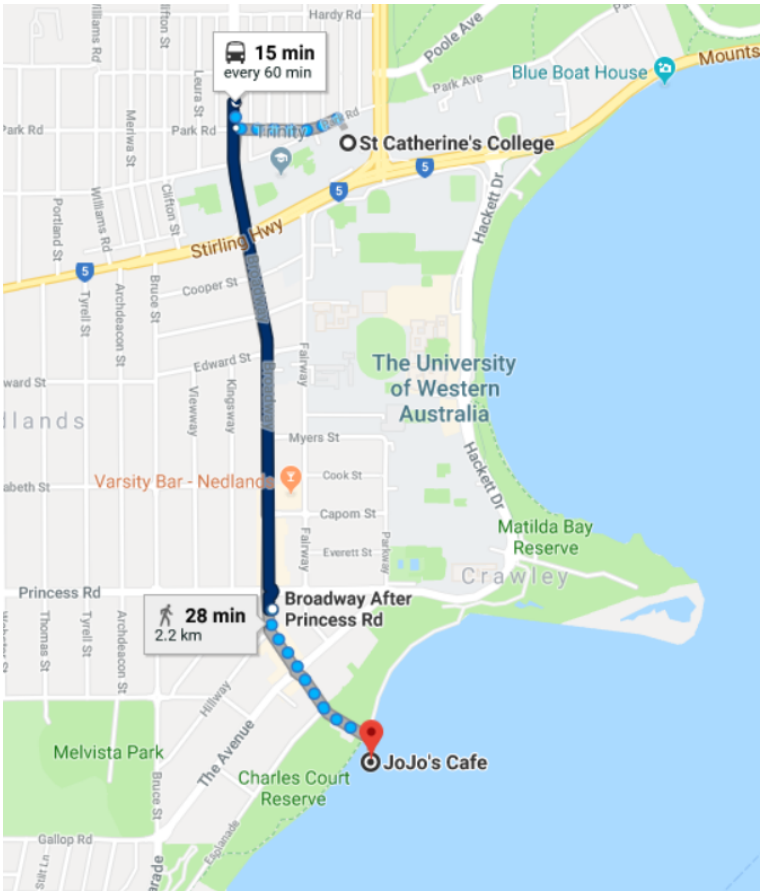


Acknowledgement

We acknowledge that the University of Western Australia is situated on Noongar land, that the Noongar people remain the spiritual and cultural custodians of their land and continue to practise their values, languages, beliefs and knowledge. We pay our respects to them and their cultures; and to elders both past and present.

Conference Dinner

The conference dinner is on Thursday 15th Feb at Jojo's Cafe on the Swan River. The dinner is approximately a 25 minute walk from the conference. You could also catch the number 24 bus near the venue. Drinks and canapes will be available from 6 pm. Dinner will be served at 7 pm.



Conference Code of Conduct

We are committed to making AMPC18 an inclusive, respectful and harassment-free experience. Harassment and hostile behaviour are unwelcome at any of the scientific and social events associated with the conference. Harassment includes degrading verbal comments, deliberate intimidation, stalking, harassing photography or recording, inappropriate physical contact, and unwelcome sexual attention.

If you have any concerns please contact one of the organisers.

Soccer

We will have the what was the traditional cricket game (now soccer) at the end of the first day of the conference (Wednesday, February 14th). At the end of the schedule (~ 5.30pm) we will walk to Riley Oval, which is approxamtely 10 minutes walk from the conference venuce.

Workshops

There will be two free workshops held on the 13th February at the conference venue.

Morning Workshop - Masterclass in Creating Opportunities and Developing your Research Skills

10am -12 noon, St Catherine's College, UWA

In this masterclass, we will hear from three senior scientists in the field of Mathematical Psychology about the opportunities for professional development that have been available to them throughout their careers and how they reached their current positions. In particular, we will focus on how they developed their skills in computational modelling and advanced statistical methods. Furthermore, we will discuss the steps that senior scientists can take to support the Early Career Researchers they work with and ensure that we promote gender diversity in STEM.

This masterclass is supported by the Institue of Advanced Studies at UWA. Professor Amy Criss, Head of Discipline, Psychology, Syracuse University and 2018 Institute of Advanced Studies Visiting Fellow, will be joined in a panel discussion by Associate Professor Amy Perfors (University of Melbourne) and Associate Professor Chris Donkin (UNSW). Discussion will be facilitated by Dr Alice Mason (UWA) who is chair of the Gender Diversity Committee in the School of Psychological Science.

The masterclass is open to attendees of any gender. You can register for the workshop here: http://www.ias.uwa.edu.au/masterclass/STEMresearch

Afternoon Workshop - Workshop on State-trace Analysis

ADD TIME, St Catherine's College, UWA

Presenters: John Dunn, Mike Kalish, Rachel Stephens

The aim of this workshop is to provide a brief introduction to the application of state-trace analysis (STA) to psychological data based on the book,

Dunn, J.C. & Kalish, M. L. (in press). State-trace analysis. Springer.

The following aspects will be covered:

Brief introduction to the logic of STA Fitting the monotonic model Analysis of continuous data Analysis of discrete data Participants will use the custom STACMR software package developed by the authors. This will require that either Matlab or R be installed (both are supported), as well as java. Any version of java on or after version 1.7 is good. If java is not installed, it can be downloaded from http://www.oracle.com/technetwork/java/javase/downloads/jre8-downloads-2133155.html.

In addition, participants should download the following files:

- State-trace analysis.pdf (a copy of the book)
- STACMR-matlab.zip (if using Matlab)
- STACMR-R.zip (if using R)

Public Lecture by Professor Amy Criss

A public lecture by Amy H. Criss, Head of Discipline, Psychology, Syracuse University and 2018 Institute of Advanced Studies Visiting Fellow. 6-7pm, Woolnough Lecture Theatre, Geology Building, UWA Register here: http://www.ias.uwa.edu.au/lectures/criss

Conference Timetable

Wednesday 2018-02-14

Morning

Time	Authors	Title
09:00		Welcome
09:10	**Amy Perfors**, Nicholas van Dam	Decision-making in black swan environments
09:30	**John C. Dunn** , Li-Lin Rao	Models of risky choice: A signed difference analysis
09:50	**Christina Van Heer**, Robert Hester, David K. Sewell, Philip L. Smith	The role of prediction error and confidence in sequential decisions
10:00	**Jared M. Hotaling**, Andreas Jarvstad, Chris Donkin, Ben R. Newell	The effects of outcome information during sampling on decisions from experience
10:20	**Yiyun Shou** , Michael Smithson	How Do People Think About the Probability of Human Extinction?
10:40		**Coffee**
11:10	**Ashley Luckman**, Sebastian Gluth, Jorg Rieskamp.	Using Response Times to distinguish between attribute-wise and alternate-wise models of inter-temporal choice.
11:30	**Yonatan Vanunu**, Jared M. Hotaling, Ben R. Newell	The Impact of Goal and Cognitive Load on Decisions from Experience.
11:40	**Timothy Ballard**, David Sewell, Andrew Neal	Human information processing in the face of reward versus punishment
11:50	Rachel Mullard, Marc Adam, **Ami Eidels**	Competitive Decision Making in Dutch Auctions
12:00	**Alice Mason**, Mark Hurlstone, Geoff Ward, Gordon Brown, Simon Farrell	Evaluating bundles of numbers: assessing the trade-off between memory and online updating in retrospective evaluation
12:10	**Luke Strickland**, David Elliott, Michael David Wilson, Shayne Loft, Andrew Heathcote	Modelling Prospective Memory in Simulated Maritime Surveillance: Cognitive Control and Competition for Capacity
12:30	**Russell J. Boag**, Luke Strickland, Andrew Heathcote, Shayne Loft	Modelling Cognitive Control Mechanisms in Simulated Air-Traffic Control
12:40		Lunch

Afternoon

Time	Authors	Title
14:00	**Brett K. Hayes**, Rachel G. Stephens, Jeremy Ngo, John C. Dunn	The dimensionality of reasoning: Inductive and deductive inference can be explained by a single process

