Symposium: Advances in Thinking, Problem Solving and Creativity: A Festschrift for Kenneth J. Gilhooly

Organiser: Linden Ball

Rationale: Since the 1970s Ken Gilhooly has made major and lasting contributions to the fields of thinking, problem solving and creativity through his research on topics such as the role of working memory and individual differences in reasoning and planning, the processes involved in insight and non-insight problem solving, the strategies underpinning creative idea production and the characteristics of real-world domain expertise. This Festschrift will present a survey of emerging issues in the psychology of thinking, problem solving and creativity in tribute to Ken’s own substantial research contributions in these areas. The symposium speakers represent a subset of the many colleagues and collaborators who Ken has influenced over the years and who are all currently working at the cutting-edge of thinking, problem solving and creativity research. Within the proposed symposium these contributors will report their latest findings and conceptual advances in relation to topics such as planning and skilled problem solving, mental imagery and creative thinking, insight problem solving, thought suppression and incubation effects, and individual differences in problem solving and learning. The symposium will offer an integrative perspective on foundational issues as well as on new developments in thinking, problem solving and creativity research. The event will be rounded off by Ken himself, who will draw on his own recent work to present a reflective review of the current state-of-the-art in research and theorising in the area of insight problem solving.

Insight into Problem Solving?

Symposium Keynote speaker: Kenneth Gilhooly (University of Hertfordshire, Hatfield), k.j.gilhooly@herts.ac.uk

Have we advanced much in understanding problem solving since Poincaré, Wallas and Duncker? This “Trinity” still loom large both in popular science accounts of the field and in introductory textbooks. While we now have a good understanding of problem solving in small-scale, well-defined problems, as search within a problem space, and can relate solving processes to cognitive resources, such as working memory, the areas of insight and creativity still strike many as mysterious. Insight tasks require a change in how they are represented (re-structuring) in contrast to tasks that can be solved by search within a problem space. Theories involving representational change and progress monitoring offer explanations which remove some of the mystery of insight. Creative problem solving in which novel solutions are required does seem to involve unconscious processes (as do many areas of psychology). Studies of “incubation” effects are beginning to remove some of the mystery but clear models are still lacking. Recent studies based on priming and embodied cognition have produced eye-catching results which although suggestive are lacking clear process explanations. Finally, the possible value of brain imaging in problem solving research will be discussed – with some caution urged in view of: (1) the differential effects of being supine (as in a scanner) as against upright on problem solving; and (2) the argument that cognitive theory illuminates imaging data rather than vice versa.

Incubation and Suppression Processes in Problem Solving

George Georgiou (University of Hertfordshire, Hatfield), g.j.georgiou@herts.ac.uk

Experimental research has shown that setting a problem aside for a period of time can facilitate solutions when the problem is resumed. This break away from a problem is referred to as an ‘incubation’ period. A number of possible mechanisms have been proposed to account for this phenomenon, including: intermittent conscious work; selective forgetting; attention withdrawal; relief from fatigue; and unconscious work. However, a crucial aspect of the incubation procedure is for the problem solver not to think about the problem during the break, by possibly suppressing thoughts of the problem whilst engaged in interpolated activities. Attempts to suppress thoughts have been shown to result in a subsequent increase in the accessibility and frequency of the suppressed thought, known as a rebound effect. The research reported here explores the extent to which the facilitating effects of an incubation period may be due to suppression effects, which paradoxically activate the avoided thoughts, thus aiding problem solving. The results of studies using delayed and immediate paradigms will be discussed.

Interactivity and Individual Differences in Mental Arithmetic
This paper reports data from a mental arithmetic task where participants were invited to complete short and long additions in two different contexts. In a first, they solved the additions without using their hands or artefacts and in a second the same problems were presented as a set of manipulable tokens. In a static context, working memory resources may be stretched, particularly by the long additions. In contrast, the cognitive system created by the coupling of internal and external resources in an interactive context may enhance arithmetic performance. The addition problems were interpolated among a series of other tasks that measured numeracy and arithmetic skills, working memory capacity, visuo-spatial processing speed and attention switching. Mental arithmetic performance was measured in terms of accuracy, latency and efficiency – indexed as the ratio of accuracy over time invested in completing the problems. A significant interaction between condition and problem type was observed: Performance was slightly better in the static condition for the short sums but declined substantially relative to performance in the interactive condition for the long sums. Individual differences in terms of working memory capacity and arithmetic skills explained a fifth of the variance in performance in the static condition, while arithmetic skills, working memory capacity and attention switching skills explained 45% of the performance variance in the interactive condition. Implications for process models of mental arithmetic in static and interactive contexts of reasoning are discussed.

Process Dissociations in Problem Solving with Verbal and Visual Insight Tasks

Linden Ball (Lancaster University), l.ball@lancaster.ac.uk

Two accounts of insight problem solving dominate the literature: the ‘special-process theory’, which attributes insight to implicit processes of spreading activation, and the ‘progress monitoring theory’, which proposes that both insight and non-insight problems draw on the same analytic planning mechanisms. We report two experiments that manipulated concurrent tasks demands during insight problem solving in terms requirements to engage in either thinking aloud (TA) or articulatory suppression (AS). Experiment 1 used verbal insight problems whereas Experiment 2 used visual insight problems. Experiment 1 revealed that insight into verbal problems was hindered by AS but facilitated by TA, whereas Experiment 2 showed the exact opposite pattern, with insight into visual problems being impared by TA and enhanced by AS. Explanations of these process dissociations in insight problem solving will be examined, including the possibility that a rapprochement between the special process and progress monitoring accounts may be necessary to capture the full pattern of data across both kinds of insight tasks.

Planning: The Force Behind Skilled Problem Solving, Insight, and Creativity

Tom Ormerod (Lancaster University), t.ormerod@lancaster.ac.uk

The contribution made by Ken Gilhooly in bringing to light important contributions made by working memory and individual differences to a full understanding of human reasoning, problem-solving, skill and expertise, cannot be underestimated. Yet, working memory and individual differences are often ignored. This is problematic, because working memory is fundamental to planning, and planning, it will be argued here, is fundamental to most successful problem-solving, and its absence can often explain much failure to solve. Here, the role of planning will be assessed across insight and creative problem-solving domains, from puzzles to real-world design tasks. It will be argued that planning, while essentially a process that guides conscious search, is both constrained and encouraged by individual differences among solvers and differences in working memory requirements generated by the problem to be solved.

Mental Imagery and Creative Thinking

David Pearson (University of Aberdeen), d.g.pearson@abdn.ac.uk

Mental imagery has a long history of association with imagination and creative thought. Experimental studies will be discussed which have examined in particular the process of ‘mental synthesis’, in which visual imagery is used to manipulate and combine separate components into new configurations. The experience of mental synthesis has been linked to successful performance across a wide range of different creative tasks, including the visualisation and development of scientific models, the conceptual stage of architectural design, and many aspects of general everyday problem-solving. Presented data from experimental studies will explore the contribution made by working memory, expertise, and mood to successful synthesis performance.
**Adult Age Effects on Belief Reasoning**

Louise Phillips (University of Aberdeen), louise.phillips@abdn.ac.uk

Older adults often perform poorly on Theory of Mind (ToM) tests that require understanding of others’ beliefs and intentions. There are opposing theories about the course and specificity of age changes in belief reasoning across the adult lifespan. In a recent study, we found that there are non-linear effects of aging on belief reasoning, with specific impairments in the ability to process false beliefs in older adults aged 65-88. Difficulties in updating information in working memory and the ability to decode social cues partially mediated the age differences in false belief reasoning. These results indicate that age differences in decoding social cues and updating information in memory may be important influences on the specific problems encountered when reasoning about false beliefs in old age.

**Symposium: Analogical Reasoning**

**Organiser:** Robert G. Morrison

**Executive Function and Knowledge in Analogical Reasoning: An Integrated Developmental, Neurocognitive and Computational Approach**

**Symposium keynote speaker:** Robert G. Morrison (Loyola University Chicago), rmorrison@luc.edu

Executive functions, such as inhibitory control, are critical to our ability to process analogies, and may as well be critical for learning the relational knowledge necessary for analogical reasoning. I will highlight developmental, neuropsychological, neuroimaging, and computational findings showing the importance of inhibitory control during relational learning and reasoning, and suggest the importance of moving cognitive neuroscience approaches to analogy beyond just reasoning to include how we learn relational knowledge necessary for reasoning.

**From your eyes only: Tracking children's and adults' strategies in analogy making**

Jean-Pierre Thibaut & Robert French (Université de Bourgogne), Jean-Pierre.Thibaut@u-bourgogne.fr

We will present eye-tracking data in which we compare children and adults in analogy making tasks. These data suggest that children do not allocate the same amount of time to the different stimuli that compose the task as the adults or that correct trials are not organized in the same way as error trials. We will present data that capitalize on these results showing that the way the stimuli are introduced in the task influence performance.

**Development of relational reasoning during adolescence**

Iroise Dumontheil (University College London), i.dumontheil@ucl.ac.uk

Relational integration refers to the ability to jointly consider several structured mental representations, or relations. As such, it is involved in analogical reasoning. I will present data on the development of relational reasoning performance from late childhood to adulthood, and on the neural correlates of relational reasoning during adolescence and adulthood.

**Growing analogy from recycled parts**

Denis Mareschal (Birkbeck College, University of London), ubjta99@mail.bbk.ac.uk

In this talk I will discuss the need for models of complex cognition to be developmentally tractable. This will be illustrated using a connectionism model of early analogical reasoning. The strengths and limitations of this approach will be discussed.

**Toward a neurocomputational model of relational reasoning**

Keith Holyoak (University of California, Los Angeles), Holyoak@lifesci.ucla.edu

I will argue that recent developments in cognitive neuroscience suggest possible mechanisms by which a computational model of relational reasoning might be realized in the brain. Relational reasoning may involve (1)
use of neural synchrony and other temporal information to bind information coded in different brain areas, (2) neurons in prefrontal cortex capable of rapid learning, (3) cross-frequency coupling as a modulator of learning, and (4) different types of inhibitory connections to control sequential processing of relational information in working memory.

**Analogue processes support learning relational categories**

Dedre Gentner (Northwestern University), gentner@northwestern.edu

Several lines of evidence converge to suggest an important role for common relational structure in category learning and use. The role of common relational structure in categories is most clearly seen in relational categories such as bisector and carnivore. Because such categories lack perceptual support, they pose a challenge to learners. I’ll describe studies that indicate that analogical comparison is a major contributor to learning relational categories, in both children and adults. Further, this work suggests that the use of consistent relational language amplifies the effects of analogical comparison.

**Learning structured representations from unstructured inputs**

Leonidas A Doumas (University of Hawaii), leonidas@hawaii.edu

Relational thinking requires explicitly relational representations. To be explicitly relational, a representation must specify relations (or relational roles) independently of their arguments and bind them to their arguments dynamically. Despite the centrality of relational thinking in human cognition, a clear description of how children and adults acquire the kinds of representations that can support relational thinking has been elusive. I will present a theory, instantiated in a computer model called DORA, of how structured explicitly relational representations are learned from unstructured examples. The resulting model provides a powerful and comprehensive account of many aspects of cognitive development and adult cognition.

**Why we’re (not) so smart with numbers**

John E. Opfer, Vyacheslav Y. Nikitin, & Frank J. Kanayet (Ohio State University), opfer.7@osu.edu

The human capacity for quantitative thinking expands profoundly during the first decade of life. What accounts for these changes? And why do adults remain innumerate across so many contexts? In this talk, I will present evidence that symbolic coding of quantities plays a key role in determining when we are (and are not) proficient at processing quantitative relations.

**Analogy and education: Encouraging analogy through helping learns to manage process demands**

Lindsey Richland (University of Chicago), lrichland@uchicago.edu

Analogy is a powerful tool for generalization and transfer, though experimental participants often fail to notice or use relevant analogs. This talk explores the relationship between the cognitive demands of learning and problem solving by analogy and instructional practices that can mitigate the likelihood that those demands overwhelm learners. Specifically, working memory and inhibitory control demands are high when learners solve problems or reason analogically about novel stimuli, but these can be reduced by strategic yet practicable use of visual information (the chalkboard, gesture, visual representations).

**Making culture: Roles for analogy**

Jeffrey Loewenstein (University of Illinois, Urbana-Champaign), jloew@illinois.edu

Some knowledge is remembered, gets talked about, becomes selected, generates new products, guides companies, shapes institutions, and otherwise makes culture. Analogy plays important roles in many of these processes. Data on cultural narratives show advantages of analogy for a wide range of outcomes, including social selection, engagement and attitudes.

**Symposium: Argumentation**

Organiser: Ulrike Hahn
Rationale: Argument is central to our everyday thought and much of the reasoning we perform takes place in the service of argument, broadly construed, that is, in the service of attempts to convince ourselves or others of a particular conclusion. The symposium brings together recent research on argumentation, focusing primarily on argument quality and the extent to which people are sensitive to argument quality in both argument evaluation and generation.

Looking for arguments: The argumentative function of reasoning

Symposium keynote speaker: Hugo Mercier (University of Neuchâtel), hmercier2004@yahoo.fr

Since it allows finding and evaluating arguments, reasoning is essential to argumentation. Dan Sperber and I have suggested that in fact argumentation is the main function of reasoning: reasoning would have evolved so we can produce arguments to convince others and evaluate arguments so as to be convinced when appropriate. Here I will support this hypothesis by showing that reasoning is designed and performs in the way expected of an argumentative device. When reasoning produces arguments it displays a confirmation bias and it starts out with lax criteria of argument quality, both traits that make sense in a dialogic context. While these traits of reasoning are detrimental for the lone reasoner, they allow for good performance in argumentative settings, as demonstrated by results in the psychology of reasoning, social psychology, developmental psychology, education and political science.

Is high-quality evidence more persuasive than low-quality evidence in the presence of counterevidence? A cross-cultural study

Jos Hornikx (Radboud University Nijmegen), j.hornikx@let.ru.nl

Different types of data (evidence) can be used to support claims, such as anecdotal and statistical evidence. Hornikx and Hoeken (2007) demonstrated that high-quality evidence in support of claims is more persuasive than low-quality evidence for Dutch participants, but not for French participants. The French participants may not have been centrally processing the claims and evidence, which is necessary to distinguish between strong and weak evidence (cf. Petty & Cacioppo, 1986). Heckler and Childers (1992) demonstrated that people process information more carefully when the information contains incongruent elements. Therefore, an experiment was conducted in which participants received incongruent evidence: evidence supporting the claim, and counterevidence. The central question was whether normatively strong evidence was more persuasive than normatively weak evidence for French participants under conditions of incongruent evidence. Dutch and French students (N = 544) indicated how probable they found claims followed by statistical evidence and normatively strong/weak expert evidence; each piece of evidence served in some cases as evidence, and in other cases as counterevidence. Analyses showed that normatively strong expert evidence was more persuasive than normatively weak expert evidence for Dutch participants, but that the two types of evidence were equally persuasive for French participants. This means that, even in a condition that promotes central processing, French participants were found to be insensitive to evidence quality.

Arguing about probability: Lay people’s criteria to assess argument quality

Hans Hoeken, Ester Sorm, & Peter Jan Schellens (Radboud University Nijmegen), h.hoeken@let.ru.nl

Argument quality can have strong and lasting persuasive effects. This raises the question of what criteria people use to distinguish high quality from low quality arguments. In an experiment, 196 participants without any training in argument theory rated their acceptance of 30 probability claims supported by either an argument from authority, from cause to effect, or from example. Arguments were systematically manipulated to violate nine specific criteria. For seven criteria, violation decreased acceptance of the claim supported. These findings provide insights into people’s argumentative competence and enable a more precise description of the persuasion process. Finally, the results have implications for the use of argument quality as a methodological tool in persuasion research.

Drawing inferences from absent evidence: A Bayesian network approach

Adam J. L. Harris, David A. Lagnado, & Victoria Cullen (University College London), adam.harris@ucl.ac.uk
The Bayesian formalisation of the argument from ignorance (Hahn & Oaksford, 2007) demonstrated that inferences from missing evidence can be valid for a range of probabilistic parameters. We go beyond this pioneering research and investigate the causal networks underlying these parameters. The research is situated within a legal setting, and concerns the absence of eyewitness testimony. We show that the normatively appropriate inference from absent evidence differs according to its likely causes, and report the results of a behavioural study demonstrating that the juror-eligible participants in our study are sensitive to this. Thus, explanations for the absence of key trial evidence are critical pieces of information for jurors. The effect of this information, both normatively and descriptively, is well understood within a Bayesian network approach to evidential reasoning.

**Utility templates for consequential argumentation**

Jean-François Bonnefon, Matthew Haigh & Andrew Stewart (Universite de Toulouse II), bonnefon@univ-tlse2.fr

People use conditional sentences when describing actions, their preconditions, and their consequences. Oftentimes, these actions and consequences matter, in the sense that they have value or utility to various agents: they then constitute consequential arguments. For example: If she praises him, he will support her (therefore, she will praise him); if you leave me, I will be crushed (therefore, don't leave me). Many arrangements of agents, targets and values are possible beyond these two examples, but our contention is that some of these arrangements have the special status of utility templates that guide and constrain interpretation. We argue that whenever it is possible, people will interpret or re-interpret a conditional sentence in order to make it coincide with one of their utility templates. We identify four potential templates through a sentence completion survey, and demonstrate their properties in two experimental studies.