Time	Authors	Title
14:20	**Dani Navarro**, Alison McCann, Alexandra Tingey, Nicole Baz, Michelle Keshwa, Amy Perfors	Extensional and intensional reasoning: A Bayesian perspective on the conjunction fallacy
14:40	Mike Le Pelley, **Ben R. Newell**, Robert Nosofsky	Once more, with feeling: deferred feedback does not "sharply dissociate" 'implicit' and 'explicit' category learning.
14:50	**Rachel. G. Stephens**, Dora Matzke, Brett K. Hayes	Disappearing dissociations in experimental psychology: Using state-trace analysis to test for multiple processes
15:10	**Guillermo Campitelli**	The prediction game: A simple pedagogical tool to introduce Bayesian inference
15:30		**Coffee**
16:00	**Paul Dudgeon**, Mariska Barendse, & Yves Rosseel	Leverage-based confidence intervals for structural equation modelling.
16:20	**Nicolas Fay** , Bradley Walker	Applying the Cultural Ratchet to a Social Artefact: The Cumulative Cultural Evolution of a Language Game
16:40	**Bradley Walker**, Nicolas Fay	An Egocentric Bias is Important to Adaptive Social Learning
16:50	**Matthew B. Thompson**, Rachel A. Searston, Gianni Ribeiro, Jason M. Tangen	Alternative statistical frameworks for communicating the strength of forensic evidence in court
17:10	**Matthew Kaesler**, John Dunn, Carolyn Semmler	Evaluating Signal Detection Models for Eyewitness Identification
17:20	**Simon De Deyne** , Amy Perfors	Near neighbour judgements as an efficient way to estimate semantic similarity.
17:30		Soccer

Thursday 2018-02-15

Morning

Time	Authors	Title
09:00	**Chi-Fai Lo**, Kwok-Kwan Wong and Ho-Yan Ip	Lie-algebraic Approach for the Leaky Competing Accumulator Model of Decision Making
09:20	Yakov Ben-Haim, **Michael Smithson**	Assessing Robustness of Statistical Models: Info-Gap Theory
09:40	**Don van Ravenzwaai**, Casper Albers, Henk Kiers	Credible Confidence: A pragmatic view on the frequentist vs Bayesian debate
10:00	**Trisha Nowland**	Mathematical Set Theory for Latent Variable Modelling in Psychology Research
10:10	**Daniel Feuerriegel**, Daniel Bennett, Phillip M. Alday, Stefan Bode	The Decision Decoding Toolbox (DDTBOX) - A multivariate pattern analysis toolbox for event-related potentials

Time	Authors	Title
10:30		**Coffee**
11:00	**Klaus Oberauer**, Hsuan-Yu Lin	An Interference Model of Visual Working Memory: Applications to Change Detection
11:20	Anthea G. Blunden, Dylan Hammond, Piers D. L. Howe, **Daniel R. Little**	Characterising the architecture and integration rule of change detection decisions
11:40	**Chris Donkin**	Inferring task-specific psychological representation
11:50	**Marton Kocsis**, Simon Farrell	The Role of Working Memory in Free Recall: The Effect of Preload at Retrieval
12:00	**Adam F. Osth** , Simon Farrell	Modeling response time distributions of free recall initiation with race models
12:20	**Kevin D. Shabahang**, D. J. K. Mewhort, Donald R. J. Franklin,	Semantic contrast effects: a holographic interface linking episodic and semantic memory
12:30		Lunch

Afternoon

Time	Authors	Title
13:50	**Roger Ratcliff**	Modeling Numeracy Decisions on a Continuous Scale
14:10	**Philip L. Smith**, Elaine A. Corbett	Modelling Speeded Multielement Decision Making as Diffusion in a Hypersphere
14:30	**Guy E. Hawkins**, Nathan J. Evans, Scott D. Brown	Normative theories are nice, but people aren't always normative: Comparing collapsing and fixed threshold models of speeded decision making
14:50	**Andrew Heathcote**, Mathieu Servant, Kirsty Hannah, Dora Matzke	Priming and Variable Control in Choice Conflict Tasks
15:10	**Quentin F. Gronau**, Andrew Heathcote, Dora Matzke	Warp-III Bridge Sampling for Comparing LBA Models
15:20		**Coffee**
15:50	**Simon Dennis**, Paul Garrett, Hyungwook Yim, Nathan Evans, Vishnu Sreekumar	Predicting memory for WHEN
16:10	**Julian Fox**, Adam Osth & Simon Dennis	Modelling condition order effects: Interference, learning, and decision strategies
16:20	**Amy H. Criss**, Jack Wilson	Output Interference and Release in Cued Recall: The role of learning during test and a response filter
16:40	**Christopher R. Brydges**, Gilles E. Gignac, Ullrich K. H. Ecker	Working memory capacity predicts ongoing reliance on misinformation: A latent-variable analysis
16:50	**Hyungwook Yim**, Adam F. Osth, Vladimir M. Sloutsky, Simon J. Dennis	Decomposing Different Sources of Interference in Recognition Memory Development - a Computational Modeling Approach

Time	Authors	Title
17:10	**Jason Zhou**, Philip Smith, Adam Osth, Simon Lilburn	Decision-Making in Source Memory: Re-evaluating the Thresholded Nature of Source Memory Retrieval
17:20		Business Meeting and End of Formal Proceedings
18:00		Dinner

Abstracts

HUMAN INFORMATION PROCESSING IN THE FACE OF REWARD VERSUS PUNISHMENT

Timothy Ballard, David Sewell, & Andrew Neal

University of Queensland

Whilst much is known about the effects of rewards and punishments on motivation and behavior, far less is known about their effects on the underlying information processing structures. A view held by many is that the human information processing system has a limited capacity. The system must therefore manage its resources efficiently, taking into account the supply of and demand for resources when deploying them to various tasks. According to this perspective, reward and punishment might increase the rate of information processing, because it makes the allocation of resources to a task a more worthwhile investment. An alternative perspective is that the potential for reward or punishment may slow the processing of information, because they increase the need for resources to be deployed toward off-task activities such as self-monitoring.

We examined these predictions using a random dot motion detection task in which participants viewed clouds of moving dots and had to determine whether the dots were moving mostly left or mostly right. For each block, the participants were given the goal of being more accurate and faster than the average participant in a pilot study. In the reward condition, participants gained money for achieving the goal. In the punishment condition, participants lost money for failing the goal. The rate of information processing was measured by estimating the drift rate parameter using the LBA model within a hierarchical Bayesian framework.

When participants were given an opportunity for reward, the average rate of information processing did not change from baseline. However, the amount of information required to make a decision (i.e., response threshold) increased. When participants were under threat of punishment, the average rate of information processing decreased, and the amount of information required to make a decision also decreased. These findings demonstrate the need to consider the context when attempting to understand how information processing will unfold.

ASSESSING ROBUSTNESS OF STATISTICAL MODELS: INFO-GAP THEORY

Yakov Ben-Haim [1] & Michael Smithson [2]

[1] Technion (Israel Institute of Technology), [2] The Australian National University

Info-gap theory provides a versatile supplement to robust statistical techniques, by evaluating the robustness of any statistical model of a data-set to uncertainties in any aspects of the model's functional form, its parameters, and the data. The info-gap robustness function quantifies the tradeoff between model accuracy and robustness. It enables researchers to address questions such as which of several models should be preferred for making predictions in future scenarios involving populations that may differ in unknown ways from the data on which the models were originally tested. We illustrate this framework with examples using CDF-Quantile distribution models fitted to real data.

CHARACTERISING THE ARCHITECTURE AND INTEGRATION OF CHANGE DETECTION DECISIONS

Anthea G. Blunden, Dylan Hammond, Piers D. L. Howe & Daniel R. Little

University of Melbourne

We propose an adaptation of the logical rule-based models (Fific, Little & Nosofsky, 2010) in order to characterise decision making based on information held in visual short term memory. Specifically, we seek to diagnose decision making processes in a one-shot multi-element change detection task, as either serial, parallel, or coactive in nature. We additionally seek to characterise whether the integration rule for each change decision is based on the maximum evidence strength or the sum of strengths across elements. The logical rule models assume that each element is represented as a Gaussian distribution of perceptual effects. To model changes, we assume that the strength of the change is represented as a folded-normal distribution.

We factorially manipulate the magnitude of change for a given element and whether a change decision requires an OR or an AND decision rule. This approach is novel in that it provides a way to unify signal detection models of change detection (Maximum Difference and Summed Difference models) with models of information process.

MODELLING COGNITIVE CONTROL MECHANISMS IN SIMULATED AIR-TRAFFIC CONTROL

Russell J. Boag [1], Luke Strickland [2], Andrew Heathcote [2], & Shayne Loft [1]

[1] University of Western Australia, [2] University of Tasmania

This project uses Bayesian Linear Ballistic Accumulator (LBA) models of decision-making to model the cognitive control mechanisms that aid prospective memory (PM) and ongoing task performance in a complex and dynamic air-traffic control (ATC) simulation. We aim to explain how operators balance competing demands from ongoing and PM tasks under different levels of time pressure, task load, and relative response importance.