**Symposium: Bayesian Approaches**

**Organiser: Nick Chater, Peter Dayan and Adam Sanborn**

**A taxonomy of inductive problems**

**Symposium keynote speaker:** Charles Kemp (Carnegie Mellon University, Pittsburgh), ckemp@cmu.edu

Inductive inferences about objects, features, and relations have been studied for many years but there are few attempts to chart the full range of inductive problems that humans are able to solve. I will present a taxonomy of inductive problems that helps to clarify the relationships between familiar inductive problems such as generalization, categorization, and identification, and that introduces new inductive problems for psychological investigation. I will discuss several computational accounts of inductive reasoning and will argue that the Bayesian approach provides a promising way to explain how people solve all of the problems in the taxonomy. To support this claim, I will present Bayesian models that help to explain how people simultaneously generalize across objects and features, how people identify categories and features, and how people imagine novel categories and category exemplars.

**Learning time-varying categories: The role of absolute and relative judgment**

Dan Navarro (University of Adelaide), Jeff Beck, Ingmar Kanitscheider and Alex Pouget navarro@adelaide.edu.au

Most theories of category learning assume that the structure of categories is static, but many categories change over time. To the extent that this problem has been studied previously, it has been assumed that memory based strategies can account for human sensitivity to change over time (i.e, weighting recent observations more heavily). We present the results of a category learning experiment involving categories that change over time in a systematic fashion, and find evidence that a simple recency weighting strategy is not sufficient to explain human performance, and that people can learn to anticipate changes before they occur. Additionally, we introduce a probabilistic modelling framework able to explore the representational origins of this effect, in terms of the extent
to which people rely on both absolute stimulus magnitudes and relative stimulus magnitudes when forming a category representation.

**A normative theory of Weber’s law**

Jeff Beck, Ingmar Kanitscheider and Alex Pouget (Universities of Geneva and Rochester), alex.pouget@gmail.com

A diverse array of studies have shown that discrimination thresholds for sensory variables are often proportional to the stimulus magnitude, a phenomenon known as Weber’s law. Typical explanations invoke a finely tuned combination of a nonlinear neural representation and noise in neural responses. For instance, one such explanation assumes that neural responses are sensitive to the logarithm of the sensory variable (or the ratio of sensory variables) corrupted by a noise with fixed variance. Here we propose a purely computational explanation for Weber’s Law which does not require an appeal to internal representation or noise. Rather, we suggest that it arises purely from the statistical nature of the problem faced by the brain. For example, imagine having to estimate the number of items in a scene. If we treat the items as blobs of activity in feature maps, the total sum of the activity provides a numerosity estimate. If the variability within the feature map is independent, the variance of the estimate scales with the mean numerosity, in contrast to Webers’ law which predicts that the variance scales with the square of the mean. However, the independence assumption is problematic because activity in such maps is likely to be scaled by global parameters which vary from trial to trial such as the overall luminosity in the image or the level of attention. It is easy to show that the presence of such global scaling parameters correlates neural activity in such a way that the variance of the total sum scales with the square of the mean, thus yielding Weber’s law. This simple intuition can be generalized to more complex models, by considering inference in scale mixture models such as the Gaussian Scale or Gamma-Poisson mixture models which precisely replicate Weber’s Law when the variance of the scale parameter is large enough.

**Reconciling intuitive physics and Newtonian mechanics for colliding objects**

Adam Sanborn, Vikash Mansinghka and Thomas Griffiths (University of Warwick, Coventry), A.N.Sanborn@warwick.ac.uk

People have strong intuitions about the influence objects exert upon one another when they collide. Because people's judgments appear to deviate from Newtonian mechanics, psychologists have suggested that people depend on a variety of task-specific heuristics. This leaves open the question of how these heuristics could be chosen, and how to integrate them into a unified model that can explain human judgments across a wide range of physical reasoning tasks. We propose an alternate framework, where people's judgments are based on optimal statistical inference over a Newtonian physical model that incorporates sensory noise and intrinsic uncertainty about the physical properties of the objects being viewed. This "noisy Newton" framework can be applied to a multitude of judgments, with people's answers determined by the uncertainty they have for physical variables and the constraints of Newtonian mechanics. We investigate a range of effects in mass judgments that have previously been taken as strong evidence for heuristic use and show that they are well explained by the interplay between Newtonian constraints and people's uncertainty. We also consider an extended model that handles causality judgments, and obtain good quantitative agreement with human judgments across tasks that involve different judgment types, with a single consistent set of parameters.

**The Bayesian Boom: Good thing or bad?**

Ulrike Hahn (Cardiff University), HahnU@cardiff.ac.uk

Two separate proposals have recently critiqued the role of normative frameworks, and, in particular, Bayesian probability in the study of cognition (Elqayam & Evans, 2012; Jones & Love, 2011), encouraging a greater focus on process theories and implementation. In light of these, the talk seeks to characterise more precisely the role of Bayesian probability in cognitive theories, trying to distinguish different ways in which the framework is brought to bear, and highlighting both its unique contributions and limitations in its present use.
Heuristics, optimality, and children’s sequential information search

Jonathan Nelson, Bojana Divjak, Gudny Gudmundsdottir, Laura Martignon, and Björn Meder (Max Planck Institute for the History of Science, Berlin), nelson@mpib-berlin.mpg.de

Consider a game of guessing which person has been chosen at random from among several people. The task is to identify the person with the smallest number of yes-or-no questions, about specific features that some people have (e.g. "Is the person wearing earrings?"). It is impractical or impossible to check which of all possible sequences of questions is most efficient. Are any heuristic or stepwise-optimal strategies effective? Does it depend on what environment the people are from? We addressed this in a Representative Environment with similar numbers of male and female people, and in a predominantly male Nonrepresentative Environment. Exhaustive search revealed that in the Nonrepresentative Environment, beard is the best first question. In the Representative Environment, gender is the best first question. Remarkably, a simple heuristic strategy--asking about the feature possessed by closest to half of the possible individuals--identifies the optimal decision tree in both environments. We conducted an experiment to explore 4th-grade children's strategies in this game, using cards with cartoon faces to represent the possible people. The children adapted their searches to each environment and preferentially asked the best first question in each environment. In the Nonrepresentative Environment, the best first question (beard) initially tied with gender for most popular. In the Representative Environment, a strong majority of children asked the most useful question (gender) first. This could suggest that people's searches are especially efficient in real-world environments.

Symposium: Causal Learning and Reasoning

Organiser: David Lagnado

Causality and cognition

Symposium keynote speaker: Noah Goodman (Stanford University), rlsharma@stanford.edu

I will explore the ways that formal theories of causal understanding can be integrated with theories of conceptual representation and inference. This will include grounding of causal concepts into perception, learning abstract knowledge about the "causes" relation, and rich causal knowledge representations formalized via probabilistic programming.

The causal structure of choice leads to self-deception: i. Data

Steven Sloman, York Hagmayer, & Philip Fernbach (Brown University), Steven_Sloman@brown.edu

What can people legitimately learn about themselves by observing their own behavior? The answer hinges on what people believe about the causes of action: Is a given action a product of free will and agency, a talent, a skill, or something else? We argue that uncertainty in the causes of actions enables self-deception. We characterize different types of self-deception in terms of the distinction between intervention and observation in causal reasoning. Diagnostic self-deception arises when people deceive themselves about the diagnostic value of their own actions, specifically when people intervene but choose to view their actions as observations in order to find support for a self-serving diagnosis. In earlier work we have shown that such self-deception depends on imprecision in the environment that gives freedom to represent one's own actions as either observations or interventions depending on which offers a more favorable inference. More recently, we have obtained more direct evidence for a motivational shift in the causal construal of choice. We report studies showing that the conditions promoting diagnostic self-deception lead to a negative correlation between the amount of effort participants report putting into a task and the actual effort they expend.

The causal structure of choice leads to self-deception: ii. Model

York Hagmayer, Steven Sloman, & Philip Fernbach (Kings College London), york.hagmayer@kcl.ac.uk
A causal theory of choice will be presented which entails diagnostic self-deception under certain conditions. The basic idea is that we use causal models of choice to decide on actions and update our beliefs about the causes of our behavior based in part on which beliefs are deemed favorable. The theory states that people are uncertain about which of three models of choice govern a specific action: (i) an Intervention Model according to which actions are only dependent on intentions, (ii) an Observation Model according to which behaviors are due to an internal factor (e.g., ability, personality, sensitivity), and (iii) a Conjunctive Model according to which both intentions and other factors are necessary for action. People also assign values to (i) actions because of their consequences and (ii) internal properties that cause behavior. When choosing, people pick the action that has the highest expected value. When updating their beliefs about the choice models, they consider the available evidence and the values entailed by the updated beliefs and pick the most favorable set. This theory predicts self-deceptive behavior when belief in the observation model is high, a potential internal cause has a high value, and the action has some negative consequences. Results from various simulation studies will be presented.

**Time and causality: Causal binding leads to shifts in event perception.**

Marc J. Buehner (Cardiff University), BuehnerM@cardiff.ac.uk

Temporal binding of action to consequence refers to a subjective shortening of elapsed time between the former and the latter. Originally it was thought that temporal binding is specific to motor learning and arises as a consequence of either sensory adaptation (Stetson, Cui, Montague, & Eagleman, 2006) or the associative nature of the forward model of motor command (Haggard, Clark, & Kalogeras, 2002). Both of these interpretations rely on the intentional quality of the causative action (c.f. Wohlschläger, Haggard, Gesierich, & Prinz, 2003). I will present evidence of temporal binding resulting from not only intentional actions but also from mechanical causation, suggesting that intentional action is not necessary for temporal binding, and that binding results from the causal relation linking both events. Consequently, ‘intentional binding’ is a special case of more general ‘causal binding’, which can be explained by a theory of Bayesian ambiguity reduction (Buehner & Humphreys, 2009, 2010; Eagleman & Holcombe, 2002).

**What are the limits of propositionally mediated associative learning?**

Jan De Houwer (Ghent University), Jan.DeHouwer@UGent.be

Associative learning refers to a change in behavior that results from the relation between events (e.g., the presence of two stimuli or a behavior and a stimulus). It is now generally accepted that associative learning is often mediated by the formation of propositions about the related events. However, this conclusion is based almost exclusively on studies in which participants had full control over the behavior that changed (e.g., causality ratings). I review the results of a number of studies on causal learning and evaluative conditioning in which associatively induced changes in more automatic reactions were examined. Whereas some studies suggest that even these instances of associative learning can be mediated by the formation of propositions, others reveal learning that does not seem to be due to propositional processes. We review the evidence and evaluate whether it is necessary to abandon the idea that all instances of associative learning are propositionally mediated.

**Symposium: Cognitive models of decision making**

**Organiser:** Nick Chater

**Rationale:** Thinking is only of practical consequence if it leads to decisions. Over the last fifty years, a vast empirical literature has documented a vast range of decision making phenomena. But what are the principles that govern how people make decisions? This symposium focusses on models aiming to explain the mechanistic and functional basis of human decision making; and to provide an integrated account of how people turn convert thoughts into decisions.

**How we think when we decide: What evidence, exactly, do we accumulate when we choose?**

Neil Stewart (University of Warwick, Coventry), neil.stewart@warwick.ac.uk
When a choice is repeated, we do not always make the same decision. Choices that are more finely balanced take longer to make. Both these pieces of evidence strongly implicate a stochastic accumulation process, where evidence is repeatedly sampled until a decision is made. Findings from single cell recording and ERP support this account. But what, exactly, is the evidence that we accumulate? There are several competing mathematical models which make strong claims about what is accumulated. I will explore these models and use eye-tracking process data to constrain an account of information accumulation in choice—the essence of how we think when we decide.

**Algebraic models and heuristics in risky choice: Foes or allies?**

Thorsten Pachur (University of Basel), thorsten.pachur@unibas.ch

Algebraic models (e.g., cumulative prospect theory; CPT) and heuristics (e.g., minimax, least-likely, priority heuristic) are usually treated as rival accounts of how people make decisions between risky options. We highlight, by contrast, that algebraic models in the expectation family can be understood as measuring (psychophysical) characteristics of the decision process (e.g., diminishing sensitivity to probabilities and outcomes, risk aversion), irrespective of whether the process is based on a multiplicative calculus or on heuristics. Fitting CPT to choices generated by various heuristics, we examined (a) to what extent it can fit choices generated by heuristics; and (b) the specific parameter constellations that the heuristics generate in CPT’s algebraic framework. CPT was able to represent choices generated by heuristics with a reasonable model fit. Moreover, the CPT parameters produced characteristic patterns that reflected the process architectures of the different heuristics in a psychologically meaningful way. For instance, noncompensatory processing of outcome information led to a more strongly inverse S-shaped weighting function, indicating insensitivity to probability information; the elevation of CPT’s weighting function captured differences between the heuristics in terms of risk aversion. Our results demonstrate the compatibility of CPT with heuristic information processing and its usefulness to reveal these simplifying principles in risky choice.

**Integration of probability: Qualitative insight and computational inability?**

Peter Juslin (Uppsala University), peter.juslin@psyk.uu.se

Research on the human ability to reason about, and to integrate, probabilities has been dominated by the claim that people lack the cognitive algorithms that correspond to many of the normative rules that are captured in probability theory, seconded by the alternative claim that such algorithms do exist but that they operate not on single-event probabilities but on representations of natural frequency. In this presentation, I will propose that the answer to this question has (well, at least) two layers: First, from a long experience with environments with (from the view point of the agent) stochastic properties, people often have a qualitative insight into the normative properties embodied in probability theory, such that base-rates or prior probabilities of events tend to affect the posterior probability of the events, or that the probability of a conjunction of many events occurring, generally speaking, tends to be low. Second: because of well-known constraints on cognitive abilities, primarily in regard to working memory with the ensuing consequences for information integration, people are spontaneously inclined to integrate probabilities by linear additive integration rather than the multiplicative rules that are often implied by probability theory. In this presentation, I will discuss empirical evidence in support of such a proposal and elaborate on the ecological conditions that may foster such a mix of at least partial normative insight combined with engagement in apparently irrational computations that can produce blatant violations of probability theory.

**Intertemporal Tradeoffs Between Prospects of Multiple Outcomes**

Daniel Read and Marc Scholten (Instituto Superior de Psicologia Aplicada ISPA, Portugal), scholten@oniduo.pt

Discounting models still dominate the analysis of intertemporal choice. Experimental evidence, however, casts doubts on the descriptive validity of these models, and we recently proposed the tradeoff model (Scholten & Read, 2010) to accommodate all the evidence in elementary choices between a smaller-sooner and a larger-later outcome. We now report how we the tradeoff model can be extended from choices between pairs of single outcomes to pairwise choices involving sequences. The core of our proposal is that choices between sequences involve a heuristic simplification process, in which outcomes are accumulated and delays are adjusted as a function of the outcomes. We show how the tradeoff model, thus extended, offers a unified account of recently discovered
anomalies in pairwise choices involving two-outcome sequences, including the hidden-zero effect, the front-end amount effect, and the mere token effect, and, in addition, fresh anomalies discovered by ourselves, including a reversal of the front-end amount effect and a dependence of the “mere” token effect on the magnitude of the token. We discuss the possibility (or impossibility) of further extending the tradeoff model to virtues, which exchange sooner costs for later benefits, and vices, which exchange sooner benefits for later costs.

Risk Sensitivity as Bayesian Inference

Jerker Denrell (Said Business School, University of Oxford), jdenrell@gmail.com

Existing explanations of why humans and animals are sensitive to risk attribute it to cognitive imperfections including diminishing sensitivity and heuristic choice processes. This paper suggests that risk sensitivity may be functional: variability in observed payoffs may be used as an informative cue about the expected value of an uncertain alternative. I show that this effect emerges naturally from a Bayesian model that incorporates uncertainty about the reliability of observations. The model provides a different explanation of risk aversion for gains and risk seeking for losses: a rational observer should infer that, in the domain of gains, a variable alternative has a lower expected payoff than a less variable alternative with an identical mean. The opposite effect emerges for losses. I also show that the inverse s-shaped weighting function assumed in prospect theory can be derived from a similar inferential account. The models help to explain why risk sensitivity is influenced by the presence of rare events and how risk sensitivity changes with repeated feedback.

Symposium: Cognitive Neuroscience of Reasoning

Organiser Jérôme Prado

Towards a multicomponential view of human deduction: behavioral and neural evidence

Carlo Reverberi (Milan University), carlo.reverberi@unimib.it

Deduction is the ability to draw necessary conclusions from previous knowledge. Thanks to this fundamental cognitive ability, information may remain dormant in previously encoded knowledge and be made explicit only when needed. Several theories have tried to explain the pattern of human competence and failures in deductive reasoning. However, important issues are still open. Does our cognitive system rely on a universal inferential machine for all types of deductive problems, or else different domains recruit different cognitive machineries? Which cognitive processes are involved in solving a deductive problem? Do such processes overlap with language or visuo-spatial processing? Here we discuss a series of fMRI and behavioral studies conducted in our laboratories, making the case for a multi-componential view of human deduction. First, we showed that the brain networks active during the generation of conclusions from conditional problems and quantified syllogisms are different. The former ones involve the Broca Area (BA 44/45), while the latter ones also activate the left inferior frontal gyrus (BA 47), as well as other areas in occipital and parietal lobes. Second, capitalizing on a novel methodological approach exploiting fine-grained inter-participant variability in deduction tasks, we showed that the activation of the left ventro-lateral frontal cortex (BA47) predicts whether participants search for logically valid solutions to syllogistic problems. Instead, activation on BA44/45 predicts whether participants successfully extract the formal structures of problems. Thus, one area (BA47) is critical for valid syllogistic inferences but not for conditional reasoning, whereas another area (BA 44/45) is active in both syllogistic and conditional reasoning. We suggest that BA47 is involved in the selection and application of relevant inferential rules, but only for complex deductive problems prompting several plausible solutions among which to choose. By contrast, BA 44/45 is involved in processing even the simplest kind of problem because it fulfills the more fundamental role of extracting its formal structure, which is required for all further processing. Such first cognitive step may be sufficient to draw elementary inferences, such as Modus Ponens, without further processing. Given the central role of Modus Ponens in everyday reasoning, this very common inference may benefit from a direct and automatic link between its formal structure and the generation of its conclusions. Consistently with this hypothesis, recent evidence from our laboratory shows that Modus Ponens can be triggered fully automatically, even when subjects are not consciously aware of the presence of its minor premise. Overall, our findings strongly suggest that the solution to different types of deductive problems elicits the use of different neural and cognitive machineries; that multiple cognitive components are
necessary to solve a deductive problem; and that some of those components are also involved in language processing.

**Individual differences in deductive reasoning: Evidence from genetic and brain studies**

Melanie Stollstorff (University of Colorado), melanie.stollstorff@colorado.edu

Deductive reasoning is influenced by emotions and beliefs. It is unknown how factors relating to emotion and beliefs interact to cause individual differences in logical reasoning. I will discuss data that explain the nature of emotion-belief interactions in relational reasoning using behavioral, genetic and neuroimaging techniques. In Study 1, reasoning behavior was influenced by beliefs such that participants were less accurate and slower to evaluate arguments in which the conclusion validity conflicted with beliefs, thereby replicating the belief bias effect. Moreover, belief-bias interacted with emotional content and serotonin transporter genotype; carriers of the short (S) allele of the serotonin transporter gene (5-HTTLPR) had increased emotional belief bias relative to long (L) carriers. Groups did not differ in non-emotional belief bias. In Study 2, I investigated the neural basis for this emotion-belief interaction using functional magnetic resonance imaging (fMRI). Healthy individuals with the S allele had decreased activation of right inferior frontal cortex (rIFC; the “belief-bias area”) and increased activity in ventromedial prefrontal cortex (vmPFC; an emotion regulation area) when reasoning with emotional belief-logic conflict problems relative to L allele carriers. Anxiety was positively correlated with activation of vmPFC in emotional belief-logic conflict reasoning. These results have implications for depression and anxiety disorders, which are related to the 5-HTTLPR S allele, emotional reactivity, and deleterious beliefs.

**Dissociations in neural activity underlying deductive and linguistic inferences**

Lawrence M. Parsons (University of Sheffield), L.Parsons@sheffield.ac.uk

Recent functional neuroimaging studies of logical thought have employed a variety of paradigms to explore the neural bases of several kinds of inferences. Martin Monti, Dan Osherson and I have conducted a series of behavioural and fMRI studies that use varied paradigms for studying propositional deduction. Our findings, replicated independently in other labs with different techniques, converge on a working model of the brain basis of propositional inference. The implicated neural processes are distinct from mechanisms involved in linguistic, visuo-spatial, and mathematical (algebraic) inferences. Discrepant findings appear to be related to sources in experimental designs, the appreciation of which affirms the subtle complexities of studying different kinds of inference.

**The brain network for deductive reasoning: A quantitative meta-analysis of 28 neuroimaging studies**

Jérôme Prado (CNRS, France), jprado@isc.cnrs.fr

Over the course of the past decade, contradictory claims have been made regarding the neural bases of deductive reasoning. Researchers have been puzzled by apparent inconsistencies in the literature. Some have even questioned the effectiveness of the methodology used to study the neural bases of deductive reasoning. However, the idea that neuroimaging findings are inconsistent is not based on any quantitative evidence. In this talk, I will present the results of a quantitative meta-analysis of 28 neuroimaging studies of deductive reasoning published between 1997 and 2010, combining 382 participants. We found that results from neuroimaging studies are more consistent than what has been previously assumed. Overall, studies consistently report activations in specific regions of a left fronto-parietal system, as well as in the left basal ganglia. This brain system can be decomposed into three subsystems that are specific to particular types of deductive arguments: relational, categorical, and propositional. These dissociations explain inconstancies in the literature. However, they are incompatible with the notion that deductive reasoning is supported by a single cognitive system relying either on visuospatial or rule-based mechanisms. These findings provide critical insight into the cognitive organization of deductive reasoning and need to be accounted for by cognitive theories.

**Symposium: Critical Thinking and its Applications**

Organiser: Hiroshi Yama
**Rationale:** The studies of critical thinking and its application have fascinated not only psychologists but also philosophers. But the two rarely work together to make the studies of critical thinking more fruitful. This symposium aims to provide a communication channel between psychologists and philosophers, with the hope that an interdisciplinary ground of the studies of critical thinking can be established. To make the communication fair, the symposium invites three philosophers and three psychologists who share an interest in the studies of critical thinking. The keynote presentation will be delivered by Wai-Ling Lai, an analytical philosopher, will explain why and how critical thinking education should be implemented through academic writing education. Secondly, Kazuhisa Todayama, a philosopher, will highlight a topic: how to help students find “what to write”. The third speaker, Tetsuji Iseda, a philosopher, will focus on what he called “meta-level critical thinking”, or critical thinking on critical thinking education. The fourth speaker, Yuko Tanaka, a cognitive psychologist, will focus on the role of critical thinking in social media in the aftermath of the earthquake hit northeastern Japan on March 11, 2011. The fifth speaker, Hiroshi Yama, a cognitive psychologist, will discuss in which situation critical thinking is needed, and conclude that it is where local rules to describe changes become useless. The final speaker, David E. Over, a cognitive psychologist who was formerly a philosopher, will argue that scope ambiguities and the associated modal fallacies should be investigated by psychologists of reasoning. The common interest of these speakers is the nature of critical thinking to be investigated by practice, speculation, and experimental data.

**A constructive and practical approach towards teaching critical thinking**

**Symposium Keynote speaker:** Wai-Ling Lai (Nagoya University, Japan) wailinglai@ilas.nagoya-u.ac.jp

One way of teaching students how to think critically about the theories, methods, and concepts they need to use is to teach them how to build a clear thesis statement and convincing logical argument for their own research. The purpose of this presentation is to show why and how critical thinking education can be implemented through academic writing education.

**How to help students to find "what to write"**

Kazuhsa Todayama (Nagoya University, Japan), todayama@is.nagoya-u.ac.jp

Given writing assignment, freshmen often have difficulty in finding "what to write", because they do not have anything particular to say on the topics. In my textbook for academic writing "Ronbun no Kyoshitsu", I proposed two methods available for squeezing out opinion about the topics given. I will introduce these methods and discuss their implications.

**Teaching meta critical thinking**

Tetsuji Iseda (Kyoto University), iseda.tetuji.6n@kyoto-u.ac.jp

Critical thinking education typically take a form of the "deficit model" communication, where disagreements between the teacher and the students on correct ways of thinking are regarded as due to some deficit on the part of students. The deficit model has been severely criticized in science communication, though. Given the analogy between CT and science communication, the deficit model might not be in some occasions. What we are doing here is a meta-level critical thinking, i.e. critical thinking on critical thinking education. Can we incorporate such meta level thinking into CT education, and is it desirable?

**Critical thinking and social media during responses to disasters – The case of the great east Japan earthquake**

Yuko Tanaka (Stevens Institute of Technology, USA), Yuko.Tanaka@stevens.edu

A 9.0 magnitude earthquake hit northeastern Japan on March 11, 2011. During responses to the catastrophe, social media, such as Twitter, were useful for sharing information and coordinating rescues. Concurrently, false information about radiation and supplies was spread in social media, causing panic in some cases. My presentation will focus on the role of critical thinking in social media in the aftermath of disasters. Specifically, I will show the empirical data collected in Japan after the Great East Japan Earthquake and discuss the relationship between critical thinking, rumor transmission, and psychological factors that affect the decision to spread information.

**When and where is critical thinking needed?**

Hiroshi Yama (Osaka City University, Japan), yama.hiroshi1204@gmail.com
Critical thinking can be viewed as the thought process to give explanations of rules based on natural laws or social customs. An explanation has to be scientific and logical, and is composed of causal models with more fundamental or more global rules. I will discuss in which situation critical thinking is needed, and conclude that it is where local rules to describe the world become useless. This process is parallel to the process of the growth of human brain, and its idea can be applied to cultural differences in cognition.

**Scope ambiguities and modal fallacies in the psychology of reasoning**

David Over, Igor Douven, and Sara Verbrugge (University of Durham, UK), david.over@durham.ac.uk

Scope ambiguities and the associated modal fallacies have been analyzed for a long time in philosophical logic. Yet there have been no published experimental studies of these ambiguities and fallacies in the psychology of reasoning. We will argue that these topics are of intrinsic interest and should be investigated by psychologists of reasoning. Moreover, we will show how modal fallacies have been committed by supporters of old paradigm mental model theory in the attempt to dismiss major results in new paradigm psychology of conditional reasoning. Illustrations from philosophical logic will be used to make points about the ambiguities and fallacies, and an experimental programme will be outlined.

**Symposium: Delusional Thinking**

**Organisers:** Ken Manktelow, and Niall Galbraith

**Rationale:** In recent decades there has been growing interest in the thinking styles underpinning delusions - one of the core symptoms of psychosis. Robust research shows that both patients and individuals high in subclinical delusional ideation, exhibit various biases in reasoning when compared to controls or to those low in delusional ideation. The implication of this work is that maladaptive thinking styles such as jumping to conclusions or liberal acceptance of implausible evidence, may play an important role in the development of delusional beliefs or in maintaining such beliefs once they have formed. Gaining an understanding of the thinking behind delusions is essential for successful therapeutic intervention and for our understanding of implausible beliefs in the non-clinical population. This symposium will explore new theoretical advances in delusional thinking, encompassing cognitive processes, as well as emotional and personality-related factors.

**A theoretical model of delusional belief: Integrating reasoning, perceptual and emotional processes**

**Symposium Key note:** Niall Galbraith (University of Wolverhampton, UK), n.galbraith@wlv.ac.uk

The current study aims to build on previous attempts to develop an integrative theoretical model of delusional belief, by incorporating emotional (e.g. Fowler et al., 2006) and perceptual processes (e.g. Maher, 2005) in addition to cognitive biases, such as liberal acceptance (Moritz et al., 2007), confirmation bias (Freeman et al., 2005) and the jump-to-conclusions bias (JTC; Freeman et al., 2008). More specifically, we argue that a complete model of delusional belief must explain four stages of belief formation: 1) Emergence of the delusional idea: delusional ideas may emerge from the desire to make sense of unusual perceptions or experiences, which may in turn may be interpreted in line with existing schemas or emotional drives. 2) Consideration and acceptance of the idea: implausible ideas are considered and not immediately rejected as untenable, consistent with Moritz, et al’s (2007) notion of liberal acceptance. 3) Selection of evidence: schemas, emotions and biases may lead an individual to search for a particular kind of evidence. Complementary to this, a JTC bias would limit the amount of such evidence that is gathered, leading to beliefs which are based on a limited pool of evidence, and evidence with a delusional theme. 4) Maintenance of the belief: a number of biases may combine to sustain the belief over time, such as a bias against disconfirmatory evidence (Woodward et al., 2007) and cognitive dissonance (Maher, 1988). We present an integrated theoretical model which encompasses this four-stage process and which is consistent with current literature on delusion formation. We present further support for the model with our own empirical studies, with data collected from both adults and children.

**People with delusions jump to conclusions: the role of reasoning in the persistence of delusional beliefs**

Rob Dudley, University of Newcastle, rob.dudley@ncl.ac.uk
A well replicated finding is that some people with psychosis and specifically with paranoid delusional beliefs make decisions on the basis of less evidence than other people without such beliefs. In effect, people with delusions jump to conclusions (JTC). This is a well replicated but ill understood finding. In this presentation I will outline three recently completed studies that describe the prevalence of JTC in a large sample of people with first episode psychosis and examine if the JTC bias is specific to delusional beliefs. A second study considers differences between people with psychosis who do or do not JTC in terms of neuropsychological functioning. A third study considers what happens to the JTC bias over time. In this study we examined the stability of JTC in people with psychosis over a two year time period. Together these studies cast a little more light on the phenomena of JTC, its prevalence, it’s association with visual working memory and its potential as a prognostic marker for poorer outcome over time.

Delusional Ideation and Probability Estimations of Delusional and Neutral Stimuli
Claire Jones, University of Wolverhampton, Claire.Jones@wlv.ac.uk

Introduction: Previous studies (Colbert & Peters, 2002; Galbraith, Manktelow & Morris, 2008; LaRocco & Warman, 2009; Linney, Peters & Ayton, 1998) have demonstrated that those who are high in sub-clinical delusional ideation exhibit reasoning biases similar to those displayed by people with delusions. The current research aimed to investigate how people in the general population who are high and low in delusional ideation reason about narratives with delusional and neutral content. Method: Using a mixed design, the Peters et al. Delusions Inventory (PDI; Peters, Day & Garety, 1996) was used to place undergraduate students into high and low delusion-prone groups (Exp. 1 N = 81; Exp. 2 N = 101). Narratives with either delusional or neutral content were presented to participants and they were asked to assign probability estimates of how likely the narrative was true, how bizarre they believed it to be, the probability of it happening to them and the probability of it happening to someone they know (Exp. 1). Additionally, participants were asked how disturbing and exciting they believe the narratives to be, as well as how bizarre, disturbing and exciting the narratives would be to most other people (Exp.2). Results: Overall, results revealed that the high delusion-prone group rated neutral narratives as more likely to be true and more likely to happen to them or someone they know than the low delusion-prone group. The high delusion-prone group rated delusional narratives as more exciting to someone they know compared to the low delusion-prone group. Conclusions: Findings are discussed in the framework of a liberal acceptance bias (Moritz & Woodward, 2004) and provide tentative support for a liberal acceptance bias in those that are high in delusional ideation. In conjunction with other reasoning biases that have previously been identified in delusion prone individuals, this may have implications for the development and maintenance of delusions.

Factors That May Moderate the Emergence of the Jump to Conclusions Bias in Sub-Clinical Delusional Ideation
Stephanie Rhodes (University of Wolverhampton), stephanie.rhodes@wlc.ac.uk

Introduction: The aim of this research was to investigate the role of sub-clinical delusional ideation, cognitive motivational factors and probability judgement in the jump to conclusions bias. Method: In study one, 64 undergraduate student participants completed numerous cognitive measures and one of two versions of a computerised and realistic data gathering task. In the probabilistic version participants were required to assess probability ratios throughout the data gathering process and in the perspective condition, participants were encouraged to gather information for the purpose of generating a point of view. In the probabilistic and perspective tasks neither high nor low delusional ideation groups showed a jump to conclusions bias when completing a computerised data gathering task. In study two, 96 student participants completed either the probability or perspective data gathering task via computer, face to face or in face to face anxiety- inducing condition. Results: Moderated multiple regression analyses revealed a three-way interaction between belief conviction, task content and task medium with respect to the quantity of information selected prior to a decision being reached. For the face to face probabilistic task, individuals that expressed a higher degree of confidence in their beliefs requested less information prior to forming a decision. However, the manipulation of task content and task medium produced various contrasting correlations inconsistent with the classic findings of the original probabilistic beads task (Hue, Garety and Hemsley, 1988). Conclusion: The results provide tentative support that task content (probability vs. perspective) and task medium (computer vs. face to face) along with belief conviction could be factors that may moderate the data gathering bias. These findings have implications for the study of the jump to conclusions bias in realistic contexts.
Delusions as Beliefs
Lisa Bortolotti (University of Birmingham), l.bortolotti@bham.ac.uk

In this talk I consider some objections to the view that delusions are beliefs and assess some alternative accounts of delusions (delusions as states in-between beliefs and perceptions, delusions as states in-between beliefs and imaginings, and delusions as failed attempts to believe). In the end, I maintain that the view that delusions are beliefs is no worse off than its competitors and offers some pragmatic advantages.

Symposium: A developmental perspective on counterfactual thinking
Organiser: Caren Frosch

Rationale: Counterfactual thinking is a pervasive form of thought that has been implicated in many other important cognitive skills such as causal cognition, theory of mind, and decision-making, and in the experience of emotions such as regret. In this symposium we will discuss the development of this type of thought by considering what counts as counterfactual thinking in children (Sarah Beck; Rafetseder & Perner), which skills are required for successful counterfactual thought (Rafetseder & Perner; Burns), and how counterfactual thinking is related to other cognitive skills (Powell; O’Connor; McCormack; and Frosch). Early studies on the development of counterfactual thinking by Harris (e.g., Harris, German & Mills, 1996) and others focussed on one question: whether counterfactual thinking emerges as a qualitatively new type of cognition around 3-4 years of age. Debate surrounding this issue is still ongoing, and, since then, findings from a diverse range of tasks have suggested either that children’s abilities develop somewhat earlier (German & Nichols, 2003; Harris, 1997), or somewhat later (Beck et al., 2006; Rafetseder, Cristi-Vargas, & Perner, 2010), or that the emergence of adult-like counterfactual thinking (e.g., as shown by regret) might be separate from the basic reasoning abilities (e.g. Guttentag & Ferrell, 2004; Weisberg & Beck, 2010; 2011). Sarah Beck will explore which of the developmental data offer good evidence for counterfactual thinking and identify questions that remain. Eva Rafetseder and Josef Perner’s talk will consider the types of counterfactual worlds that children create with respect to the proposal that creating a counterfactual world should typically involve creating a fictional world as close as possible to the actual world (Lewis, 1973). They will conclude that adult-like performance only emerges during adolescence. Patrick Burns will discuss how executive functions are related to the development of counterfactual thought and in particular he will identify inhibitory control and task switching as predictors of performance on certain counterfactual tasks. The discussion will then extend to consider how counterfactual thinking is related to other aspects of cognitive and affective development, such as the attribution of blame and judgments of another person’s regret (Nina Powell) as well as the experience of regret and its effect on profitable decision making (Eimear O’Connor). The two final talks will focus specifically on the relationship between counterfactual thinking and children’s ability to reason about causal relations. In particular, we consider how counterfactual thoughts are related to an ability to make appropriate intervention judgments on causal systems (Caren Frosch) and how encouraging children to think counterfactually might improve their reasoning about causal systems (Teresa McCormack).