The ATC task involved classifying pairs of moving aircraft as either 'in-conflict' or 'not in-conflict'. On some trials aircraft also contained a PM target which required execution of an atypical PM response. These decisions require the integration of multiple information sources (e.g., relative distance, airspeed) on a dynamic display while balancing several competing task requirements (e.g., time pressure, PM demands, relative response importance). Moreover, decisions typically unfolded over relatively long time-scales (up to 10 seconds). Initial work suggests that models of simple choice such as the LBA can account for ongoing and PM task performance in these complex, long time-scale, less controlled applied settings.

Our modelling shows evidence of both proactive and reactive control mechanisms. In terms of proactive control, response thresholds were higher under PM load. This suggests individuals proactively raise ongoing task thresholds when holding PM intentions. This effect was larger when the importance of the PM task was emphasised and smaller when the importance of the ongoing task was emphasised. This suggests that holding PM intentions encourages operators to make deliberate strategic adjustments to how they perform their primary ongoing task, and that these adjustments vary systematically as a function of PM task importance.

WORKING MEMORY CAPACITY PREDICTS ONGOING RELIANCE ON MISINFORMATION: A LATENT-VARIABLE ANALYSIS

Christopher R. Brydges, Gilles E. Gignac, & Ullrich K. H. Ecker

Universiy of Western Australia

Misinformation often affects inferences and judgments even after it has been retracted and discredited. This is known as the continued influence effect. Memory processes have been theorized to contribute to the continued influence effect, and much previous research has focussed on the role of long-term memory processes at the time misinformation is retrieved during inferential reasoning and judgments. Recently, however, experimental research has focussed upon the role of working memory (WM) processes engaged in the updating and integration of information, when the retraction is encoded. From an individual differences perspective, susceptibility to continued influence effects should be predicted by a person's WM abilities, if continued reliance on misinformation is influenced, at least in part, by insufficient integration of the initial misinformation and its subsequent retraction. Consequently, we hypothesized that WM capacity would predict susceptibility to continued influence effects uniquely, positively, and more substantially than short-term memory (STM) capacity. Participants (N = 216) completed a continued-influence task, as well as a battery of WM and STM capacity tasks. Based on a latent variable model, our hypothesis was supported (WM capacity: beta = .36, p = .013; STM capacity: beta = -.22, p = .187). Consequently, we suggest that WM capacity is a measurable "risk factor" for continued reliance on misinformation.

THE PREDICTION GAME: A SIMPLE PEDAGOGICAL TOOL TO INTRODUCE BAYESIAN INFERENCE

Guillermo Campitelli

Edith Cowan University

In this talk I will present the prediction game, a pedagogical tool to introduce Bayesian inference. The purpose of presenting the prediction game is to provide a pedagogical tool to introduce Bayesian inference to researchers or students who do not have any knowledge of Bayesian inference. Moreover, this tool aims to solve a number of shortcomings of introductory tutorials to Bayesian inference. (At least, all those I examined). The main problem of introductory tutorials is that they start too complex. They present the Bayes theorem very early on, losing most readers in the first page. Another shortcoming is that a number of useful components of Bayesian inference are missing. For example, the prior predictive distribution is almost never presented. The prediction game consists of a grid with two margins: the bottom margin represents the values of one parameter, and the right-hand side margin represents possible values of data. By putting poker chips into the bottom margin the player creates something equivalent to a prior probability distribution. By sliding the poker chips through each column of the grid the player generates a joint probability of parameter values and possible data values. And, by adding the number of poker chips on each row and indicating the number of poker chips in the right margin the player develops the prior predictive distribution. When the observed data value is announced the corresponding row is highlighted, and the player with more chips in that row is the winner. The right margin of that row is the marginal likelihood. The posterior distribution is obtained by dividing all the values on that row of the grid by the marginal likelihood. Obtaining the ratio of the marginal likelihood of two players is the equivalent to calculating a Bayes factor.

OUTPUT INTERFERENCE AND RELEASE IN CUED RECALL: THE ROLE OF LEARNING DURING TEST AND A RESPONSE FILTER

Amy H. Criss & Jack Wilson

Syracuse University

Output interference is the finding that performance declines with test trial. In cued recall tasks, participants are presented with a cue word and tasked to output the target word studied alongside. Participants may choose to respond or not, and a response if given may be correct or incorrect. We aim to understand the empirical pattern of output interference in cued recall and the underlying theoretical mechanisms. We first analyzed published cued recall data and found fewer correct and incorrect responses across test trial. Next, we tested the contribution of cue and target memories on output interference through a release from output interference paradigm: one member of each pair was an exemplar from one of two categories, and that member was either the cue word or target word (post-cued). The critical comparison was when one category was tested in a blocked fashion and the blocking was either by cue category or by target category. We found that release from output interference only occurred when the test probe included information about the blocked words. Specifically, release occurred for blocked cues; release occurred for blocked targets only when the test probe included the target category, in effect treating the target category like an extra cue. Together these data suggest that interference is driven both by learning the test probe and by imperfect filtering of already provided responses.

NEAR NEIGHBOUR JUDGEMENTS AS AN EFFICIENT WAY TO ESTIMATE SEMANTIC SIMILARITY.

Simon De Deyne & Amy Perfors

University of Melbourne

A popular way to estimate how words are similar involves asking participants to assign a magnitude judgement of similarity for a pair of words using a rating scale. This method has various limitations associated with the use of rating scales and lack of context when only two items are compared. Moreover, from a practical point of view, the procedure becomes prohibitively expensive for a large number of items. For example, for 1,000 items, obtaining one observation per pair would require nearly half a million judgements.

In two studies, we explore an alternative procedure in which participants either generate or rank a small number of near neighbours to a natural language concept. To evaluate the validity of this new task, we used pair-wise similarities collected for 15 basic level categories such as “birds” or “tools”. For each of the categories, we construct a sparse near neighbour graph and show that a mechanism of spreading activation

based on random walks (see De Deyne, Navarro, Perfors & Storms, 2016) can be used to accurately predict pair-wise similarity judgements using a limited amount of information.

While these results suggest excellent external validity at a fraction of the cost, we also discuss some theoretical implications about the number of near neighbours and fundamental differences between similarity-based and feature-based inference in natural language concepts.

PREDICTING MEMORY FOR WHEN

Simon Dennis [1], Paul Garrett [2], Hyungwook Yim [1], Nathan Evans [3], & Vishnu Sreekumar [4]

[1] University of Melbourne, [2] University of Newcastle, [3] Vanderbilt University, [4] NIH Research Laboratories

We present a model that predicts when people will believe events from their lives occurred on a person by person and stimulus by stimulus basis. Participants wore a smartphone in a pouch around their necks for two weeks. The smartphone collected timestamps, GPS, accelerometry, audio segments and images. These data sources were augmented with weather conditions, temperature, moon phase and tags derived from the audio using a machine learning model. A week later they were shown a selection of images and were required to indicate on which day each was taken. A conditional logit model predicted leave one person out judgements, leave one day out judgements and leave one observation out judgements. We highlight the advantages of using cross validation over other methods of model selection.

INFERRING TASK-SPECIFIC PSYCHOLOGICAL REPRESENTATION

Chris Donkin

University of New South Wales

Most psychological theories of cognition propose that when an individual encounters a task, they rely on a mental representation of the stimuli used in that task. Standard approaches for measuring the mental representation of such stimuli are explicit and subjective. For example, observers may be asked to rate what they believe to be the similarity between pairs of items. One of the major issues with this approach is that one must assume that the stimuli have the same mental representation in the similarity rating task as in any other task. Our approach is to subvert this problem, by directly extracting the mental representation of stimuli from the cognitive task of interest. Specifically, we use the Generalized Context Model to infer the mental representation of a set of 20 colors from responses in a visual working memory task. Along the way, we also use the model to infer the strength of memories for items on the current and previous trial, thus investigating the role of recency, primacy, and proactive interference in visual working memory. Finally, we also use the model to infer the mental representation of 20 letter stimuli in a verbal working memory task.

LEVERAGE-BASED CONFIDENCE INTERVALS FOR STRUCTURAL EQUATION MODELLING.

Paul Dudgeon[1], Mariska Barendse[2], & Yves Rosseel[2]

[1] The University of Melbourne, [2] Ghent University

Leverage is a measure of how far away one individual's set of scores of 2 or more variables is from the scores of all other individuals. Besides its usage in regression diagnostics, leverage is also used in estimators of the covariance matrix of regression parameters when standard assumptions of homoscedasticity and/or normality are violated—these are called heteroscedastic-consistent (HC) estimators in the literature, and they were originally proposed by Huber in the 1970s and by White in the 1980s. Because linear regression is a particular form of structural equation modelling (SEM), HC-type estimators are theoretically possible in SEM also. However, only White's HCO estimator is currently available in SEM. It is often referred to as a robust estimator or a sandwich estimator in the SEM literature. This presentation develops leverage-based sandwich estimators for deriving standard errors and confidence intervals (CIs) in SEM. These new estimators correspond to the HC3 estimator used in linear regression. Our research shows that the current "robust" estimator used in SEM is not as robust as the appellation given to it implies. More importantly, we show

that the incorporation of leverage into the current sandwich estimator used in SEM results in much better coverage in CIs, even for samples sizes as low as 50 (where current estimator's robustness bombs badly).