What counts as counterfactual thinking in children?
Symposium Keynote Speaker: Sarah Beck (University of Birmingham), s.r.beck@bham.ac.uk

The first studies on the development of counterfactual thinking focussed on one question: whether there was a shift in children's speculation about what might have been at 3-4 years of age. Since then findings from a diversity of tasks have suggested that children’s abilities develop somewhat earlier (German & Nichols, 2003; Harris, 1997), later (Beck et al., 2006; Rafetseder, Cristi-Vargas, & Perner, 2010), or that the emergence of adult-like counterfactual thinking (e.g. shown by regret) might be separate from the basic reasoning abilities (e.g. Guttentag & Ferrell, 2004; Weisberg & Beck, 2010; in press). In my talk I will explore which of the developmental data offer good evidence for counterfactual thinking and identify questions that remain.

What makes a counterfactual world counterfactual? A developmental approach
Eva Rafetseder & Josef Perner (University of Salzburg), eva.rafetseder@sbg.ac.at
Creating a counterfactual world has been defined as creating a fictional world as close as possible to the actual world (Lewis, 1973). In this sense counterfactual worlds are special instances of fictional worlds into which most facts from real worlds are imported. It “involves a change in some features of the actual world in addition to those required by the truth of the antecedent of the counterfactual, while other such features are left unchanged” (Woodward, 2011). Edgington (2011) clarifies that only those features should be changed that are causally dependent on the antecedent. In fact, adults are quite successful in reaching a consensus about counterfactuals. This indicates that there is a consensus about how to reason counterfactually, i.e., which features of the actual world have to be changed and which should be left untouched. In my talk I will explore that this, however, is an ability that develops gradually from very early on and reaches adult-like performance only during adolescence.

**Executive functions and the development of counterfactual thinking**

Patrick Burns (University of Cambridge), pb527@cam.ac.uk

Byrne (2005) in her account of imaginative thinking makes the claim that counterfactual thinking taxes executive resources and that this might account for the poor performance of young children on tasks of counterfactual thinking. We present empirical evidence that bears directly on this claim. We find that inhibitory control and task switching, but not working memory, predict children’s performance on certain counterfactual tasks. Implications for the development of counterfactual thought are discussed.

**Does counterfactual reasoning influence how we blame others? A comparison of the role of reasoning in attributions of regret and blame.**

Nina Powell (University of Birmingham) nlp765@bham.ac.uk

The research I’ll be presenting aims to better understand the role of reasoning and in moral judgements, specifically judgements of blameworthiness. We did this by examining whether blame judgements respond to the development of counterfactual reasoning in the same way as judgements made about another person’s experience of regret from a bad outcome respond to the development of counterfactual reasoning. Based on the research of Guttentag and Ferrell (2004) we looked at 6-year-olds’, 8-year-olds’ and adults’ regret attributions alongside blame attributions. We found that attributions of blame followed a similar pattern to judgements of others’ experience of regret at both age groups of children, and differed in adults. Six-year-olds did not incorporate counterfactual reasoning in their judgements of others’ regret or blameworthiness – 6-year-olds were focused on the salient features of the bad outcome being the same regardless of the means by which the bad outcome occurred. Eight-year-olds, however, did reason counterfactually about others’ Feelings of regret and blameworthiness by recognising that a person who acted atypically or made a commission would feel worse and would be more to blame for the bad outcome. Interestingly, adults showed a similar pattern to that of the older children with judgements of regret, but made a rational correction for judgements of blameworthiness by recognising that the bad outcomes were unintentional, unforeseen, and unavoidable. Our findings add to the literature suggesting that blame attributions, a facet of morality, are reasoned, even more so than regret attributions in that blame attributions are influenced by the development of the ability to consider counterfactuals and make rational corrections when attributing appropriate blame to another person.

**Do children who experience regret make better decisions?**

Eimear O’Connor (Queen’s University Belfast), eoconnor06@qub.ac.uk

Two studies investigated the development of regret and whether it influenced profitable decision making. Participants were 6-7 year olds. On Day 1, children chose between two boxes to win a prize. The regret condition was designed to induce feelings of regret because the unchosen box contained a better prize; a baseline condition was also included in which both prizes were the same. Children were asked to rate their feelings towards their prize before and after the alternative prize was revealed. On Day 2, there was a fee to open the unchosen box from Day 1. Profitable decision making involved paying to open the unchosen box in the regret but not the baseline condition. Children were asked to choose again between the two boxes to examine if levels of reported regret on Day 1 were related to subsequent choices. Reported regret was found to emerge at 6-7 years of age; additionally, participants who reported regret on Day 1 were significantly more likely to engage in profitable decision making on Day 2. Logistic regressions were performed which found regret was a significant predictor of profitable decision making controlling for age and verbal ability.
Counterfactual thinking about causal systems
Caren Frosch (University of Leicester), Teresa McCormack, David Lagnado, and Patrick Burns, cf159@le.ac.uk

According to a psychological relatedness view of causal and counterfactual thinking, causal and counterfactual judgments are closely related. Consequently, causal judgments should typically be accompanied by the ability to make counterfactual judgments, and vice versa, and hence we might expect causal and counterfactual judgments usually to be consistent with one another. This research focused on children’s counterfactual judgments about interventions on a causal system. Schulz, Kushnir, & Gopnik (2007) make the strong claim that ‘when children infer that a relationship is causal, they commit to the idea that certain patterns of interventions and outcomes will hold’ (p.70). We report three experiments which examined whether children can think counterfactually to make correct intervention judgments on different causal structures. Children aged between 4 and 8 participated and in the first two experiments we examined whether their intervention judgments were consistent with their causal structure judgments by asking counterfactual and future hypothetical questions. In the third experiment the children were explicitly told what the correct causal structure was and were asked future hypothetical questions about intervening on the causal system. The results of the three experiments suggest that the representations that support causal structure judgments do not easily support simple judgments about interventions in children.

Counterfactual reasoning and children's causal learning: a training study
Teresa McCormack (Queen’s University Belfast), Tom Beckers, Victoria Simms, & Jemma McGourty t.mccormack@qub.ac.uk

Recent developmental evidence suggests that the well-known blocking effect in causal learning may be underpinned by the ability to engage in controlled inferential reasoning, specifically the ability to make relevant modus tollens inferences (Simms, McCormack, Beckers, in press). The findings from a new study will be described that attempted to boost levels of blocking by training children to think counterfactually about observations linking pairs of cues to outcomes. We hypothesized that encouraging children to think counterfactually might improve the likelihood that children would make the appropriate modus tollens inference during test, increasing levels of blocking. Children were assigned to either a counterfactual training group, in which they were shown a series of trials and asked about what the outcomes would have been if the causal status of cues had been different, or to a control group in which they were shown the same observations but asked only factual questions about what they had seen. Children were then given a causal learning task that allowed levels of blocking to be measured. Two age groups were tested: 4-5-year-olds and 5-6-year-olds. Counterfactual training boosted levels of blocking, but only the in younger group. Age differences in blocking were apparent only in the control group. We interpret the results as suggesting that training younger children to think counterfactually had an impact on blocking because it improved their modus tollens reasoning to a level similar to that of older children.

Symposium: Dual Process Theories of Reasoning

Organiser: Valerie Thompson

Rationale: Dual process theories of reasoning have become increasingly popular in the past decade. These theories posit that human reasoning and decision-making are subserved by two qualitatively different processes: Type 1 processes generate fast, intuitive responses that may or may not be overturned by more deliberate, Type 2 processes. Although there is much controversy about the need to posit two different types of processes or systems (but see J. Evans and K. Stanovich, this session for a reply), one of the hallmarks of a successful theory lies in its ability to generate novel predictions and data. The generative capacity of dual process theories is illustrated in the current symposium, which addresses the relevance of dual process theories to moral judgments, individual differences in the propensity for Type 2 thinking, one’s ability to detect potentially conflicting responses, as well as the role of confidence and metacognition in mediating between intuition and analysis.

Conflict detection, logical intuitions, and dual process theories of thinking
Symposium keynote speaker: Wim De Neys (CNRS & Paris Descartes University, Sorbonne Paris Cité), wim.de-neys@parisdescartes.fr

Human reasoning has been characterized as often biased, heuristic, and illogical. In my talk I will present an overview of findings that establish that despite the widespread bias and logical errors, people at least implicitly detect that their heuristic response conflicts with traditional normative considerations. I will clarify that this conflict sensitivity calls for the postulation of logical and probabilistic knowledge that is intuitive – and that is activated automatically when people engage in a reasoning task. In other words, I believe it makes sense to argue that our intuitive reasoning system is often cueing the correct logical response in classic reasoning tasks. I will sketch the opportunities and challenges of this idea for the dual process view of human thinking.

The cognitive reflection test and Type 2 thinking
Keith Stanovich, (University of Toronto), Maggie Toplak and Richard West, keith.stanovich@utoronto.ca

The Cognitive Reflection Test (CRT, Frederick, 2005) is designed to measure the tendency to override a prepotent response alternative that is incorrect and to engage in further reflection that leads to the correct response. In this study we show that the CRT is a more potent predictor of performance on a wide sample of tasks from the heuristics and biases literature than measures of cognitive ability, thinking dispositions, and executive functioning. It accounted for substantial additional variance after the other measures of individual differences had been statistically controlled. We conjecture that this is because neither intelligence tests nor measures of executive functioning assess the tendency toward miserly processing in the way that the CRT does. We interpret the data patterns involving the CRT in terms of a tripartite model of cognition.

Intuitive and deliberative processes in moral judgment
Eoin Gubbins and Ruth Byrne (Trinity College Dublin University of Dublin Ireland), egubbins@tcd.ie

When people reason about the appropriateness of actions that violate moral principles, they are influenced by whether the actor caused the outcome, e.g., she pushed some occupants of an overcrowded lifeboat into the sea (a personal or direct action) or whether the actor enabled the outcome, e.g., she asked some of the lifeboat occupants to go into the sea (an impersonal or indirect action). The difference may arise because people rely on fast intuitive (and emotional) processes in cases of personal direct action and deliberative reason in cases of impersonal indirect action. We report the results of an experiment to test the difference for a variety of moral dilemmas. The results showed that judgments of the morality of an actor’s decision are influenced by information about whether the actor experienced a strong or a mild emotion, differentially for personal and impersonal actions.

Second Thoughts About First Impressions
Shane Frederick (Yale University), shane.frederick@yale.edu

Many judgments and decisions yield intuitive impressions that are less attractive upon further review. Fluency is the enemy of reflection: the more readily an intuition emerges, the greater our "intuitive confidence" (Simmons and Nelson, 2006), and weaker the motivation to revisit it. Here, we explore several subtle (and not so subtle) methods for (1) reducing intuitive confidence in the impressions that emerge and (2) enhancing the amount of scrutiny those impressions later receive. We measure the success of our manipulations in terms of respondents' performance on the Cognitive Reflection Test (CRT): specifically, the number of correct answers, the number of intuitive errors, and the amount of time they spend.

Analytic thinking: Would you know it if you saw it?
Valerie Thompson (University of Saskatchewan, Canada), valerie.thompson@usask.ca

In several studies (e.g., Thompson, Prowse Turner, and Pennycook, 2011), we have demonstrated that the extent of Type 2 analysis can be predicted on the basis of a metacognitive judgment called the Feeling of Rightness,
which, in turn, is predicted by the fluency with which an initial response was produced. In the course of this research, we have uncovered a number of incidental findings that have profound implications for what we consider to be the nature of Type 2 thinking. For example, when offered the opportunity to change their initial responses, people are almost as likely to change from a normatively correct to an incorrect solution and vice versa; the length of time spent rethinking an answer predicts the probability that it will change but not necessarily that it will be correct; and cognitive capacity predicts the probability that an initial, intuitive answer is correct but does not necessarily predict the quality of subsequent analytic engagement. The implications of these and other findings for current Dual Process Theories will be discussed.

**Dual Processes, Probabilities, and Cognitive Architecture**

Mike Oaksford (Birkbeck University of London) and Nick Charter, m.oaksford@bbk.ac.uk

It has been argued that dual process theories are not consistent with Oaksford and Chater’s probabilistic approach to human reasoning (1994, 2007: Oaksford et al, 2000), which has been characterised as a “single-level probabilistic treatment[s]” (Evans, 2007, p. 98). In this paper, it is argued that this characterisation conflates levels of computational explanation. The probabilistic approach is a computational level theory which is consistent with theories of general cognitive architecture that invoke a WM system and an LTM system. That is, it is a single function dual process theory which is consistent with dual process theories like Evans’ (2007) that use probability logic (Adams, 1998) as an account of analytic processes. This approach contrasts with dual process theories which propose an analytic system that respects standard binary truth functional logic (Heit & Rotello, 2010; Klauer, Beller, & Hütter, 2010; Rips, 2001, 2002; Stanovich, 2000, 2011). The problems noted for this latter approach by both Evans (2002, 2007) and Oaksford and Chater (1991, 1998, 2007) due to the defeasibility of everyday reasoning are rehearsed. Oaksford and Chater’s (2010) dual systems implementation of their probabilistic approach is then outlined and its implications discussed. In particular, the nature of cognitive decoupling operations are discussed and a Panglossian probabilistic position developed that can explain both modal and non-modal responses and correlations with IQ in reasoning tasks. It is concluded that a single function probabilistic approach is as compatible with the evidence supporting a dual systems theory.

**Dual-process theories of higher cognition: advancing the debate**

Jonathan St B T Evans, Keith E Stanovich (University of Toronto), keith.stanovich@utoronto.ca

Dual-process and dual-system theories in both cognitive and social psychology have been subjected to a number of recently published criticisms. However, they have been attacked as a category, incorrectly assuming there is a generic version that applies to all. We identify and respond to five main lines of argument made by such critics. We agree that some of these arguments have force against some of the theories in the literature, but believe them to be badly overstated. We argue that the dual-processing distinction is supported by much recent evidence in cognitive science. Our preferred theoretical approach is one in which rapid autonomous processes are assumed to yield default responses unless intervened upon by distinctive higher order reasoning processes. What defines the difference is that the latter involve hypothetical thought and load heavily on working memory.

**Smart People Show More Belief Bias**

Dries Trippas (Plymouth University), Simon Handley, and Michael Verde, dries.trippas@plymouth.ac.uk

**Introduction:** Belief bias is the tendency for people’s reasoning to be influenced by the believability of the conclusions they are evaluating. According to Selective Processing Theory (SPT) there are two components to belief bias: increased acceptance of believable conclusions in the response stage, and the use of qualitatively different reasoning strategies for believable compared to unbelievable conclusions. We demonstrate that only people with high cognitive capacity exhibit this second component. **Method:** After completing the AH4 test of general intelligence (an index of cognitive capacity), participants judged the validity of 64 multiple model syllogisms and rated their confidence in each judgement. We manipulated argument validity, conclusion believability, and available response time (10 s vs. unlimited). **Results:** When people had unlimited time to respond, endorsement rates and signal detection analysis of confidence judgments converged in showing that the high cognitive capacity group showed significantly better reasoning for unbelievable arguments. The low capacity group showed only a response bias with no effect of believability on reasoning. Under time pressure of a 10 sec deadline, neither group showed a reasoning advantage for unbelievable arguments. **Discussion:** We propose a
modified version of SPT which suggests that conclusion believability affects the quality of reasoning only when people have adequate cognitive capacity and sufficient time to engage in alternative reasoning strategies. Our results are notably inconsistent with previous work attributing belief bias solely to response bias (Dube, Rotello, & Heit, 2010).

**Are beliefs biased by logic? The effect of a secondary load on reasoning**
Stephanie Howarth (Plymouth University), Simon Handley, Clare Walsh, stephanie.howarth@plymouth.ac.uk

**Introduction:** Dual-Process accounts claim that responses to reasoning tasks often default to automatically cued belief-based responses. However, recent research suggests that reasoning on the basis of beliefs may not be as fast and automatic as these accounts claim. This paper aims to test these alternative views by examining how individuals reason under a secondary load, when instructed to make judgements based upon logic or beliefs.

**Method:** In two experiments participants completed 64 MP arguments under belief or logic instructions, whilst doing a spatial task (Experiment 1), an articulatory suppression task (Experiment 2), generating random numbers (Experiment 2) or without a secondary load.

**Results:** Of the secondary tasks, only Random Number Generation impacted on performance and it impaired logical judgements more than belief-based judgements. However, in both experiments overall, belief judgements took longer than logic judgements and a conflict between belief and logic slowed performance on belief judgements more than logical judgements.

**Discussion:** Logic judgements required more resources, in accordance with the Default Interventionist (DI) accounts. However, the latency results, which show that belief judgements take longer and are influence by validity, are inconsistent with DI predictions.

**Conclusion:** These findings challenge the dual processing accounts of reasoning which assume that reasoning on the basis of beliefs is both faster and less effortful than logical inferences. More generally they question the assumption that the speed and effort of cognitive processing should be related.

**Symposium: Factors Affecting Heuristic Choices**
Organiser: Kinga Morsanyi

**Rationale:** How do children and adults evaluate, weight, and integrate information? When people make decisions about choice options, they are often confronted with conflicting pieces of information. Whereas careful consideration of different options might lead to optimal choices, there is much evidence to suggest that people’s attention is often captured by salient options, which, then, can have a disproportionate effect on decision outcomes. The purpose of this symposium is to explore the sources of people’s biases, and how they change with development.

**Beyond expectation: Modeling affective risky choice with heuristics**

**Symposium keynote speaker:** Thorsten Pachur (University of Basel), thorsten.pachur@unibas.ch

This keynote talk will focus on decision-making about affect-rich probabilistic outcomes (e.g., when people choose between medications that can have side effects). He will present evidence from behavioral, process tracing, and neuroimaging studies, as well as from computational modeling, that although trade-off models (which assume that risky choices are best described by the sum of the possible consequences weighted by their probabilities) generally describe risky decisions well, they fail to correctly explain choices about affect-rich outcomes. Indeed, in these contexts people tend to rely on simple heuristics.

**Averaging and adding in children’s worth judgments: A bias can highlight normative understanding**
Anne Schlottmann, Rachel Harman and Julie Paine (University College London), a.schlottmann@ucl.ac.uk

This talk will explore the strategies used by young children when judging the value of compound games for 2 prizes varying in size or winning probability). Judgement should be additive, but children averaged expected values. This bias may reflect some difficulty in understanding the implications of the independence of events, but children grasped that with independent events, overall value goes beyond value of the visible options.
A lexicographic trade-off model for the development of framing effects in risky choice
Hilde M. Huizenga, Anna van Duijvenvoorde, Bernd Figner & Brenda Jansen (University of Amsterdam), H.M.Huizenga@uva.nl

I report investigations of the development of framing effects in risky choice in children and adolescents between the ages of 8 and 16. Her results indicate that young children considered only one attribute: risk. Nevertheless, with increasing age children were also influenced by frames, although they still considered risk first. The second part of the symposium will concern reasoning about options which are not probabilistic or inherently affect-rich.

People’s judgements of the truth of propositions, and its application to intuitive decisions about the correctness of mathematical solutions
Rolf Reber (University of Bergen, Norway), Rolf.Reber@psysp.uib.no

This talk will present data from adults to show that neutral materials can nevertheless become associated with affect through the ease with which they can be processed. Indeed, the perceptual characteristics of problems can drive people’s judgment of the correctness of mathematical solutions. He will also argue, on the basis of a Bayesian analysis, that fluency as a source for judging the truth of propositions is epistemically justified.

Effect of mode or order of presentation (discrete vs. continuous) on children’s ability to overcome intuitive inference in geometry
Ruth Stavy and Reuven Babai (Tel Aviv University), Ruth@post.tau.ac.il

This presentation explores children’s intuitive judgments of the perimeters of geometric shapes. She demonstrates that many children intuitively believe that shapes with larger areas must have larger perimeters. Intuitive judgments, however, are also affected by the way the shapes are presented. Specifically, children were less affected by this intuition when the perimeters of the shapes to compare were presented discretely, rather than continuously.

Children’s logical reasoning in an adaptive training system
Maartje Raijmakers, Nina Gierasimczuk and Han van der Maas (University of Amsterdam), m.e.j.raijmakers@uva.nl

This talk will focus on the development of nonverbal deductive reasoning from preschool to grade 8 in the adaptive train and game environment of mathsgarden.com. She will show that working memory capacity and mathematical reasoning are important determinants of reasoning performance, and that strategies need more or less resources, depending on the efficiency of selecting relevant information.

Children’s logical reasoning in an adaptive training system
Kinga Morsany (University of Cambridge), Simon Handley, Caterina Primi and Francesca Chiesi, km574@cam.ac.uk

This talk will present evidence for two general developmental patterns: an increase in the effect of context on reasoning, and an increase in the ability to rely on (complex and abstract) rules. She will argue that these seemingly contradictory tendencies are driven by the same underlying factor: increases in working memory capacity. Nevertheless, domain specific knowledge and thinking styles also have a significant effect on reasoning performance.

Symposium: Inductive Reasoning
Organisers: Aidan Feeney, Brett Hayes, Evan Heit

Rationale: Inductive reasoning allows us to reduce our uncertainty about the way that the world is. At the most general level, when we make an inductive inference we are generalising from a sample which can consist of experiences with individuals or information about entire categories. In fact, one of the major functions of categories is that they support inductive inferences. For example, knowing that cats possess a property helps us to evaluate whether lions also have the property. Difficulties arise when we attempt to make inferences about
individuals but are uncertain about their category membership. However, perhaps the greatest difficulty in evaluating a category-based inductive inference is deciding which of the many relations between the categories is relevant to the inference. The property to be projected often determines which of the relations we know about inform our reasoning, and property effects are said to demonstrate inductive selectivity. One set of models of inductive reasoning holds that it is the similarity between the categories which determines the strength of an inductive argument whereas Bayesian models allow for causal and other sorts of relations. The participants in this symposium have all made important contributions to our understanding of these and other issues related to inductive reasoning and each will present recent work at the cutting edge in this exciting and fast developing field.

**Reasoning in the probabilistic language of thought**

**Symposium keynote speaker:** Noah Goodman (Stanford University), ngoodman@stanford.edu

I'll argue that a productive way to think about reasoning is as probabilistic inference over representations set up by the language used to ask for a response. To make this work requires formal semantics phrased in terms of stochastic lambda calculus—a compositional system that supports probabilistic inference. As examples I'll discuss the (apparent) dissociation between inductive and deductive reasoning, unifying property induction with syllogistic reasoning, and extending this model to inductive judgements about causality and beliefs.

**Children's Conceptual Biases and the Development of Induction**

Marjorie Rhodes (New York University, marjorie.rhodes@nyu.edu)

The process of induction-generalizing information obtained from limited samples to inform broader understandings—plays a critical role in learning across the lifespan. An important open question relates to the extent to which the mechanisms that support induction are stable across development. Prior empirical work suggests important developmental changes in a critical component of induction—how children and adults evaluate whether a particular sample of evidence is informative about a broader category. This talk will examine the mechanisms underlying developmental changes in sample evaluation, and will present recent empirical studies suggesting that these developmental differences stem from children's conceptual biases to treat categories as highly homogeneous (and thus to neglect the features that make some samples more informative than others). This research has implications for our understanding of how the mechanisms that support inductive learning change across childhood, of how conceptual biases constrain learning, and of the implications of developmental data for models of adult induction.

**Induction with uncertain categories: Feature-based vs. category based strategies**

Brett Haye, b.hayes@unsw.edu.au

Most previous work on category-based induction has involved predictions based on certain category membership. There are many situations however, where inductive predictions have to be made about instances whose category membership is uncertain. This talk will review recent work on the cognitive processes involved in induction under category uncertainty. We show that consideration of multiple category alternatives in induction is dependent on the relative salience of those categories. We also present evidence that people often use feature-based reasoning whereby inductive predictions are based on knowledge of feature correlations rather than category membership.

**Executive Function and Selective Inductive Inference**

John Coley (University of New South Wales, j.coley@neu.edu)

Categorical inductive inferences are selective; we use different relations to guide inferences about different kinds of properties. This requires considering multiple relations between categories, and potentially inhibiting highly salient but irrelevant knowledge. As such, I will explore possible linkages between executive function—one component of the cognitive system involved in such strategic problem-solving and inhibitory control—and individual differences in selective inductive inference.
Semantic inhibition and selective category-based inductive reasoning

Aidan Feeney, Aimee Bright (Durham University), aimee@equisapiens.co.uk

Categories can be related in a number of different ways. They can be highly associated, like the categories rabbit and carrot, or they can have some more structured relationship such as belonging in the same super-ordinate taxonomic category, like the categories carrot and bamboo. If one knows that carrots have certain cells, then in deciding whether rabbits or bamboo also possess those cells, one must choose the most relevant relation on which to base an inference. In two experiments participants evaluated inferences that placed taxonomic and associative relations in conflict. In Experiment 1 participants’ ability to resist associative lures was strongly correlated with a measure of semantic but not response inhibition. Experiment 2 replicated the association with semantic inhibition and showed that a measure of working memory explained no additional variance. These results suggest that very particular central executive processes are required for selective category-based inductive reasoning.

Flexible similarity in inductive reasoning and recognition memory

Evan Heit and Brett Hayes (University of New South Wales), b.hayes@unsw.edu.au

Two experiments examined the relationship between recognition and inductive reasoning involving multiple forms of similarity. A common study set (members of a conjunctive category) was followed by a test set containing old and new category members, as well as items that matched the study set on only one dimension. In recognition, participants memorized study instances and responded positively at test to old items. In induction, a novel property was attached to study items and participants were asked to respond positively to test items that shared this property. The nature of the inductive property varied across conditions. Overall there was a strong relationship between positive responses in recognition and induction, even when meaningful properties were used for induction (r = 0.85). When there was no time pressure, patterns of positive responding were strongly affected by property type, indicating that different types of similarity were driving recognition and induction. By comparison, speeded recognition and induction judgments showed weaker property effects and could be explained by generalization based on single similarity metric.

Symposium: The limits of reason

Organisers: Magda Osman, Maarten Speekenbrink and Keith Jensen

Rationale: The scope of the symposium is to examine the various examples of sophisticated high-level cognition (e.g., transitive inference, causal inference, rule transfer) in non-humans (e.g., birds, rats, chimps) that have been characterized as analogs of reasoning. According to the received view, reasoning is a cognitive operation that requires symbolic manipulation, which in turn depends on some form of linguistic capability in order for symbolic representation to occur. Therefore, a key question that arises from this is: Assuming that animals do not possess linguistic skills, how is it that they are able to demonstrate behaviour indicative of complex symbol manipulation? This question itself is deeply problematic, because an appropriate model to evaluate non-human reasoning is lacking. The received view of reasoning defines logical reasoning within linguistic structures (e.g., Aristotelian logic, Frege's propositional calculus, Wittgenstein propositional logic). One might argue that this is an inappropriate perspective. Firstly, research on human reasoning suggests that humans themselves do not naturally reason in line with formal logic. Instead, humans appear to demonstrate forms of reasoning that are bounded by cognitive constraints (Simon, 1982). If humans are limited in the kinds of logical operations they can perform, and rely on apparently pseudo-logical short-cuts (heuristics), then it seems fair to allow for the fact that animals may possess reasoning skills that are not based on logical operations per se. Secondly, non-human cognition involves capabilities that are suited for practical purposes that are different to those of humans. Therefore, the criteria used for human rationality may not be directly applicable to non-human animals. The proposed symposium will introduce the audience to a range of studies on animal reasoning that may challenge our commonly held beliefs about what constitutes reasoning ability. Moreover, the aim is to stimulate discussion on foundational issues concerning reasoning and rationality.

Who cares? Other-regarding preferences in apes and humans
Keith Jensen (Queen Mary, University of London), k.jensen@qmul.ac.uk

Humans, arguably, are motivated to perform costly acts that benefit others out of a concern for the welfare of others, and to punish others out of a sense of fairness and morality. Nonhuman primates do engage in mutualistic, as well as altruistic acts, and they certainly do harm each other. Some research has suggested that the same motivations as seen in humans, notably empathy and fairness, are also at play. However, evidence for these sentiments has not been consistent. In this talk I will suggest that the prosocial and punitive acts of chimpanzees and bonobos are not motivated by other-regarding concerns as they are in humans. These results are contrasted with similar studies conducted on children. I will conclude that self-regard may be sufficient to explain apparently other-regarding behaviours in nonhuman primates, but that humans, from an early age, exhibit genuine concern for the well-being of others.

Rules, Causal powers and the animal mind

Robin Murphy (University of Oxford), robin.murphy@ccc.ox.ac.uk

Much of the debate surrounding the merits of attributing reasoning powers to animals (including humans) conflates two questions in learning. One relates to the nature of the behavioural response, and the other the underlying cognitions. The evidence that animals can learn rule-based behaviours that appear analogous to traditional linguistic abilities or can learn causal structures such as causal chains says little about the cognitive representations supporting these behaviours. As this symposium suggests, frugal mechanisms can approximate the output of complex reasoning. We discuss experimental work with rats and humans involving rules and sensitivity to causal power that show how rats, people and simple algorithms can be sensitive to these structures without internalizing the structures themselves.

Overall similarity and relational complexity affect children’s and great apes’ reasoning about relational similarity

Alenka Hribar (Max Planck Institute, Leipzig), hribareva@eva.mpg.de

In the present studies we compared 4- and 5-year-old children’s and great apes’ (chimpanzees, bonobos, and orangutans) reasoning about spatial relational similarity. We presented them with a spatial mapping task where they needed to find a reward in one array of three identical cups after observing the reward being hidden in another array of three cups. Apes’ and children’s performance was affected by the arrays’ overall similarity and by the number of relations needing to be mapped – they both preferentially engaged in a mapping strategy, which demanded encoding of only one instead of two relations.

Lessons from Lloyd-Morgan’s Canon: Simple accounts of apparently rational behaviour in rodents

Dominic Dwyer (Cardiff University), dwyerdm@Cardiff.ac.uk

There has been much recent interest in reports that non-human animals appear to produce behaviour that, in humans, would typically be considered to reflect sophisticated mental processes. Here, I examine three examples in rats (causal-reasoning, sensitivity to the absence of stimuli, and the relationship between effort and reward) where higher-order mental processes might be invoked. In each case I will argue that alternative accounts, based on “lower” mental processes, are also consistent with the observed data. According to the principles of parsimony encapsulated by Lloyd Morgan’s Canon the mere existence of such simple alternative accounts should negate any interpretation in terms of more sophisticated processes such as reasoning. Even if this principle is not accepted, the fact that these simpler accounts might offer both more accurate and more clearly specified mechanisms, supports the same conclusion. Before observations of non-human animal behaviour are used to inform the analysis of reasoning in humans due consideration should be given to cognitively simple mechanisms.

How do chimpanzees solve inference tasks?

Amanda Seed (University of St Andrews, Fife) and Joseph Call, ams18@st-andrews.ac.uk

In several studies on inferential reasoning, chimpanzees can pass some conditions in which they must infer how to get food from incomplete information. For example when a reward is hidden in one of 2 cups, and one of them is shaken and produces no sound, some subjects choose the other cup, consistent with the notion that they have inferred by exclusion that the food must be inside. And when food is hidden under one of two boards, they choose
the board that is inclined rather than one that is flat. However, when both boards are inclined but only one is visibly propped up by a piece of wood, they choose at chance between them rather than reasoning that the inclined but unsupported board must have food beneath it. In a recent experiment, chimpanzees needed to infer which of 2 tools was connected to a reward. The results showed a similar pattern: chimpanzees could infer which tool was connected when given positive evidence that one could move the reward but the other could not, but most failed to solve the task when only given evidence that one option was certain and the other only possible: for example when one tool only moved the reward when the experimenter’s hand was moving the banana too [4].

Why do chimpanzees succeed on some sorts of reasoning tasks but not others? We discuss the role that might be played by object property knowledge (e.g. permanence), mechanical knowledge (e.g. connection), and logical reasoning (e.g. reasoning by exclusion) in explaining the data.

Symposium: Mental Models and Everyday Reasoning

Organiser: Ruth Byrne (Trinity College Dublin), rmbyrne@tcd.ie

Rationale: This invited symposium has been organized as a tribute to Phil Johnson-Laird. It will present recent research examining the extension of the mental models theory to various aspects of everyday reasoning including reasoning about clinical tests, defeasible reasoning, moral reasoning, reasoning about intentions, the influence of emotions on reasoning, and the acquisition of concepts.

Mental models of Boolean concept acquisition and representation

Symposium keynote speaker: Geoff Goodwin (University of Pennsylvania), ggoodwin@psych.upenn.edu

Negation, conjunction, and disjunction are major building blocks in the formation of concepts. This talk describes a new model-based theory of these Boolean components, which explains how individuals acquire and represent Boolean concepts. The theory predicts that when individuals acquire Boolean concepts they simplify the models of instances of those concepts. A computer program implementing the theory yields the number of mental models required to represent a Boolean concept. Evidence corroborates the theory by showing that the number of mental models required to represent a concept predicts the difficulty of acquiring it. The model-based theory also accounts for how individuals represent Boolean concepts from descriptions of those concepts. It proposes that individuals represent only instances of a concept, and for each instance, only those properties, affirmative or negative, that the description asserts as holding in the instance. This representation lightens the demands on working memory, but it also leads to predictable conceptual ‘illusions’ in which individuals envisage as instances of a concept some cases that in fact are non-instances, and vice versa. Experimental evidence documents these illusions while also showing that they can be alleviated in predictable ways. The findings in both of these domains, concept acquisition and concept representation, cannot easily be explained by alternative theories. As mental models may also underlie deductive reasoning, the present theory integrates hitherto separate areas of investigation.

Spatial Belief Revision

Markus Knauff (University of Giessen), Leandra Bucher, Stefan Czoschke, & Jelica Nejasmic, markus.knauff@psychol.uni-giessen.de

Belief revision is the process of changing one’s beliefs when a newly acquired fact contradicts the existing belief set. Psychological research on belief revision almost exclusively used conditional reasoning problems in which an inconsistency arises between a fact, contradicting a valid conclusion, and the conditional and categorical premises. In the talk, we will present a new experimental paradigm in which we explore how people change their mind about the location of objects in space. In our spatial belief revision paradigm, the participants receive premises that describe the spatial relations between a set of objects. From these premises they draw a conclusion which then, in the next step, is contradicted by a new incontrovertible fact. The participants’ task is to decide which one of the spatial premises may be abandoned. We report a set of experiments showing that people solve this belief revision task by modifying a preferred layout model. We also show that the model variation process follows the principle
of minimal change and can be modulated by the reasoners’ background knowledge and pre-existing beliefs. The experiments are a first step towards a detailed theory of spatial belief revision.

**Moral reasoning in children**

Monica Bucciarelli (University of Torino, Italy), monica.bucciarelli@unito.it

I advance a theory of the development of moral reasoning. I conducted a series of experiments involving children (9 to 10 years), adolescents (13 to 14 years) and adults. The experiments were designed to test the predictions derived from three main assumptions of the theory: emotions and moral judgments are two independent systems and children experience an emotion first for moral scenarios and an evaluation first for immoral ones; the ability to reason from conscious premises to conscious conclusions appears with judgments of moral actions before judgments of immoral actions; with the classical moral dilemmas, children base their decision on a utilitarian rule of thumb rather than engage in complex deliberative reasoning. The results of the experiments confirmed my predictions. I discuss these in the light and against the background of recent theoretical accounts of moral judgments.