MODELS OF RISKY CHOICE: A SIGNED DIFFERENCE ANALYSIS

John C. Dunn [1] & Li-Lin Rao [2]

[1] University of Western Australia, [2] Chinese Academy of Sciences

Risky choice involves selection between two or more options each of which is a set of n ordered pairs, (pi,xi) , where xi is a (positive, negative, or zero) payoff and pi is its probability of occurrence, with . There are a large number of different models of risky choice that fall into two broad classes; fixed utility models that satisfy the condition of *simple scalability* and everything else. A prominent example of the former is Cumulative Prospect Theory (Tversky & Kahneman, 1992); a prominent example of the latter is Decision Field Theory (Busemeyer & Townsend, 1993). While it is known that behaviour can be observed that inconsistent with all models, this has largely been based on the construction of special cases. We decided to test the class of fixed utility models against a set of relatively unselected risky choices using signed difference analysis (SDA). The advantage of this approach is that there is no requirement to posit a particular form for the error function that links the difference in the utility of two gambles, A and B, with the probability of choosing A over B, $P(A>B)$. We presented groups of participants with 30 *variable* gambles (A) each paired with one of four *fixed* gambles (B) and tested the prediction of fixed utility models that $P(A>B)$ has the same order over A for all B using the statistical test developed by Kalish, Dunn, Burdakov and Sysoev (2016). We discuss the implications of the results and explore a relatively simple extension to a (minimally) more complex model.

References

Busemeyer, J. R., & Townsend, J. T. (1993) Decision Field Theory: A dynamic cognition approach to decision making. *Psychological Review, 100*, 432–459.

Kalish, M. L., Dunn, J. C., Burdakov, O. P., & Sysoev, O. (2016). A statistical test for equality of latent orders. *Journal of Mathematical Psychology, 70*, 1-11

Tversky, A. & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty, 5(4)*, 297–323.

APPLYING THE CULTURAL RATCHET TO A SOCIAL ARTEFACT: THE CUMULATIVE CULTURAL EVOLUTION OF A LANGUAGE GAME

Nicolas Fay & Bradley Walker

The Univeristy of Western Australia

Material artefacts evolve by cumulative cultural evolution (CCE) - the accumulation of adaptive We present a large-scale experiment investigating the CCE of a social artefact in transmission chains, each containing 8 adult human participants (N=408). The social artefact is what Wittgenstein[Office1] calls a language game, the subset of language used to perform a particular activity; in the present study, communicating a route on a map. Two social learning conditions were compared: Observation and Social Interaction. Participants were tasked with accurately communicating a route on a map to the next person in the chain. Over the experimental generations the routes were reproduced with progressively higher accuracy in both conditions, demonstrating the CCE of the language game. The rate of CCE was comparable across the conditions, but route reproduction accuracy was consistently higher in the Social Interaction condition compared to the Observation condition. In both conditions performance improved due to the accumulation of adaptive patterns of verbal route descriptions, and the progressive elimination of non-adaptive patterns. Whereas the change in content was similar across the conditions, the change in process was fundamentally different between the Observation and Social Interaction conditions. In conclusion, social artefacts, like material artefacts, are subject to cumulative cultural evolution.

THE DECISION DECODING TOOLBOX (DDTBOX) - A MULTIVARIATE PATTERN ANALYSIS TOOLBOX FOR EVENT-RELATED POTENTIALS

Daniel Feuerriegel [1], Daniel Bennett [2,1], Phillip M. Alday [3], & Stefan Bode [1,4]

[1] University of Melbourne, [2] Princeton University, [3] Max Planck Institute for Psycholinguistics, [4] University of Cologne

In recent years, model-based cognitive neuroscience has increasingly used electroencephalographic (EEG) data to characterize the timing of processes related to parameters in cognitive models. This approach has been successfully applied based on well-known ERP components (e.g. Ravenzwaaij, Provost & Brown, 2017, J. Math. Psychol.). However subtle multivariate patterns of EEG data, revealed by multivariate pattern analysis (MVPA), can also provide useful neural correlates of model parameters. Here we present DDTBOX, an open-source MVPA toolbox for EEG data. DDTBOX runs under MATLAB and is well integrated with the EEGLAB/ERPLAB and Fieldtrip toolboxes. It trains support vector machines (SVMs) on patterns of event-related potential (ERP) amplitude data, following or preceding an event of interest, for classification or regression of experimental variables. ERP amplitude patterns can be extracted across space/electrodes (spatial decoding), time (temporal decoding), or both (spatiotemporal decoding). DDTBOX can also extract SVM feature weights, generate empirical chance distributions based on permuted-labels decoding, provide estimates of the prevalence of decodable information in the population, and perform a variety of corrections for multiple comparisons. DDTBOX complements conventional model-based analyses of ERP components, as subtle multivariate patterns can be detected that would be overlooked in standard ERP component-based analyses. These multivariate patterns can be used to predict model parameters directly (e.g. Grootswagers et al., 2017, J. Cogn. Neurosci.) or to provide complementary information to inform behavioural modelling results (e.g. Bode et al., 2012, J. Neurosci.). In summary, DDTBOX is an easy-to-use and open-source toolbox that allows for characterising the time-course of information related to perceptual and cognitive processes. It can be applied to data from a large number of experimental paradigms and is expected to be a valuable tool for model-based cognitive neuroscience.

MODELLING CONDITION ORDER EFFECTS: INTERFERENCE, LEARNING, AND DECISION STRATEGIES

Julian Fox, Adam Osth, & Simon Dennis

University of Melbourne

The list length effect (LLE) – that recognition is poorer for items from long lists than short lists – is a benchmark finding in memory research. Recently, however, its existence has been debated. Dennis, Lee and Kinnell (2008) highlighted that previously observed LLEs were due to various confounding factors, and that when these are controlled, there is a null LLE. This finding of a null LLE was used to argue against the common belief that items are the primary source of interference in recognition. Contrary to this, Brandt and colleagues demonstrated that when analysis is restricted to the first study-test cycle in an experiment, a LLE results; and that it's only once performance is averaged across multiple study-test cycles that a null LLE results. They explained that in the first study-test cycle, participants commit a short or long list of items to memory (e.g., 20 or 80 items); but that in the second study-test cycle, participants often study the opposite list type, meaning that each would have committed an equal amount of items to memory (i.e., 100 items). Their proposal was that this gradual equating of items that participants experience throughout testing effectively masks the LLE. The present study replicated Brandt's results and used computational modelling to investigate the condition order effects, particularly whether they are caused by (1) the accrual of item-noise, (2) changes in learning or (3) changes in response thresholds. The data was fit with variants of the Osth and Dennis (2015) model, now extended to include the decision-making and RT components of the drift diffusion model.

WARP-III BRIDGE SAMPLING FOR COMPARING LBA MODELS

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The Linear Ballistic Accumulator (LBA; Brown & Heathcote, 2008) model is one of the most popular choice response time models in mathematical psychology. When fitting the LBA to experimental data,researchers are often interested in comparing two or more possibly non-nested model versions. The principled Bayesian solution to this problem is to compute posterior model probabilities and Bayes factors. Both quantities rely

on the marginal likelihood of the models which is in many applications a high-dimensional integral that usually cannot be evaluated analytically. Here we illustrate how Warp-III bridge sampling (Meng & Schilling, 2002) can be used to estimate the marginal likelihood for (hierarchical) LBA models. Warp-III sampling is an advanced version of bridge sampling that enables the efficient estimation of the marginal likelihood, even for cases in which the posterior distribution is skewed.