**Reasoning about intentions**

Ruth Byrne (Trinity College Dublin, Ireland), rmbyrne@tcd.ie

We often reason about whether the outcomes of other people’s actions are intentional or not; some outcomes are intentional and some outcomes are side effects. But people sometimes judge a side effect to be intentional, e.g., the environment is affected when a company introduces a program to increase profits. And they do so more often when the side effect is negative e.g., the environment is harmed, than when it is positive, e.g., the environment is helped. We report several experiments that show that counterfactual thoughts exhibit a similar asymmetry—people think ‘if only’ about events leading to a negative side effect more than a positive side effect. The experiments show that people judge a side effect (e.g., affecting the environment) to be only partially intentional whereas they judge a main effect (e.g., increasing profits) to be fully intentional. The experiments also show that the side effect asymmetry occurs whether the main goal is negative (a company aiming to increase profits) or positive (an International Aid Agency aiming to save people from starvation). The results are discussed in relation to alternative theories of the cognitive processes underlying judgments about other people’s intentions.

**Reasoning about clinical tests**

Vittorio Girotto (University IUAV of Venice) and Michel Gonzalez, girotto.vittorio@gmail.com

The model theory predicts that naïve individuals (i.e., individuals who are unfamiliar with the rules of probability calculus) can solve posterior probability problems by applying extensional procedures to finite sets of countable units (Johnson-Laird et al., 1999). Previous studies have corroborated this prediction. In this paper, we report studies that extend the analysis of naïve extensional competence to clinical reasoning. Participants were patients who reasoned about realistic epidemiological data. The results show that extensional procedures can be used to improve understanding of clinical test accuracy.

**How emotions affect reasoning in psychological disorders**

 Amelia Gangemi (University of Messina, Italy) and Francesco Mancini, gangemia@unime.it

The hyper-emotion theory of psychological illnesses attributes these illnesses to emotions of aberrant strength, which in turn prompt a greater amount of reasoning about their sources. One consequence is that patients become expert reasoners in the domain of their psychopathology, and therefore more accurate in building mental models of problematic situations. It follows that if individuals suffering from depression or anxiety reason about matters pertinent to their emotions, their reasoning should be better than both the reasoning of non-clinical controls on the same topics and their own reasoning on other topics. We report experimental findings that corroborate this prediction: they show that patients reason better than controls, but only about contents pertinent to their illness. The theory has a second consequence: Patients should develop characteristic strategies of reasoning that depend on the nature of their illnesses. We report studies that corroborate a dialectical pattern of obsessive–compulsive reasoning and a different pattern of reasoning in anxiety disorders.
Symposium: Mental Model and Deduction

Organiser: Ruth Byrne

Rationale: This invited symposium has been organized as a tribute to Phil Johnson-Laird. It will present recent research examining new developments in the mental models theory of deductive reasoning including conditional, disjunctive, spatial and syllogistic inference.

Preferred mental models and the evaluation of consistency

Symposium keynote speaker: Marco Ragni (University of Freiburg, Germany), ragni@cognition.uni-freiburg.de

Reasoning about the consistency of assertions is important in everyday life and central to rationality. In logical terminology, a set of assertions is consistent or “satisfiable” if there is at least one possibility in which all of the assertions hold (e.g., Tarski, 1944). Nevertheless, the task of assessing consistency is computationally intractable, i.e., with an increasing number of assertions the task soon becomes impossible to solve in a feasible amount of time (Garey & Johnson, 1979). While determining consistency is complex and sometimes difficult, we can already predict – and in fact some experiments show – that not all problems are equally likely to be recognized as consistent. However, only a few reasoning theories make assumptions about the human reasoning process towards consistency. In this talk, I will outline the theory of preferred mental models which postulates that individuals construct certain sorts of mental models rather than others and that there is a specific transformation process for finding alternative models. As a consequence, not all other possible models are inspected during the reasoning process. The explanatory power of the theory ranges from human spatial relational reasoning to determining the consistency of monadic assertions, i.e., assertions about the properties of sets of entities. This will be demonstrated on three experiments.

mReasoner: A unified computational theory of reasoning

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mReasoner is a unified implementation of mental model theory, and a computational cognitive system of high-level thinking and reasoning. It accounts for human level deductive and probabilistic reasoning. The architecture rests upon three core systems: 0) a linguistic system that constructs intensional representations of the meaning of premises; 1) a system that construct an initial mental model representation and scans it to putative conclusions; and 2) an advanced system that modifies initial models to search for alternative models of the premises. It unifies heuristic and model based approaches to monadic reasoning. We discuss the system's strengths, limitations, and its role as a cognitively plausible reasoning engine.

Temporal and spatial reasoning

Csongor Juhos and Ana Cristina Quelhas (ISPA, Portugal), Csongor.Juhos@ispa.pt

The mental model theory postulates that the meanings of assertions, and knowledge about their context can modulate the logical meaning of sentential connectives, such as “if” and “or”. One known effect of modulation is to block the representation of possibilities to which a proposition refers. But, modulation should also add relational information, such as temporal order, to models of possibilities. Three experiments tested this prediction. Experiment 1 showed that individuals spontaneously matched the tense of their conclusions (in Portuguese) to embody implied, but unexpressed, temporal relations in conditional premises. Experiment 2 demonstrated the same phenomenon in inferences from disjunctions. Experiment 3 showed that the number of such implicit relations in inferences from conditionals affects both accuracy and the speed of reasoning. These results support the modulation hypothesis.

Reasoning and numerical ambiguities: a test of the mental model theory’s principle of truth

Robert Mackiewicz (Warsaw School of Social Science and Humanities), robert.mackiewicz@swps.edu.pl

The principle of truth postulates that individuals think about what’s true, not what’s false. This study investigated whether it predicted performance in reasoning about numbers, e.g. Either A is bigger than 22 or else A is bigger
than 26. Is it possible that A equals 27? Reasoners should respond, ‘yes’, but the response is wrong, because in this case both clauses of the exclusive disjunction would be true. The inference contrasts with control problems in which the focus on truth does not yield errors. Participants responded to experimental and control problems -- disjunctions in Experiment 1 and biconditionals in Experiment 2. In Experiment 1 they drew their own conclusions about the numbers and in Experiment 2 they evaluated given numbers. Experiment 1 yielded correct responses to 73% of controls but only 13% of experimental problems; the results for Experiment 2 were 76% and 6%, respectively. Both experiments showed that individuals tend to focus on the truth. They consider one clause in an exclusive disjunction and fail to think about the concomitant falsity of the other clause. Likewise, they think about the truth of both clauses in biconditionals, but not the possibility that both are false. This focus does not affect performance with control problems, but yields striking errors with experimental problems. The results show that the model theory’s principle of truth can be extended to reasoning about unknown numbers.

**Primbing the Search for Counterexamples in Children And Adults**

Henry Markovits (University of Québec at Montréal), henrymarkovits@gmail.com

One of the important, but unexplained, components of mental model theory is the search for alternate models. In the following, I present a representational redescription model (Karmiloff-Smith) of the alternatives generation process that suggests that the search for alternatives goes through a sequence of developmental stages, consistent with a progression from very concrete to very abstract forms of reasoning. Recent evidence is presented, using a priming paradigm, that is consistent with this model.

A dual-process approach of the mental model theory concerning conditional reasoning and development

Pierre Barrouillet and Caroline Gauffroy (University of Geneva), Pierre.Barrouillet@unige.ch

We present a theory that combines the mental model theory (Johnson-Laird & Byrne, 2002) and Evans’ heuristic-analytic approach (Evans, 2006). This theory assumes that fast, tacit, and automatic heuristic processes deliver an initial representation that constitutes the core meaning of conditionals, whereas fleshing out this initial representation would involve optional analytic processes. This contrast in the processes underpinning the construction of mental models determine differences in the epistemological status for the models pertaining to the initial representation on the one hand and those constructed through fleshing out on the other hand. The different developmental courses of heuristic and analytic processes permit a series of developmental predictions. We shall review a series of developmental studies that have tested these predictions in a variety of tasks including the evaluation of both the truth-value and the probability of indicative, causal, and deontic conditionals.

**Symposium: Mental and Social Simulation**

**Organiser:** Keith Markman, Ruth Byrne

**Rationale:** Mental Simulation has evolved into a core theoretical idea spanning nearly all of psychology. The present set of talks will illuminate, from a variety of perspectives, what the conscious human mind does when it moves away from the mundane here-and-now and travels to the past, projects into the future, or creates meta-thoughts about the present.

**Counterfactual Structure and the Ascription of Meaning**

Keith D. Markman (Ohio University), markman@ohio.edu

Previous work by Kray et al. (2010) demonstrated a connection between counterfactual thinking and perceptions of meaning and inevitability. The present work demonstrates that this is only the case for counterfactual narratives that are subtractive and convergent in structure. By contrast, counterfactual narratives that are additive and divergent in structure reduce perceptions of meaning and inevitability. Underlying mechanisms will be discussed.

**Opportunity Stops Knocking: Regret and Temporal Asymmetry in Perceived Opportunity**

Denise R. Beike (University of Arkansas) and Keith D. Markman, dbeike@uark.edu
According to the lost opportunity principle, regret is experienced when thoughts of opportunities in the past loom larger than thoughts of opportunities in the future to change an undesired outcome. The authors will discuss how perceptions of future and past opportunity are constructed, how these change as time passes, and how attempts to mitigate the emotional experience of regret interact with such thoughts to influence emotional reactions and behavioural choices.

**Thinking About the Self in Time: Temporal Landmarks on the Future Landscape Affect people’s Thinking About, and Motivation to Pursue, Future Selves.**

Anne E. Wilson (Wilfrid Laurier University, Ontario, Canada) and Johanna Peetz, awilson@wlu.ca

Temporal landmarks such as birthdays and significant calendar dates structure the subjective perception of time. The present work suggests that these landmarks have implications for identity and motivation. Specifically, landmarks can induce a contrast between present and future self, whereas when landmarks are absent, people are more likely to assimilate their future qualities with present self.

**Vicarious Task Completion: The Effect of Perceived Completion on Subjective Experience**

Xi Zou and David Faro (London Business School), dfaro@london.edu

Viewing a task as complete, even if it has not yet been completed, colors people’s subjective evaluation of their past experience with the task. This is demonstrated in a series of studies that manipulate task size and perception of completion.

**Mental Real Estate: Inferring Interpersonal Attitudes from Own and Others’ Recall and Forgetting**

Malia Mason (Columbia Business School), mfm2139@columbia.edu

This talk will offer the speculation that people conceive of memory as “real estate” of the mental variety. That is, they believe memory is a finite asset actors allocate according to their interests, concerns, and priorities. Thus, a forgotten name or birthday signals that a person has failed to assign adequate mental resources and therefore must hold the target in relatively low esteem. A series of studies will provide evidence for the notion that an individual’s speech and actions often reveal one’s knowledge, especially one’s social memory.

**The Meaning of Spontaneous Thought**

Michael I. Norton and Carey K. Morewedge, (Harvard Business School), mnorton@hbs.edu

Spontaneous thoughts – thoughts that occur in the absence of premeditation or external stimulation – arise frequently in everyday life. In this talk, it will be suggested that their very lack of an apparent source causes people to imbue spontaneous thoughts with special meaning, leading such thoughts to potently influence judgment.

**Symposium: Moral Reasoning and Values**

Organiser: David Lagnado

**Moral Judgment and Counterfactual Thinking**

Symposium keynote speaker: Joshua Knobe (Yale University), joshua.knobe@yale.edu

A series of recent studies have shown that people’s moral judgments influence their intuitions about various matters that might at first seem entirely non-moral (causation, freedom, intention, etc.). We present a new model to explain these findings. The model claims that the effects arise through a two-step process. First, people's moral judgments impact their counterfactual thinking; then counterfactual thinking plays a role in each of the relevant intuitions.

**Causal Deviance**

Mark D. Alicke (Ohio University), alicke@ohio.edu
Actions that are intended to produce harmful consequences can fail to achieve their desired effects in numerous ways. We refer to action sequences in which harmful intentions are thwarted as deviant causal chains. The culpable control model of blame (CCM) is a useful tool for predicting and explaining the attributions that observers make of the actors whose harmful intentions go awry. We have investigated six types of deviant causal chains; those in which: an actor’s attempt is obviated by the intervention of another person or the environment; the intended effects could not have been produced regardless of the actor’s behavior; other causes diminish the actor’s causal role; the actor brings about foreseen but undesired consequences as a result of pursuing his or her focal goal; the focal action produces a chain of increasingly remote causal events; and the actor derives unforeseen benefits from his or her nefarious actions. A basic assumption of the CCM in these cases is that attributions for the participants’ actions will depend on positive and negative evaluations of their intentions and behaviors. I will describe empirical findings that are consistent with this assumption, and predict other findings for causal deviance phenomena that have not yet been investigated empirically.

Finding fault: Causality and Counterfactuals in Group Attributions
Tobias Gerstenberg, Ro‘i Zultan and David Lagnado, t.gerstenberg@ucl.ac.uk

Attributions of responsibility play a critical role in many group interactions from olympic team sports to scientific collaborations. In this talk, we will explore the role of causal and counterfactual reasoning in blame attributions in groups. We will motivate a general framework that builds on the notion of pivotality: an agent is pivotal if she could have changed the group outcome by acting differently. In a series of experiments, we tested successive refinements of this notion – whether an agent is pivotal in close possible situations and the number of paths to achieve pivotality. In order to discriminate between potential models, we introduced group tasks with asymmetric structures. Some group members were complements (for the two to contribute to the group outcome it was necessary that both succeed) whereas others were substitutes (for the two to contribute to the group outcome it was sufficient that one succeeds). Across all our experiments, we found that people’s attributions were sensitive to the number of paths to pivotality. In particular, an agent incurred more blame for a team loss in the presence of a successful complementary peer than in the presence of a successful substitute.

The good, the bad and the physical: When moral evaluation shapes causal judgment
Briar Moir and John McClure (Victoria University of Wellington), john.mcclure@vuw.ac.nz

Research on causal chains with adverse outcomes has found that human actions are seen as more causal and blameworthy than physical events that produce the same outcome. However research suggests that positive motives and outcomes lead to different judgments. The present research examines causal and blame judgments in causal chains with positive and negative actions and outcomes. It examines whether different patterns of findings reflect the positivity of the causes or the relationships between causes in the chain. This research varied the actor’s motive (positive or negative) and the valence of the outcome (positive and negative) in causal chains and measured cause and blame attributions for the outcome. It also measured the probabilistic contribution of each of the causes in the chain and the role of counterfactual reasoning. The results replicate previous findings with negative actions and outcomes, but show contrasting attribution patterns when actions are positively motivated or chains lead to positive outcomes. Specifically, negative actions are rated higher than physical causes as explanations, whereas positive actions are rated lower than physical events. Judgments of the probabilistic contribution of distal events to the outcome is lower for positive outcomes than for negative outcomes. The findings are discussed in terms of Alicke’s (2000) culpable control model and Mandel’s (2003) judgment dissociation theory. The results suggest that people’s moral evaluations of causes shape their judgments of the contribution of the cause to the outcome. However, these effects are very different for cause and blame judgments suggesting different reasoning processes.

The Role of the Primary Effect in the Assessment of Intentionality and Morality
Michael R. Waldmann and Alex Wiegmann (University of Goettingen), mwaldma@gwdg.de

In moral dilemmas performing an action often leads to both a good primary and a bad secondary effect. In such cases, how do people judge whether the bad secondary effect was brought about intentionally, and how do they assess the moral value of the act leading to the secondary effect? Various theories have been proposed that either focus on the causal role or on the moral valence of the secondary effect as the primary determinants of
intentionality and morality assessments. We present experiments which show that these theories have neglected a further important factor, the primary effect. A new theory is proposed that is based on the key assumption that people’s judgments of intentionality and morality depend on the strength of assumed reasons the agent has for the primary and secondary effects.

**Counterfactuals Mediate the Link between Morality and Causality/Blame**

Bobbie Spellman (University of Virginia, Charlottesville), spellman@virginia.edu

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**Symposium: New paradigm psychology of reasoning**

**Organisers:** Shira Elqayam and David Over

**Rationale:** The psychology of thinking and reasoning has recently been undergoing a transformation which is nothing short of a Kuhn-style paradigm shift. This has been partly the result of the great impact of Bayesian, or more widely subjective probability and utility, analyses and approaches in psychology generally. Fewer and fewer researchers are finding extensional logic a plausible candidate for a psychological theory of human reasoning. However bounded and restricted, it will not do for a processing or computational account or as a normative standard, especially not for natural language conditionals. It cannot in any way explain inductive, informal, and pragmatic reasoning. The founders of contemporary subjective probability and utility, de Finetti and Ramsey, moved on from the logic of certainty, in which premises are simply assumed and so in effect treated as certain. They aimed to develop, in their words, the logic of uncertainty, probability, and partial belief, in which people’s degrees of belief and utility judgments affect the conclusions they come to and the decisions that they make. Psychologists in the new paradigm have been inspired to explain thinking and reasoning as resulting from probability and utility judgments and to integrate it more fully with decision making.

However, there is wide diversity within the new paradigm, and there are many questions for debate. Should Bayesianism laid down as a normative standard as well as a computational level theory? Is the pursuit of normative standards helpful in the first place? How closely should computational models echo Bayesian principles? What is the nature of the processing models and their relation to Bayesian functions? What is the role of social and pragmatic factors? What are the neurological underpinnings of these processes?

Our aim to showcase the productivity and diversity of the new paradigm, by looking at contributions to its central core as well as explorations of its boundaries. We have included logical, meta-theoretical, conceptual, and empirical contributions, from psychologists, philosophers, linguists, and neurologists. We hope for a stimulating debate on what is important in the new paradigm and what its future direction should be.

**Inference from preferences**

**Symposium Keynote Speaker:** Jean-François Bonnefon (CNRS and Université de Toulouse), bonnefon@univ-tlse2.fr

Among the core aspects of the New Paradigm psychology of reasoning is its attention to decision-theoretic issues, that is, to reasoning on propositions which are both uncertain and valued. In this talk, I describe how preferences over propositions influence the inferences we make from these propositions, focusing on two mechanisms: folk axioms of decision and politeness expectations. Folk axioms of decisions (the way we think people decide) help to predict the inferences we make from conditional statements, when these statements feature valued propositions; and politeness expectations (the way we think people phrase disturbing information) help to predict the inferences we make from quantifiers and connectives applied to propositions we find threatening.

**The mental probability logical perspective on the new psychology of reasoning**

**Niki Pfeifer** (Munich Center for Mathematical Philosophy, Ludwig-Maximilians-Universität München), Niki.Pfeifer@lrz.uni-muenchen.de
Some proponents of the new psychology of reasoning argue that classical logic and deductive experimental paradigms should be abandoned in favour of probabilistic approaches. I agree very much with the need of enriching the psychology of reasoning with probabilistic approaches. However, I do not agree with abandoning deduction and logic. Rather, I advocate "mental probability logic". It is deductive since it models inference as the deductive transmission of the uncertainty of the premises to the conclusion. Moreover, probability theory presupposes logic. Finally, I will discuss how formal and empirical work fruitfully interact by selected experimental studies.

**Indicatives, concessives, and evidential support**

Igor Douven (University of Groningen) and Sara Verbrugge, i.e.j.douven@rug.nl

This paper discusses the issue of categorical acceptability of indicative and concessive conditionals. It presents experimental results in favor of the claim that evidential support is crucial in the acceptability of indicative conditionals and also in differentiating between the acceptability of an indicative conditional and the acceptability of the corresponding concessive conditional.

**Uncertainty and the de Finetti tables**

Jean Baratgin and Guy Politzer (Institut Jean Nicod, University of Paris 8), jean.baratgin@univ-paris8.fr

**Introduction:** The new paradigm adopts the Bayesian model as the norm of reference to study human reasoning. Contrary to the traditional binary approach based on propositional logic, a third truth value that represents uncertainty is introduced. A variety of three-valued systems of logic are available. We examine their descriptive adequacy for the usual connectives, including the conditional. Within this framework the so-called *defective* truth-table in which participants choose a third truth value when the antecedent of the conditional is false becomes an explainable and coherent response. **Method:** For each connective (negation, disjunction, conditional, and material implication in a disambiguated formulation) participants produced a truth-table with nine entries defined by the combinations of the values *true, uncertain, and false* for the antecedent and the consequent. **Result:** For negation, conjunction and disjunction the great majority of the participants produced one table in each case that coincides with the corresponding table of the logic of de Finetti. For the conditional they produced two of de Finetti’s tables (conjunction and conditional). For the material implication they produced the latter two tables and de Finetti’s material implication. **Discussion:** For each connective the responses of the great majority of participants can be identified with truth tables that belong to de Finetti’s three-valued logic. Further investigation is needed to interpret the high rate of three-valued conjunctive response to the conditional. **Conclusion:** The logic of de Finetti (and only this one) has a very good descriptive adequacy when uncertainty takes place as a third truth value.

**The probability of iterated conditionals**

Janneke Huitink (Radboud University, Nijmegen), Shira Elqayam and David Over, janneke.huitink@gmail.com

Iterated conditionals of the form ‘if p, then (if q, then r)’ are a hot topic in philosophical logic, as they fine-tune the differences between opposing approaches to conditionals. In contrast, although in recent years psychologists have gained much knowledge about how people understand conditionals, by studying the conditional probability hypothesis and the “defective”, or de Finetti, truth table, there are no published psychological studies of iterated conditionals. This talk presents preliminary experimental evidence from a study comparing the iterated form, ‘if p, then (if q, then r)’ with the ‘imported’, non-iterated form, ‘if (p and q), then r’, using a probability evaluation task and a truth table task, and taking into account qualitative individual differences. This allows us to critically contrast

**Dual Processes in Explicit and Entymematic Conditional Reasoning: Its Probabilities All the Way Up**

Mike Oaksford (Birkbeck, University of London), m.oaksford@bbk.ac.uk

Entymematic conditional inference, where the conditional is not explicitly stated, is ubiquitous in a way that explicit conditional reasoning is not (Dennett, 1998; Rescher, 2007). An experiment is reported that exploits the difference between explicit and entymematic reasoning to distinguish between rival accounts of System 2
“analytic” processes in dual process theories of reasoning (Evans, 2007; Stanovich, 2011). Enthymematic reasoning is hypothesised to be susceptible to a particular probability manipulation that cannot be combined with any logical response to produce the inferential behaviour observed in explicit inference. In contrast, a probabilistic approach can explain both patterns of inference suggesting that in conditional inference, it is probabilities “all the way up.”

A probabilistic treatment of the appeal to authority

Adam Harris (University College London), adam.harris@ucl.ac.uk

The appeal to authority is a prevalent argument form, both in day-to-day affairs, and in more formal settings, such as the courtroom. Day-to-day, a colleague might inform me of a fact that she learned from the weather forecaster. Within the courtroom, expert witnesses are common place. Traditionally, the legitimate appeal to authority has been distinguished from the fallacy of ad Verecundiam. Within pragmatic accounts of argumentation, ad Verecundiam is better characterised as the excessive use of an authority to silence an argumentation opponent. However, even for non-fallacious instances, there are stronger and weaker instantiations of the appeal to authority. Our contention is that the gradedness of the strength of the appeal to authority is best represented by a probabilistic analysis. Specifically, we suggest that Bayesian Networks provide an appropriate formalisation of the appeal to authority, and provide an empirical test of this contention.

On late divergence points and skin deep individual reasoning differences

Wim De Neys (CNRS and Université de Toulouse), bonnefon@univ-tlse2.fr

Although human thinking is often biased, some people are less susceptible to this bias than others. The nature of these individual differences has puzzled researchers for a long time. We propose that a critical but overlooked question in this debate concerns the time point at which the individual variance arises: Do good and bad reasoners take different paths early on in the reasoning process or is the observed variance late to arise? We clarify that although the dominant views in the literature have popularized an early divergence point, recent empirical findings clearly argue against it. We discuss how this case for late divergence points results in a rehabilitation of the role of traditional normative rules and implies that individual reasoning differences are less profound than traditionally assumed.

Neural mechanisms of dual-process reasoning: evidence from fNIRS and rTMS

Takeo Tsujii (Nihon University School of Medicine, Tokyo), tsujiitakeo@gmail.com

Deductive reasoning is the cognitive process of drawing valid conclusions from a given set of premises. Although it should be performed independently of prior knowledge and intuitive beliefs, actual human reasoning often relies on them. Sometimes such beliefs provide valid solutions to problems, though they can also bias judgment. This tendency toward bias in human reasoning has been experimentally studied through the demonstration of belief-bias effect in syllogistic reasoning. Belief-bias effect refers to the tendency of subjects to be more likely to accept the conclusion to a syllogism if they find it believable than if they disbelieve it, irrespective of its actual logical validity. A series of experiments in our laboratory have investigated the neural correlates of belief-bias effect using near-infrared spectroscopy (NIRS) and transcranial magnetic stimulation (TMS). We found that the right inferior frontal cortex (IFC) is critical for performing incongruent reasoning trials. The belief-bias effect was enhanced when the activation of right IFC was impaired by the manipulations of attention-demanding dual task, time-pressure, and magnetic stimulation. These findings successfully demonstrated the neural correlates of belief-bias effect, supporting the proposals of dual-process theory.

De Finetti-tables and working memory load

Walter Schaeken (Katholieke Universiteit Leuven) and Aline Sevenants, walter.schaeken@ppw.kuleuven.be

The aim of the present study is to uncover the relation between cognitive ability and the answer patterns yielded by the truth table task. According to the Mental Models Theory, people with high working memory capacity
answer according to two-valued or ‘logical’ answer patterns. The Suppositional Theory however predicts that the answer patterns given by the most intelligent ones are three-valued. Not only correlations are examined, but in a series of experiments it is tested with a dual task paradigm whether a differential load on participants’ working memory alters their answer patterns. A positive correlation is observed between the cognitive ability measures and three-valued answer patterns, but no effect of the working memory load manipulation is revealed. With an inspection of the classification times we aim to shed light on the processes underlying truth table judgments.

Moral judgment and metacognition

Valerie Thompson (University of Saskatchewan, Canada), valerie.thompson@usask.ca

Symposium: Pragmatics and reasoning: Where’s there’s a will there’s a may

Organiser: Denis Hilton

Rationale: Affirmations and denials of what will or did (not) happen are framed in ways that carry hints about what may or may not happen (or have happened). For example, in the well-known Asian Disease Problem, where participants are told that 600 lives will be lost to a disease if no action is taken, they are told that use of a treatment will lead either to a) 400 lives being saved, or to b) 200 people will die. Although the affirmations about what will happen if this treatment is used are the same, the frames suggest different inferences about what may happen. If it is the case that the affirmation “400 lives will be saved” implies that more may be saved (the at least interpretation) then it would be logical to prefer this to an option that affirms that 200 will die for sure.

Framing, Language, and Reason

David R. Mandel (DRDC Toronto and York University), david.mandel@drdc-rddc.gc.ca

Framing effects on choice under conditions of risk are usually treated as compelling evidence of irrationality in human decision-making, a conclusion that rests on the assumption that numeric quantifiers used to describe an option’s expected outcome are interpreted as exact values. Contrary to that assumption, Experiment 1 showed that the modal interpretation of quantifiers in a standard choice task had a lower-bounded at least interpretation. Moreover, interpretations varied with option explication, moderating the framing effect in a manner well predicted by a rational-choice model. In Experiment 2, quantifiers were modified using the terms exactly or at least, with exact interpretations eliminating the framing effect, as in Experiment 1. The findings indicate that framing effects in similar tasks are due mainly to linguistic processes. Two reasoning errors (the mathematician’s and psychologist’s fallacies) are invoked to help explain why untenable claims of irrational decision-making in this area have persisted for so long.

Possibilities are rare: A pragmatic approach to verbal probabilities

Karl-Halvor Teigen (University of Oslo), Petra Filkuková and Marie Juanchich, k.h.teigen@psykologi.uio.no

In daily and professional life, people encounter a number of situations with uncertain outcomes, where judgments of uncertainty have to be communicated to others. This is sometimes done with numerical p values, but more often with verbal phrases like “a chance”, “a possibility”, or simply “it can happen”. Such expressions are semantically compatible with a whole range of outcomes and probabilities. However, in a series of experiments, we show that they tend to be used pragmatically to describe extreme (and hence rather improbable) events.

Social utility structures & choice of need, may and need not in rule-giving situations

Denis Hilton and Laetitia Charalambides, hilton@univ-tlse2.fr

In institutional contexts, recognised authorities generally juggle with multiple constraints to make appropriate decisions. Thus, efficient rule-making should enable an authority to satisfy his/her institution’s goals and at the same time avoid threatening or overly disconcerting the person or group to whom the rule is addressed. With this idea in mind, we chose to generate a series of contexts where an authority finds herself successively (1) in a
position where she has to juggle with satisfying the demands of two parties equally, (2) in a position where the pressure to satisfy one of the two parties (strong demand vs. weak demand) becomes stronger. Our predictions were that in the case of a strong demand to satisfy a third party, the rule-maker’s principal objective is to get the hearer to comply with the rule, therefore she will formulate the rule as if it is a duty for the hearer (she wants as many hearers as possible to comply with the rule and maximises this probability by choosing must). In contrast, in the case of a weak demand, the speaker’s main aim is to avoid detrimental effects for the hearers if too many hearers comply with the rule. The speaker therefore edicts a rule which is formulated as a right (by choosing may or need not). Although may and need not logically imply each other, we predicted and found that the negative form need not is used to signal a release from obligation; i.e. when an obligation that used to be imposed in the past, is no longer valid in the present. Our results suggest that social utility structures determine choice of deontic expressions in the manner predicted.

Symposium: Probability and logic
Organiser: David Over
Rationale: The great impact of the new Bayesian/probabilistic theories in the psychology of reasoning has stimulated an interest in the relationship between probability and logic. Traditional studies of logical inference in the psychology of reasoning were focused on premises that were assumed and so in effect treated as certain. This focus had very limited relevance to inferences in everyday and scientific reasoning from uncertain premises (most beliefs, hypotheses, and assertions). Tversky & Kahneman (1983) did point out the relation between probability and logical validity for the special case of inferring A from A & B: the logical validity of this inference is equivalent to fact that the probability of A & B cannot be coherently greater than the probability of A. However, the newer probabilistic approaches in the psychology of reasoning are much more general and can be seen as following de Finetti and Ramsey in being concerned with the logic of uncertainty, probability, and partial belief, or with inductive logic. Probabilistic validity can be defined in general and for conditionals that do not suffer from the “paradoxes” of the material conditional. The new approaches move on from the binary, extensional, and monotonic logic presupposed by traditional psychology of reasoning. This symposium will address advanced topics in the relationship between probability and logic.

Modelling the understanding of conditionals by conditional events and productions
Gernot D. Kleiter (University of Salzburg), gernot.kleiter@sbg.ac.at

Human reasoning has a special relationship to logic. For about one hundred years psychology used classical logic as a framework for experiments and theories. Psychology studied how humans solve syllogisms, how they make inferences with argument forms like the Modus Ponens or the Modus Tollens, and how they understand conditionals, e.g., in the Wason Selection Task. Probability logic differs from classical logic in several important respects. (i) Probability logic accounts for the fact that in real life humans are required to make inferences in an uncertain environment and with uncertain knowledge. (ii) While classical logic is monotonic, probability logic is non-monotonic and defeasible. Inference is monotonic if in a valid argument a conclusion is inferred from a set of premises, then this conclusion cannot be retracted when new premises are added. Human reasoning is clearly non-monotonic. (iii) While classical logic is truth-functional, probability logic is not "probability-functional". In classical logic the truth value of a conjunction, e.g., is determined by the truth values of its parts. The probability of the conjunction of two events, however, is not determined by the probabilities of the two events. (iv) Classical logic involves a number of paradoxes, e.g., the paradoxes of the material implication. Probability logic does not lead to these paradoxes. Many psychological investigations and discussions are focused on the human interpretation of conditionals (if A, then B). In probability logic the interpretation of conditionals is modelled by conditional events. A conditional event B | A is true if A and B are true, false if A is true and B is false, but its truth value is void if A is false. The present contribution reports the results of four experiments on the human understanding of conditionals. In all four experiments the participants are presented a sequence of fifty two items. Each item asks for the probability that a conditional holds. The first investigation includes an n-back task to measure working memory. The second investigation compares the understanding of conditionals in twelve years old children, in fifteen years old adolescents and in adults. Here the participants were also submitted two versions of the Wason selection task. The third and the fourth study included two probabilistic prediction tasks. The results show an
overwhelming dominance of conditional event interpretations. There is, however, a minority of participants who consistently give conjunction interpretations. We observed very few material implication interpretations and very few biconditional interpretations (both below one percent of the responses). We could not replicate the findings reporting a prevalence of biconditionals in adolescents, but we also found that younger participants give more conjunction responses. In both studies, male participants give consistently more conditional event interpretations than female ones. We observed one correlation with the n-back task and a correlation with the deontic version of the Wason selection task. The conditional event interpretation of conditionals may be conceived as a production in a production system. Like a conditional event a production is non-applicable if the if-condition does not match the content in the working memory. Such a conception opens the door to embed the human understanding of conditionals into a theory of cognitive representations and processes.

Deductions from Uncertain Premisses: a Probabilistic Approach

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It is argued that one of the success stories of a probabilistic approach to uncertainty is its ability explain the value of reasoning from uncertain premisses, and the dangers to be avoided. It is suggested that a structurally similar approach applies to reasoning from vague premisses.

All roads lead to Rome: on the inevitability of objective Bayesian inductive logic

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In principle there are many ways in which one can provide semantics for probability logic. For example, one can appeal to probability theory, to argumentation theory, to Bayesian statistics, to evidential probability, or to objective Bayesian epistemology (Haenni et al., 2011). In this talk I will discuss the motivation behind the objective Bayesian approach, and will argue that a number of consideration make it stand out as uniquely promising.
Individal papers

Acquisition of Hebrew as a second language A Psycholinguistic Perspective

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The aim of the present work is to

I- Approach Psycholinguistics as an interdisciplinary Science where Linguistics and Psychology are integrated in such a manner which requires knowledge of Philosophy, Pedagogy, Education, Culture, Neuroscience and Computer science.

II- Pinpoint that Psycholinguistics as a branch of Cognitive Science faces problems such as:- (1) determining the amount of knowledge which one needs in order to be able to use the acquired Language (at the levels of Semantics, Syntax, Phonology and Pragmatics). (2) highlighting the mental process involved in using the acquired language (comprehending a lecture, reading a book, writing a letter, conducting a conversation). (3) setting Cognitive Processes (processes of perception, remembering, thinking).

III- Present second language acquisition theories such as (1) Behavioral theory (20th century) (based on Ibn Khaldun Introduction (14th century) with respect to "Linguistic Faculty". (2) Cognitive theory (3) Interlanguage theory.

IV- Apply the three classes of variables (Linguistic environment, Cognitive processes, Innate Linguistic mechanisms) as related to the acquisition of Hebrew as a second language.

V- Examine word-by-word association to bring into view that beginners acquiring the second Language resort to a response correlated with the impulse in a linear (syntagmatic) way, while the advanced learners resort to a response correlated with the impulse in a Paradigmatic way.