NORMATIVE THEORIES ARE NICE, BUT PEOPLE AREN'T ALWAYS NORMATIVE: COMPARING COLLAPSING AND FIXED THRESHOLD MODELS OF SPEEDED DECISION MAKING

Guy E. Hawkins [1], Nathan J. Evans [2], & Scott D. Brown [1]

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Theories of perceptual decision making have been dominated by the notion of evidence accumulation to a fixed threshold; the assumption of a process of accumulating evidence in favor of different alternatives until some fixed threshold level is reached, which triggers a decision. Recent theories have suggested that thresholds may not be fixed during each decision, but rather decrease as time passes - an assumption known as "collapsing thresholds". Collapsing thresholds have been proven to lead to better performance than fixed thresholds in tasks where the difficulty of decisions changes randomly, and in tasks where decision speed is emphasized, for example using deadlines. Despite the theoretical advantages of collapsing thresholds, reviews of data from typical decision-making paradigms have supported the traditional assumption of fixed thresholds. With data from three experiments, we investigated whether participants adopt collapsing thresholds in those paradigms where doing so is the optimal decision strategy. We find that strong emphasis on decision speed - particularly the use of response deadlines - encourages the adoption of collapsing thresholds, but this is not the case when simply instructing people to respond speedily or when decision difficulty varies randomly from one trial to the next. Our results suggest that collapsing threshold models may be most useful in deadline experiments, and this might also explain previous results regarding the difference between humans and non-human primates on this topic.

THE DIMENSIONALITY OF REASONING: INDUCTIVE AND DEDUCTIVE INFERENCE CAN BE EXPLAINED BY A SINGLE PROCESS

Brett K. Hayes [1], Rachel G. Stephens [1], Jeremy Ngo [1], & John C. Dunn [2]

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Three-experiments examined the number of latent dimensions needed to account for inductive and deductive reasoning. In each study, participants were presented with arguments that varied in logical validity and consistency with background knowledge (believability), and evaluated them according to deductive criteria (whether the conclusion was necessarily true given the premises) or inductive criteria (whether the conclusion was plausible given the premises). We examined factors, which, according to dual-processing theories, modulate the contribution of heuristic and analytic processes to reasoning: working memory load (Experiments 1 and 2), individual working memory capacity (Experiments 1 and 2) and decision time (Experiment 3). A number of empirical dissociations were found. Argument validity affected deduction more than induction. Argument believability affected induction more than deduction. Lower working memory capacity reduced sensitivity to argument validity and increased sensitivity to argument believability, especially under induction instructions. Reduced decision time led to decreased sensitivity to argument validity. State-trace analyses of each experiment, however, found that only a single underlying dimension was required to explain patterns of inductive and deductive judgments. This was true even when partial-order constraints were applied. This shows that functional dissociations, which have traditionally been seen as evidence for dual-processing accounts, are consistent with a single-process model of reasoning.

PRIMING AND VARIABLE CONTROL IN CHOICE CONFLICT TASKS

Andrew Heathcote [1], Mathieu Servant [2], Kirsty Hannah [3], & Dora Matzke [4]

[1] University of Tasmania, [2] Vanderbilt University, [3] University of Newcastle, [4] University of Amsterdam

We propose a theory of how priming caused by choice conflict, and variability in control deployed to resolve the conflict, affects decision processes. We derive a measurement model with analytic likelihoods from the theory that is able to account for the fine-grained time course of both response speed and accuracy as quantified by delta functions and conditional-accuracy functions. We show it provides a unified and parametrically coherent account of behavior in the Stroop, Simon and Flanker tasks in fits to data from two experiments each reported by Pratte, Rouder, Morey and White, Ratcliff and Starns (2011) as well as new data that enables conflict effects in the Simon task to be broken into interference and facilitation components relative to a carefully calibrated neutral condition. We then show that the theory fails for some participants in Simon-task data collected by Forstman, van den Wildenberg and Ridderinkhof (2008). We extend the theorie's concept of variable control to allow complete failures to exercise any control on some trials, causing participants to perform the wrong task, and show the measurement model derived from the extended theory provides a parsimonious, coherent and accurate account of data from all participants. We end by discussing the increasing evidence for the important role of variability in understanding cognitive control.

THE EFFECTS OF OUTCOME INFORMATION DURING SAMPLING ON DECISIONS FROM EXPERIENCE

Jared M. Hotaling [1], Andreas Jarvstad [2], Chris Donkin [1], & Ben R. Newell [1]

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Decisions from experience often differ from decisions based on described alternatives. This may stem from the fact that decisions from experience require that individuals learn about their choice alternatives by observing potential outcomes. We investigated the roles of attention and memory in the choice process by comparing two types of decision procedures: a) one where monetary value information is present during sampling, and b) one where values are revealed after sampling. In three experiments participants made a series of choices between pairs of risky gambles represented as urns containing different mixtures of blue and red balls. They began each trial by sampling balls from each urn. After observing a representative sample from each urn, participants chose which urn they would like to draw from for a consequential payment. In Experiment 3 some outcome samples were highlighted to increase visual and auditory salience.

Results from all three experiments suggest that individuals place greater weight on rare events when outcome values are absent during sampling. This pattern is roughly consistent with the 'description-experience gap', in which decisions from description – which likewise involve separable representations of value and probability information – also indicate greater weighting of rare events relative to decisions from experience – which do not. In Experiment 3, we found that highlighting a rare reward increased its salience when outcome values were present, but not when they were absent, suggesting that highlighting rare outcome values during sampling led participants to place greater weight on these outcomes when making their choices. Parameter estimates from a hierarchical Bayesian prospect theory model supported the conclusion that value-absent choices involved greater overweighting of rare events. We discuss the implications of these findings on our understanding of the interplay between attention, memory, and choice.

EVALUATING SIGNAL DETECTION MODELS FOR EYEWITNESS IDENTIFICATION

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Eyewitness identification researchers have only recently employed signal detection theory (SDT) to understand witness performance on the police lineup task, in which a witness to a crime must either select one member from a (typically) six-person array who matches their memory of the perpetrator, or indicate that the perpetrator is not present. In addition to calculating empirical SDT measures from lineup data using Receiver Operating Curve analysis, researchers have fit a model called SDT-compound detection (SDT-CD) in attempt to discover the underlying theoretical parameters. However, SDT-CD has been selected for use without quantitative comparison against other potential SDT models. Of particular relevance to model selection is the contentious proposition that the sequential, rather than simultaneous, presentation of lineup members leads to superior witness decision performance, as the sequential lineup task challenges the plausibility of many SDT models that assume simultaneous presentation of items. This work compares the performance of

three competing models; SDT-CD, a "maximum familiarity" model (MAX) and a novel sequential model (SDT-SEQ), in characterising sequential lineup data by using the Parametric Bootstrap Cross-fitting Method (PBCM). We tested both general model types (i.e. landscaping) and specific instances of the models as fit to 26 datasets in order to examine issues of model mimicry. Preliminary results highlight the challenges of using this approach to select between highly similar models and indicate that competing models strongly mimic each other.

THE ROLE OF WORKING MEMORY IN FREE RECALL: THE EFFECT OF PRELOAD AT RETRIEVAL

Marton Kocsis & Simon Farrell

University of Western Australia

Existing empirical evidence that suggests that working memory (WM) is involved in free recall of information from long-term memory primarily comes from examination of individual differences in WM capacity that — due to their correlational nature — are unable to distinguish effects at encoding from those at retrieval. In two experiments, we experimentally manipulated WM load via an informational preload during free recall. Participants were presented with a list of 8 words, followed by a 4 (study 1) or 6 (study 2) digit sequence (the preload). Participants were then asked free recall the word-list while maintaining the digit sequence, which was then reported in serial order after free recall of the word-list. While the preload had a small but consistent decrement on recall accuracy across all serial positions, there was no reliable effect on other benchmark measures of free recall. An ex-Gaussian model was fitted to free recall response time distributions, and it was found that preload was found to specifically affect the delay in retrieval onset, but did not influence the rate of memory search. Simulations of response time distributions via random-sampling-with-replacement model of memory retrieval suggest that preload may have influenced the recoverability of word-lists in memory. Given previous studies has found that attention-based manipulations at retrieval tend to impair free recall, our findings extend this research by suggesting that attentional components of WM are more critical to free recall than the storage capacity of WM.

ONCE MORE, WITH FEELING: DEFERRED FEEDBACK DOES NOT "SHARPLY DISSOCIATE" 'IMPLICIT' AND 'EXPLICIT' CATEGORY LEARNING.

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The controversy over multiple category-learning systems rolls on with proponents of the multiplicity view seemingly impervious to evidence suggesting that single system interpretations can accommodate large tranches of the available data. In 2014, Smith et al. published a Psychological Science paper in which they claimed to have found one of the "strongest explicit-implicit dissociations yet seen in the categorization literature". In the spirit of pursuing theoretical development, we present empirical and modelling results that appear to categorically rule out Smith et al's key claim that deferring feedback has a deleterious effect on tasks that require 'Information-Integration', while leaving rule-based learning intact. We find, perhaps unsurprisingly, that delaying feedback causes a performance decrement in tasks which require holding information about more than one dimension in memory – for both information-integration AND rule-based tasks.

LIE-ALGEBRAIC APPROACH FOR THE LEAKY COMPETING ACCUMULATOR MODEL OF DECISION MAKING

Chi-Fai Lo, Kwok-Kwan Wong, & Ho-Yan Ip

The Chinese University of Hong Kong

In this talk we have proposed a new method, namely the Lie-algebraic approach, to tackle the Leaky Competing Accumulator (LCA) model of decision making with multiple alternatives and time-dependent model parameters. By exploiting the Lie symmetry of the Fokker-Planck equation (or the Backward Kolmogorov equation) associated with the model, we have succeeded to solve the equation and derive the joint probability density function (p.d.f.) and marginal p.d.f. for each alternative in closed form, subject to

the natural boundary condition. With this joint p.d.f. a likelihood function can be explicitly constructed and thus model-fitting procedures become feasible. We have generated some time series of the model by Monte-Carlo simulations, and applied the maximum-likelihood analysis to examine the efficiency and accuracy of the calibration of model parameters. The preliminary results are satisfactory and encouraging. So far as the authors know, currently the LCA model can be applied to cases of two or three alternatives only because of the lack of a closed-form joint p.d.f. for the case of N alternatives. Hence, the authors believe that the new approach will help shed light on further studies of the LCA model.

USING RESPONSE TIMES TO DISTINGUISH BETWEEN ATTRIBUTE-WISE AND ALTERNATE-WISE MODELS OF INTER-TEMPORAL CHOICE.

Ashley Luckman, Sebastian Gluth, & Jörg Rieskamp.

University of Basel

An important distinction in the inter-temporal choice literature is between models which rely on attribute-wise comparisons, and those which rely on alternate-wise comparisons. The former assume that decisions are made by comparing attribute levels across options, i.e. comparing the delays involved and the amounts involved, and weighting each of these dimensions. The later, such as discounted utility, instead assume the decision is made by calculating a holistic value for each option separately, then comparing these values. Recent research has found mixed support for attribute-wise models using process tracing measures, such as eye-tracking and mouseover designs. We suggest a new method using response time predictions from race models of evidence accumulation to distinguish between these two processes. Race models assume that two streams of evidence are being accumulated. In an alternate-wise race model we assume that each of the two accumulators is based on the value of one of the options under consideration, while in attribute-wise race models we assume each accumulator corresponds to one of the differences in attributes (i.e. delay or amount) which is being considered. These assumptions allow the two processes to make divergent response time predictions under simple manipulations. For instance, in a choice between an option yielding a smaller amount of money received sooner and an option yielding a larger amount received later, both models predict that preference for the smaller-sooner option will increase, as its amount increases. However, whereas an alternate-wise model will predict a decrease in response times, because the drift rate of the smaller-sooner option's accumulator will increase, an attribute-wise model will predict an increase in response times, as the drift rate for the amount difference will decrease. We present simulations confirming these predictions, while also considering behavior under single accumulator diffusion models and models with inhibition. Finally, we present preliminary data from an experiment testing these predictions against each other.

EVALUATING BUNDLES OF NUMBERS: ASSESSING THE TRADE-OFF BETWEEN MEMORY AND ONLINE UPDATING IN RETROSPECTIVE EVALUATION

Alice Mason [1], Mark Hurlstone [1], Geoff Ward [2], Gordon Brown [3], & Simon Farrell [1]

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Retrieving samples from memory is a critical tool for decision-making. We introduce incentive compatible methods to investigate the extent to which memory predicts evaluation. We present participants with a sequence of monetary values and ask them to complete both a free-recall task and a willingness to-pay (WTP) task. In order to assess whether there is indeed a trade-off between memory-based and moment-by-moment strategies in evaluation, we varied participants' expectation about the upcoming task (memory or evaluation). Using Bayesian mixed effects models, we predict WTP from both the items that were recalled and those that were presented and discuss how the position of a value in a sequence determines evaluation. Our findings indicate that when participants complete both memory and evaluation tasks there is a cost to memory accuracy, but memory is still an effective strategy for performing evaluation.

COMPETITIVE DECISION MAKING IN DUTCH AUCTIONS

Rachel Mullard, Marc Adam, & Ami Eidels

University of Newcastle

Dutch Auction is a descending price auction where an item begins at a set maximum price. This price is gradually lowered over a fixed amount of time until a bidder makes a bid, at which point that bidder is guaranteed the purchase, at the current price. Bidders must consider ('trade-off') certainty and price: bid early and you secure the commodity but pay a premium; bid later and the price is lower but you risk losing the bid to another. These properties make Dutch Auction a fascinating context for the study of competitive decision making. We conducted a set of experiments in which triplets of participants took part in a computerised Dutch Auction, playing against each other in various conditions. In another experiment, the same participants played individually against a computer opponent. I shall present our methods and preliminary results, and discuss necessary assumptions for the computer opponent.

EXTENSIONAL AND INTENSIONAL REASONING: A BAYESIAN PERSPECTIVE ON THE CONJUNCTION FALLACY

Daniel Navarro [1], Alison McCann [1], Alexandra Tingey [1],Nicole Baz [1],Michelle Keshwa [1], & Amy Perfors [2],

[1] University of New South Wales, [2] University of Melbourne

The conjunction fallacy is one of the most striking findings in the heuristics and biases literature, in which people rate a pair of propositions (e.g. Linda is a bank teller and a feminist) as more probable than one of the constituents (e.g. Linda is a bank teller). This is especially likely to occur when the description of Linda is more representative of one category (feminist) than the other. An extensive literature on the conjunction fallacy demonstrates that the effect is robust, but also sensitive to linguistic and pragmatic factors.

In this talk we present a Bayesian perspective on the problem. Extending earlier work on the pragmatics of conjunction effects, we argue that there is a degree of ambiguity to the inference problem that people need to solve. In an extensional reasoning scenario the problem is assumed to be to infer the properties that Linda has (in the world) and it cannot be the case that Linda is a feminist bank teller without also being a bank teller. In an intensional reasoning scenario the goal is to identify the meaning of the ideas being described or communicated. Intensional reasoning allows a conjunction to be more likely than a constituent: if my intent is to communicate "red circle" to you, and you infer "circle", a communication failure has occurred. In an effective communicative system, it is necessary to be able to specify (and to infer) the smaller of two nested sets, and conjunction 'fallacies' are necessarily permitted. Consequently, while probabilistic reasoning models based on extensional logic do not produce conjunction fallacies, it is entirely possible for an intensional reasoning system to do so.

Motivated by this theoretical perspective we present a series of experiments showing that people's behaviour in these tasks is highly sensitive to the distinction between extensional and intensional semantics. When a reasoning problem is framed in a way that emphasises the communicative and social aspect to the situation, strong conjunction effects appear. When the task is reframed to emphasise the extensional and non-social aspects, the fallacy is either attenuated or absent. This sensitivity occurs across many different social categories (e.g. feminist bank tellers) as well as reasoning about purely physical events (dice rolls). We argue that this sensitivity to framing occurs because people switch between solving different inference problems, both of which are sensible but are not equivalent to each other.

MATHEMATICAL SET THEORY FOR LATENT VARIABLE MODELLING IN PSYCHOLOGY RESEARCH

Trisha Nowland

Macquaire University

The latent variable model has described as psychology's most successful export to other fields; yet the problem of factor indeterminacy, known to Spearman since the earliest mathematical developments in latent variable modeling, remains unsolved. In this presentation I explore how the historical development of set theory, which emerged in mathematics at roughly the same time as the latent variable model in psychometrics may support us in drawing conclusions from our research on more sturdy ground than is otherwise truly possible with the latent variable model. Philosophical, methodological and direct applications will be shown to each

contribute to a unifying account for the mathematical, statistical and psychological aspects of psychometric practices which draw on latent variable modelling techniques.

AN INTERFERENCE MODEL OF VISUAL WORKING MEMORY: APPLICATIONS TO CHANGE DETECTION

Klaus Oberauer & Hsuan-Yu Lin

University of Zurich

Popular models of visual working memory assume that working memory is limited by a constant resource, which is conceived as either quantized (as in slot models) or infinitely divisible. These models share the assumption that the probability and quality of retrieval depends on the resource assigned to a representation in working memory. We will present an alternative model that incorporates the principles of general theories of memory: Retrieval is cue-based, and performance is limited by interference arising from several sources. Representations compete for retrieval according to the amount of activation each of them receives at retrieval. Activation arises from three sources: Persistent activation of representations of recently encoded items, activation from the retrieval cue, and background noise. One item is held in the focus of attention; this item is represented with higher precision, and suffers less interference from competing items and from noise. So far the model has been applied successfully to the continuous-reproduction paradigm. Here we will apply the model to recognition/change detection; testing how well it fares in comparison to competing models of visual working memory.

MODELING RESPONSE TIME DISTRIBUTIONS OF FREE RECALL INITIATION WITH RACE MODELS

Adam F. Osth [1] & Simon Farrell [2]

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Memory models have characterized retrieval in free recall as multialternative decision making. However, the majority of these applications have only been applied to mean response times (RTs) and not to complete RT distributions, which offer more constraint. We fit RT distributions of free recall initiation with both a racing diffusion model and the linear ballistic accumulator (LBA: Brown & Heathcote, 2008) model in a hierarchical Bayesian framework. We applied models with various psychological assumptions about how drift rates for each serial position are generated. Recency was either a power law or an exponential function. Primacy was treated either as a strength boost to the early list items so that both primacy and recency items jointly compete to be retrieved, or as a mixture model where on some proportion of trials, the start context is reinstated and primacy items race with little competition from recency items. Results from a large number of datasets strongly favor the start context reinstatement model with an exponential recency function.

DECISION-MAKING IN BLACK SWAN ENVIRONMENTS

Amy Perfors & Nicholas van Dam

University of Melbourne

In the real world we are often faced with decisions in which the possible outcomes are extremely good or bad but the probability of that outcome is extremely low: winning the lottery or being struck by lightning are prototypical examples. Should you buy a lottery ticket? Should you climb to the top of a hill in a rainstorm? These kind of situations are known colloquially as 'Black Swan' scenarios and create a particularly hard decision problem. However, despite decades of research, decision theory is relatively silent about how people do (or should) reason about them: most of the standard tasks involve probabilities ranging between 10% to 90 % and the outcomes are a manageable fraction of existing savings. In this study we evaluate how people reason in situations when one or both options involve extremely low probabilities (from 0.1 to 1.5 %) of very bad outcomes (losing all of the points accumulated so far). We explore how decisions change as a function of the number of points available and the number of 'black swan' options available. In addition, we evaluate if people's approach varies based on whether they are making a single bet or planning a strategy of bets over multiple games. Finally, we present some exploratory research investigating whether individual differences in anxiety and tolerance of uncertainty predict differences in behaviour in black swan situations.

MODELING NUMERACY DECISIONS ON A CONTINUOUS SCALE

Roger Ratcliff

The Ohio State University

I present a model for decision making for stimuli and responses in continuous space. The model is applied to three numeracy tasks: in one, a two-digit number is presented and the participant has to move their finger to a matching location on a number line, in the second, an array of dots is presented and the participant is to move their finger to a matching location on an arc, and in the third, an array of dots is presented and the participant has to speak the number. The model is composed of diffusion processes on lines and planes in which evidence from a stimulus (distributed across space) drives the noisy decision process which accumulates evidence over time to a criterion at which point a response is initiated. Noise is represented as a continuous Gaussian process. The model produces fits for the full distributions of response times and choice probabilities across the stimulus space and

SEMANTIC CONTRAST EFFECTS: A HOLOGRAPHIC INTERFACE LINKING EPISODIC AND SEMANTIC MEMORY

Kevin D. Shabahang [1], D. J. K. Mewhort [2], & Donald R. J. Franklin [2]

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Just as there are contrast effects in perception, some memories tend to stand out in memory, with a classic example being Release from Proactive Interference (RPI). We implemented an interface between semantic and episodic memory as a hologram populated by subjects' lexicon (a dynamic distributed store containing 10,000 words and their 99,990,000 pair-wise associations). Studying a word reinforces it in the hologram and alters the strength of all other words in proportion to their similarity to the studied word. When studying a list of words, subjects create inter-item associations, as a full or partial chain. Recall is prompted by a start instruction or by the word just recalled. Momentary strength of words is the item's simple strength plus a value contributed from a probe item's association strength with the item. Whereas earlier implementations of the hologram used Gaussian vectors, we added semantics to the model by using word vectors constructed with the BEAGLE algorithm. We collected stimuli used in a variety of RPI tasks and were able to capture performance at the word level. Our model also captured the classic Von Restroff isolation effect in addition to other non-semantic effects such as the Hebb repeated list effect.

HOW DO PEOPLE THINK ABOUT THE PROBABILITY OF HUMAN EXTINCTION?

Yiyun Shou & Michael Smithson

The Australian National University

There is surprisingly little research or theory regarding how people think about probabilities of events with extreme consequences and unknown (but arguably very small) probabilities. Eliciting and modeling probability judgements for such events raise both technical and conceptual issues regarding measurement and statistics. In the present study, participants were asked to estimate the probability of human extinction where the cause of extinction was not specified, versus where a specific existential threat was made salient. We report methods and four main findings. First, people's catch-alls for extreme events were shaped by specific examples of such events presented to them. Second, the distributions of extinction probability judgments display a consistent mixture of "deniers" and "pessimists". Third, these probability estimates are associated with general optimism and anxiety. Finally, extinction probability judgments show a strong conjunction fallacy whereby the probability of extinction due to a specific threat is judged to be higher than the probability of extinction generally

MODELLING SPEEDED MULTIELEMENT DECISION MAKING AS DIFFUSION IN A HYPERSPHERE

Philip L. Smith [1], & Elaine A. Corbett [1,2]

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We generalize the circular 2D diffusion model of Smith (2016) to provide a new model of speeded decision-making in multielement visual displays. We model decision making in tasks with multielement displays as evidence accumulation by a vector-valued diffusion process in a hypersphere, whose radius represents the decision criterion for the task. We show that the methods used to derive response time and accuracy predictions for the 2D model can be applied, with only minor changes, to predict performance in higher dimensional spaces as well. We apply the model to the double-target deficit paradigm of Duncan (1980) in which participants judge whether briefly-presented four-element displays contain one or two digit targets among letter distractors. A 4D version of the hyperspherical diffusion model correctly predicted distributions of response times and response accuracy as a function of task difficulty in single-target and double-target versions of the task. The estimated drift rate parameters from the model imply that the mental representation of the decision alternatives, which we term the 'decision template' for the task, encodes both configural and local stimulus properties. Along with its application to multielement decision making, the model has the potential to characterize the speed and accuracy of multiattribute decisions in studies of cognitive categorization, visual attention, and other areas.

DISAPPEARING DISSOCIATIONS IN EXPERIMENTAL PSYCHOLOGY: USING STATE-TRACE ANALYSIS TO TEST FOR MULTIPLE PROCESSES

Rachel G. Stephens [1], Dora Matzke [2], & Brett K. Hayes [1]

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Dissociations have served as a key source of evidence for theory development in experimental psychology. Claims about the existence of multiple distinct psychological processes or systems are often based on demonstrations that manipulations such as working memory load, mood or instructions have differential effects on task performance. For example, a manipulation may have a larger effect on performance in one task, and a smaller or no detectable effect in another, as identified by statistical models like analysis of variance. However, inferring distinct underlying processes based on such interaction effects can be misleading. Such an inference depends on the strong – and probably often false – assumption that underlying psychological variables map linearly onto the observable dependent variables. Fortunately, state-trace analysis offers an alternative approach to test for dissociations, avoiding the linearity assumption. We apply state-trace analysis to databases of studies from category learning and from reasoning that have been cited as evidence for qualitatively distinct processes. We show that many of the dissociations thought to reflect the operation of distinct processes disappear against the stricter criteria of state-trace analysis. We argue that it is important for experiments to be designed with state-trace analysis in mind, and for statistical tools to be developed so that the approach can be readily applied. This will lead to a more rigorous foundation for theoretical claims about distinct underlying psychological mechanisms.

MODELLING PROSPECTIVE MEMORY IN SIMULATED MARITIME SURVEILLANCE: COGNITIVE CONTROL AND COMPETITION FOR CAPACITY

Luke Strickland [1], David Elliott [1], Michael David Wilson [2], Shayne Loft [2], & Andrew Heathcote [1]

[1] University of Tasmania, [2] University Western Australia

Event-Based Prospective Memory (EVPM) requires remembering to perform intended deferred actions when particular stimuli or events are encountered in the future. In the laboratory, the EVPM paradigm engages participants in an ongoing task, with a requirement to make an alternative response to occasionally presented PM target stimuli. These paradigms typically present a simple, static stimulus on each trial, with no time pressure to respond. We recently put forward the 'Prospective Memory Decision Control' (PMDC) model (Strickland et al., under review), which uses the linear ballistic accumulator (Brown & Heathcote, 2008) to measure possible effects of capacity sharing between PM and ongoing tasks, proactive control over thresholds and reactive control on PM trials. We have already fitted PMDC to basic paradigms, and found that EVPM leads to tonic proactive control over ongoing task decision thresholds, as well as reactive inhibition of ongoing task processing on PM trials. We have not found capacity sharing between PM and ongoing tasks. In the current study, we fitted PMDC to an applied task: simulated maritime surveillance. The task required classifying ships travelling along a display in the presence of significant time pressure and perceptual noise. The EVPM intention required an alternative response to ships with certain target features. Consistent

with basic PM paradigms, we found evidence of reactive inhibition of ongoing task processing on PM trials. However, in contrast to basic paradigms, we found capacity sharing between PM monitoring and the ongoing task, rather than proactive control over ongoing task thresholds. Capacity sharing likely arose in this task due to the increased decision complexity posed by maritime surveillance. Proactive control over ongoing task thresholds was likely not invoked due to time pressure. Our findings exemplify how fitting a quantitative PM architecture derived from basic tasks can provide valuable insights into the processes that underlie PM in applied contexts.

ALTERNATIVE STATISTICAL FRAMEWORKS FOR COMMUNICATING THE STRENGTH OF FORENSIC EVIDENCE IN COURT

Matthew B. Thompson [1], Rachel A. Searston [2], Gianni Ribeiro [3], & Jason M. Tangen [3]

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What forensic experts should say, or should be allowed to say, about the results of forensic comparisons has been a contentious issue in the legal and forensic science communities. It is common practice for forensic pattern identification experts, such as in fingerprints and ballistics, to testify that two impressions originate from the same source to the exclusion of all others in the absence of statistical information. Experts have even claimed 100% accuracy, or that the rates of error are so improbable that they need not be considered. An alternative framework is necessary. When, if ever, should experts claim to have determined that two items share a common source, and should they present error rates, or the probability of coincidental matches? Here we explore options for the statistical representation and communication of forensic evidence in court. We argue that we have reached a turning point, where Australian state and federal police jurisdictions are seeking alternative frameworks for presenting evidence in court, but where well-considered proposals are scarce. We propose an avenue by which the mathematical psychology community might lend their own expertise to the problem.

THE ROLE OF PREDICTION ERROR AND CONFIDENCE IN SEQUENTIAL DECISIONS

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The mechanistic role of subjective confidence has been well characterised in the domains of decision making and memory, but substantially less research has investigated how confidence influences the learning process. A representation of confidence may be useful when learning in probabilistic environments, where outcomes or feedback are inherently uncertain and an agent has to cope with some level of error and, potentially, sudden changes in the environment (change points). Previous work suggests that confidence ratings reflect the predicted likelihood of change points and the prediction error in sequential decisions. As such, representations of confidence may be used to track task variables, such as change points, prediction error, and outcome history. However, these have typically been conflated in previous work. Thus, we sought to unpack the contributions of these in a systematic manner. This talk will discuss preliminary findings from four empirical studies where observers learned about outcomes sampled from a Gaussian distribution, and made sequential predictions and confidence estimates in their choices. The implications of these results on the mechanistic role of confidence and prediction error in learning and decision making will be discussed. We show that observers behaviour can be well characterised by a simple additive learning model and that their behaviour is remarkably consistent, over both stationary and changing environments, and changes in paradigm.

CREDIBLE CONFIDENCE: A PRAGMATIC VIEW ON THE FREQUENTIST VS BAYESIAN DEBATE

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Throughout the last few decades, a heated debate has been going on between frequentists and Bayesians. There are substantial theoretical and philosophical differences between both methods. Recently, a number of papers have come out claiming that for pragmatic purposes, both philosophies may not be all that different. In

this presentation, I will discuss work that examines numerical correspondence between frequentist confidence intervals and Bayesian credible intervals based on non-informative priors. I show that numerically the differences between confidence intervals and credible intervals are very often negligible. I'll conclude with my take on the consequences of this for the frequentist-Bayesian debate from a practical viewpoint.

THE IMPACT OF GOAL AND COGNITIVE LOAD ON DECISIONS FROM EXPERIENCE.

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In the past decades, numerous studies have investigated how people adapt their decision making processes in response to cognitive demands. However, those studies have almost exclusively considered paradigms in which all relevant information is presented simultaneously and conveniently to participants (i.e. Decisions from Description), and therefore, very little is known about how people adjust their decision processes due to increases in cognitive demands in Decisions from Experience. In order to address this issue, we suggest an adaptive mechanism that is guided by an optimal performance-effort trade-off and by the task's goal. Previous studies have shown that different tasks' goals in experience based decisions reveal evidence for different underlying processes. Specifically, it has been argued that extreme values are often overweighted in preferential choices (e.g. Tsetsos et..al, 2012), but underweighted in perceptual choices (e.g. Vandormael, et. al., 2017). In order to investigate this discrepancy and the effect of cognitive load on these mechanisms, we applied a novel paradigm in two experiments, in which the tasks' goal was manipulated within subjects. In both versions participants were presented with an array of numbers. In the 'Preferential' task they had to choose between a fixed reward and a gamble with an equal chance of winning any of one of the numbers in the array. In the 'Perceptual' task the goal was to decide whether the fixed value was higher than the average of the numbers in the array. Cognitive load was manipulated between subjects by applying different time constraints for the array display, and the variance of the arrays was manipulated within subjects in order to test the impact of extreme values. Findings show that in the 'Preferential' task under high cognitive load settings, subjects tended to pick the array more often when it had high variance (i.e. risk seeking), while variance had no effect in the 'perceptual' task nor under moderate cognitive load settings in either task. These findings are consistent with the idea that extreme values influence risk preference especially when cognitive resources are scarce.

AN EGOCENTRIC BIAS IS IMPORTANT TO ADAPTIVE SOCIAL LEARNING

Bradley Walker & Nicholas Fay

University of Western Australia

Social learning is crucial to culture and cumulative cultural evolution. Researchers have focused on demonstrating copying behaviour and the cognitive biases that guide it. However, people's dominant response is to not copy the behaviour of others. Using agent-based modeling, the present paper demonstrates that non-copying is important to adaptive social learning. We simulated populations of agents that varied in population size and structure. Each agent was allocated a cultural variant from a pool of different-quality variants. At each time step agents could copy the variant of another agent. Copying behaviour was determined by agents' levels of content bias (preference for high-quality variants) and coordination bias, which varied from an egocentric bias that promoted non-copying to an alignment bias that promoted copying. Egocentric bias maintained a larger pool of cultural variants (compared to an alignment bias), and, consistent with Darwinian selection dynamics, this enhanced the environment from which a content bias could select the optimal cultural variant. This improved population-level adaptation, especially in small populations and large populations organized into small neighborhoods.

DECOMPOSING DIFFERENT SOURCES OF INTERFERENCE IN RECOGNITION MEMORY DEVELOPMENT - A COMPUTATIONAL MODELING APPROACH

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Previous studies have pointed out that there are different sources of interference (noise) that affect recognition memory performance. For example, it can be difficult to recognize whether I had eggs for breakfast today if there were other items on today's breakfast menu (these difficulties stem from item-related noise: item-noise), if I had eggs for breakfast in the past (i.e., these difficulties stem from context-related noise: context-noise), or if other items and other contexts are stored in memory (i.e., background-noise). Although often overlooked, background-noise has been shown to make the most substantial contribution to memory performance in adults. On the other hand, there has not been a systematic examination on how different sources of interference change across development. Therefore, in the current study, we examined how different sources of interference contribute to recognition memory across development by utilizing a computational model. The model is embedded in a hierarchical Bayesian framework and is capable of parameterizing different sources of interference in a given task. Preliminary data testing 4-, and 7-year-olds, and adults with a source recognition task showed that context noise was the major factor decreasing throughout development, whereas the change in the contribution of item noise and background noise was minimal. The results imply that, at least from the ages of 4 to adulthood, the major contribution of recognition memory development stems from context noise.

DECISION-MAKING IN SOURCE MEMORY: RE-EVALUATING THE THRESHOLDED NATURE OF SOURCE MEMORY RETRIEVAL

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Source memory is memory for the context in which items were previously encountered. Past research has largely aimed to establish whether source memory retrieval is better characterised as a threshold or continuous process in two-alternative forced choice tasks, using ROC functions. Recently, Harlow and Donaldson (2013) introduced a continuous report paradigm to study performance in source memory tasks, and found evidence of a retrieval threshold underlying response accuracy. However, this account does not consider response time (RT) distributions. To investigate the role of decision-making in source memory retrieval, this study used the Smith (2016) circular diffusion model to introduce diffusion analogues of the threshold and continuous models of source memory retrieval in a replication of the Harlow and Donaldson (2013) task. Model selection done using the BIC found support for a circular diffusion model where memory discretely fails, as both RT and response accuracy data suggested that there were two components in performance.