VI- Highlight mental processes at the time acquiring Hebrew as a second language in relation to thinking and culture (for example focusing on the procedure of human mind correlating a form with a meaning through a language system).

VII- Set forth an experimental study of psychological processes through which one acquires and executes language system.

VIII- Focus on "Linguistic Performance" as an evidence of "mental processes" to underline the rate of success and failure of the learner, and the range of his/her achievement "Linguistic Competence" analogous with native speakers competence of the language.


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Introduction: Since the time of Plato, philosophers and educational policy-makers alike have assumed that the study of mathematics improves one’s logical reasoning skills. Today, this argument, known as the ‘Theory of Formal Discipline’ (TFD), is used in policy debates to prioritise mathematics in school curricula. However, there is no strong research evidence that justifies it, and some suggestive evidence that it is incorrect. Method: Participants completed Evans, Clibbens and Rood’s (1995) Conditional Inference Task at the beginning and end of one year of post-compulsory study of either mathematics or English literature. Raven’s Matrices and the Cognitive Reflection Test provided measures of potential domain-general mechanisms for reasoning improvement (Stanovich, 2009). Results: The mathematics students improved in conditional reasoning to a greater extent than the English literature students, despite having received no explicit tuition in conditional logic. Intriguingly, the improvement came about via increased rejection of invalid inferences but not increased acceptance of valid inferences. Our data further indicate that the mechanism of improvement is specifically related to mathematical study as opposed to a domain-general cognitive change. Discussion: In line with the TFD, advanced mathematical study was related to improved conditional reasoning skills. This is surprising given previous research findings that not even training in formal logic brought about improved conditional reasoning performance (Cheng et al, 1986). Furthermore, it seems that the mechanism of improvement is domain-specific rather than domain-general. Conclusion: Our results are consistent with the claims made by Plato, and many others since, that studying advanced mathematics is associated with improved logical reasoning skills.
Testing Dual Process Theories: An ERP Study of Belief Bias

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Introduction: Dual process theories of reasoning provide a good explanation for a range of empirical phenomena, and a number of methods have been used to demonstrate the presence of two types of process. Several alternative models of how the dual processes interact have been suggested, broadly categorised here into serial models in which one process precedes the other (e.g. the default interventionist model) and parallel models in which both processes occur simultaneously. None of the techniques used so far to demonstrate dual processes in reasoning have sufficient temporal resolution to directly test which of these alternatives is correct. Event-related potentials (ERPs) do have adequate temporal resolution, and so this study will use ERPs to uncover the stages of the reasoning process and establish if the dual processes proceed serially or in parallel. Method: Participants evaluated 192 relational reasoning problems in which the conclusions were either valid or invalid and believable or unbelievable. ERPs were time-locked to the onset of the final word of the conclusion. Results: ERPs were similar for problems in which logic and belief conflict, and similar for problems with no conflict between logic and belief, but conflict problems elicited a more positive P3 than no conflict problems between 300ms-500ms. Discussion The initial difference between the conditions is a result of the interaction of belief and logic, i.e. whether these factors conflict or not, rather than a consequence of either of these factors solely. This suggests that both logic and belief are influencing the ERPs at the same time and at an early stage in the reasoning process. This finding therefore supports parallel models of dual process theory. Conclusion: ERPs were used to assess the stages of reasoning in a belief bias experiment. The results support parallel models of dual process theory. Other Info Possible themes for this paper are ‘Dual Processes’ or ‘Cognitive Neuroscience of Reasoning’. We would be happy for this to be presented as a poster in the event that it is not accepted for a symposium.

Counterfactual reasoning in Chinese speakers

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Introduction: Bloom (1981) found differences between Chinese and English speakers in inferences drawn from a counterfactual story, attributed to the fact that English distinguishes indicative and subjunctive conditionals but Chinese does not. These findings were repeatedly dismissed (Au, 1982, 1984; Liu, 1985). The present study compared counterfactual reasoning in Chinese speakers who were similar to Bloom’s participants (university graduates, educated without compulsory English), younger Chinese speakers (educated with English and a more westernised system), and English native speakers. Method: There were three groups of participants: mature Chinese speakers, Chinese undergraduates, and English undergraduates. Participants read a counterfactual story in their respective native language, followed by a consequent evaluation task and open-ended questions. Results: Quantitative results revealed that mature Chinese speakers were significantly less likely to infer the falsity of consequents than Chinese and English undergraduates. Qualitative data revealed differences in explanations of their inferences between mature Chinese speakers and English speakers, and Chinese undergraduates performed in-between the other two groups. Quantitative and qualitative differences similar to those found between English and Chinese speakers were also found between mature Chinese speakers who had or had not learnt English later in life. Discussion and conclusion: Chinese speakers similar to those originally tested by Bloom (1981) do not seem to have difficulty with counterfactual reasoning (as argued by Bloom), but their inferences differ from those of English speakers. Younger Chinese speakers perform more similarly to English speakers than to mature Chinese speakers. Such differences could be due to linguistic and/or cultural reasons.
The relative contributions of individual differences in working-memory capacity and presentation mode on multiple-cue probability learning

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Introduction: What permits an individual, such as a pilot, to perform above average in a complex stochastic task? A plausible model of a pilot’s task is that s/he must respond to several stimuli (cues) that are related to an appropriate control response (criterion). The acquisition of skilled behaviour in this kind of task has been studied extensively as Multi-Cue Probability Learning (MCPL). Both properties of task, and individual differences, have been shown to affect MCPL performance (“achievement”). We sought to extend this research by investigating the relative contributions of individual differences in WMC and task features on achievement. Furthermore, we hypothesized that presentation mode that is compatible with an individual’s WMC capability facilitates learning. Method: In 3 experiments using an MCPL paradigm we manipulated the presentation style – graphical or numerical – for cue and feedback displays and measured several individual differences in working memory. In each case the dependent variable was achievement. Results: We found that achievement was always far superior for graphical relative to numeric presentation. Also verbal and visual WMC were significant predictors of achievement irrespective of presentation style. However, there was no significant interaction between the specific nature of WMC ability and presentation mode. Discussion: Our results are discussed in the light of recent work on dual processes in MCPL and also in terms of their implications for the independence of visual and verbal working memory, and for personnel selection and display design. Conclusion: The research is ongoing and we hope to have further data regarding the influence of other task features on achievement by the time of the conference.

An examination of the reasoning process of expert poets during initial writing

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Introduction: There is a growing interest in studying the creative processes that arise in artistic domains. For example, McDonnell (2011) examined the creative processes of a pair of filmmakers and artists who had a longstanding collaborative relationship. The current study examines the core reasoning processes underpinning poetic writing among expert poets. Method: Eight published poets were asked to perform a writing task in response to a writing cue. Participants were given 30-45 minutes to write until they produced a poem that they were satisfied with. They were then given a break before selecting a second writing cue and repeating the task. Participants were asked to think aloud while writing the poem and the session was recorded and transcribed for analysis. Results: The data indicated that initial idea generation is typically associative in nature and related to concepts that are proximal to the poet in time and location. Once an idea has been selected a search is conducted that is focused around that idea and during this process an initial line of poetry is produced that is highly influential to the progress of the poem. Discussion: We suggest that poets’ inspiration and initial writing originates from automatic processes that are associative in nature. Subsequent creative writing takes this ideational output and explicates it through the application of more deliberate reasoning, a key component of which involves making evaluative judgements regarding quality. Conclusion: The study of poetry composition confirms the value of applying dual-process theories to understand the reasoning underpinning real-world creative endeavours. Themes: Creativity and problem solving, real world reasoning We would be willing to have our submission be presented in the poster format in case it cannot be fitted into a symposium.

The influence of causal beliefs on temporal perception

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Introduction: Most contemporary theories of causation agree that causal relationships are inferred rather than perceived. Among the cues used to infer relationships, temporal priority is probably the only uncontested one. It is always and usually implicitly assumed that a causal candidate must temporally precede its effect, with temporal order information being delivered by one’s sensory input. What happens then if there is a conflict between the causal and temporal order, when the effect precedes its cause? According to the default viewpoint, the causal relationship should be rejected and replaced by one that is consistent with the perceived temporal order. Method: We have conducted 3 computer-based experiments featuring causal settings of varying complexity, ranging from a lamp that switches on click to a fully-fledged darts game. In each case the causal and the temporal order contradicted each other, with the effect occurring 100-300ms before the participant’s action that
presumably caused it. Participants were asked to order the events and in some cases provide direct causal judgments. **Results:** Depending on the complexity of the task, 50%-80% of the participants changed the temporal order of events so that the assumed causal relationships were preserved. This was the case even when participants were aware of the question while performing the task and, more interestingly, when temporally consistent but less preferred causal explanations were available. **Discussion-Conclusion:** Our experiments provide evidence for top-down influences of causal beliefs in the perception of temporal order. It appears that especially in small time-scales temporal order is inferred and even when our temporal resolution capabilities suffice, our perception is biased or distorted to fit pre-existent causal theories.

**Emotion, relevance, and arousal in conditional reasoning**

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**Introduction:** Recent work suggests that emotions have an impact on reasoning and that this may be particularly linked to physiological arousal. We examined whether this was moderated by relevance, the extent to which emotion and arousal are related to the semantics of the reasoning contents. **Method:** In two experiments we presented conditional reasoning statements. The interpretation of these statements was manipulated using images (Expt 1) or videos (Expt 2) along two dimensions: affective value (emotional vs. neutral interpretation) and relevance (emotion is related to the semantic content or not). Skin conductance (SC) responses were recorded. **Results:** In both experiments, there was a significant interaction between relevance and affective value. Participants were less likely to provide normatively correct responses when reasoning about emotional contents, but only when emotions were not relevant. When contents were relevant, emotion did not have a deleterious effect on reasoning. Physiological data shows an increase in arousal when stimuli were emotional, independent of relevance; and a negative link between SC and reasoning about emotional contents only in the irrelevant condition. **Discussion:** The results show that relevance is an important variable that moderates the link between emotion and reasoning. Results also confirm the important role of physiological arousal in mediating the link between incidental emotion and reasoning. Results provide a possible account for the discrepancies observed between the effects of incidental and integral emotion on reasoning. **Conclusion:** These studies confirm the important impact of emotion on reasoning and increase our understanding of the cognitive and affective mechanisms underlying this interaction.

**Taking Wason to the market: Studies of the Wason selection task in competitive markets**

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**Introduction:** Individuals frequently violate normative logical principles. The Wason selection task, the most studied reasoning task, is a prototypical example. The social psychological literature on decision-making shows that interacting groups perform as well as the best individual group member in intellective tasks with demonstrably correct solutions. These studies assume that group members share common goals. We extend this research by replacing standard face-to-face group interactions with competitive auctions, where subjects bid for various cards, allowing for conflicting individual interests. **Method:** We report several experiments using the classical Individual-Group-Individual paradigm. First subjects attempt to solve the Wason problem individually; then they deal with the problem in group settings; finally, they face several similar problem individually. The experiments vary with respect to the group stage. The subjects are placed (in between-subjects designs) in (1) interacting groups with aligned incentives, (2) interacting groups with conflicts of interest, (3) combinatorial auctions, and (4) combinatorial auctions with dyads of (cooperating) partners. **Results:** Competitive combinatorial auctions induce impressive learning effects that match standard interacting groups, and lead to specific and general knowledge transfers to new reasoning problems. However, auctions have a clear advantage in circumstances where the conflicts between the members of the group are made salient. Finally, we illustrate the advantages of groups and markets and show that teams of traders learn faster and with less feedback than individuals. **Discussion and Conclusions:** We explain these results within the theoretical framework of collective induction and the strict interaction rules governing competitive auctions. We discuss the potential use of auctions in collective decision-making.

**A cognitive model to bridge psychology and economic modelling**

**Introduction**
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Introduction: It has become commonplace in recent years to question the standard approach to microfounding economic models using rational agents. Some authors, especially in macroeconomics, have moved away from microfounded models to aggregate descriptive population models. An alternative approach (which we follow) is to develop microfoundations which are psychologically realistic and to derive the behaviour of firms and markets from this. Discussion: The challenge is to find an approach that is both psychologically realistic and mathematically tractable in an economic context. We propose a model based on homeostatic adaptation to a base satisfaction level, detection of deviations from this base, pattern recognition, selection of strategies from memory to restore equilibrium, and consumption of cognitive and material resources to implement the chosen strategies. While not capturing all psychological phenomena, this model improves significantly on rational expected-utility models while remaining simple enough to inform economic reasoning and models of market behaviour. One way in which this is done is to extend the principles of economic reasoning and marginal application of scarce resources to the processes within the individual’s brain as well as those taking place between individuals in a market. Results: The model is not yet empirically tested, so this remains a theory paper but it does make testable predictions as well as describing a number of existing observed phenomena in economic decision making. Subject to the success of future experimental work, the model appears to be able to provide better explanations, and better predictions, of the economic behaviour of individuals than other models currently available.

Fluency and Dual Processes in Creativity and Liking Judgments

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Introduction: Fluency has dominant effects on judgment. In this work, we show when people are involved in automatic or deliberative thinking, by extending fluency effects to creativity judgment. We propose that, with limited knowledge people focus on attribute information and think analytically; with some knowledge people think intuitively when information is fluent while analytically when information is disfluent, depending on judgment subjectivity and information salience. Method: In Study 1, we presented descriptions of two new ideas and feature lists of two new products in easy---or hard---to---read font and asked subjects to rate creativity (novelty and feasibility) and liking. In Study 2, we presented the two products in descriptions. A pre---test showed that people were less familiar with one idea than other three targets. Results: In Study 1, although fluency did not affect the judgments of the unfamiliar idea, it affected liking of the two products and novelty and liking of the familiar idea. In Study 2 fluency affected novelty and liking of the two products. Discussion: People used attribute information to evaluate the unfamiliar idea. For more familiar idea and products, they relied on fluency to judge novelty and liking. When we presented products in feature lists, attribute information was used to evaluate novelty. People based feasibility evaluation on attribute information. Conclusion: Limited knowledge does not necessarily lead to intuitive thinking. Rather it can inspire deliberative reasoning if attribute information is accessible. More knowledge cannot guarantee analytic thinking; fluency comes into play when judgment is subjective (e.g. liking and novelty) and attribute information is less salient (e.g. in description)

Reasoning in Schizophrenia: A Review of the Literature

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Introduction: A long tradition of research on schizophrenia considered the deficits on logical reasoning a typical feature of this mental disorder. In this paper, we’ll try to explain why the “lack of logic” paradigm seems to fail to understand schizophrenics’ reasoning abilities. Methods: The most recent literature on schizophrenics’ reasoning abilities will be reviewed. Results and discussion: Differences in reasoning between schizophrenic patients and controls are surprisingly small, and, in some cases, schizophrenics seem to be more logical than normal controls. When schizophrenic patients make mistakes about the judgment of a syllogism’s validity, or when they tend to jump to conclusions, they do it for a general weakness in cognitive performances (e.g., a lower I.Q. or a weakened memory), rather than for a schizophrenia’s specific impairment. Moreover, schizophrenics perform even better than normal controls on specific reasoning tasks, e.g. they don’t get distracted by the syllogism’s content, they falsify conditional rules without being diverted by the heuristic traps, and they are usually less sensitive to some reasoning bias. Conclusions: An increasing amount of data coming from the cognitive perspective seems to reach
the same conclusions that phenomenological psychiatry had reached long time ago: that is, we have to interpret schizophrenia not as a deficit of rationality, but, in some respects, as an excess of it.

Do you have to be smart to know what the others are thinking?

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**Background:** Research concerning mindreading has dealt extensively with its (in)dependence on executive functions. However, surprisingly few studies focused on direct relationship of mindreading with intelligence. Especially verbal intelligence is sometimes considered as confounding factor for better mindreading performance. Therefore, the aim of our study was to investigate effect of verbal intelligence and memory on mindreading of pre-adolescents without any disorders and also its possible relationship to empathy. **Method:** Our sample consisted of 47 preadolescents aged 13 – 15 (M = 13.76, SD = 0.35, n(boys) = 19, n(girls)= 28) who filled in two mindreading tests, **Imposing Memory Task** (Kinderman, Dunbar, & Bentall, 1998) and **Awkward Moments Test** (Heavey et al., 2000), **Basic Empathy Scale** (Jolliffe & Farrington, 2006) and we obtained data about their intelligence from verbal subtests of **Intelligenz Struktur Analyse** (Fay, Trost, & Gittler, 2001): Searching for common features, Revelation of the relationships, Generation of terms and Memory. **Results:** There was no significant correlation after controlling for gender and age effects. However, the above average intelligence group showed superiority in mindreading measure over average children (but surprisingly not over below-average children). **Conclusion:** Our results are in line with findings of Rajkumar et al. that point to the mindreading as independent cognitive domain.

To do or not to do? A cognitive consistency model for drawing conclusions from conditional instructions and advice

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**Introduction:** This paper investigates a cognitive consistency model of the directionality of **Do q if p** performative conditionals that use probability expressions to express uncertainty about the antecedent p, and the implications of the antecedent for taking the action q in the consequent. We hypothesize that the directional sign of the antecedent is calculated by multiplying the desirability/undesirability of the precondition for performing the action in question, the polarity of the probability expression used in the antecedent, and the presence or absence of an explicit negation of that probability expression. We then expect that this sign is equivalent to the sign of the consequent. **Method:** We present two experiments. In the first one, participants had to complete antecedents with an appropriate probability expression in order to equilibrate the performative conditional, while in the second experiment they had to produce the consequents given the antecedents. **Results:** Results show that participants complete antecedents with a probability expression whose polarity enables balance to be established, while the second experiment shows that participants produce consequents that maintain balance with the antecedent. **Discussion:** These results extend previous results on sentence directionality and suggest that cognitive balance principles are important in maintaining the pragmatic coherence between antecedents and consequents in such conditional sentences. **Conclusion:** The combination of signed elements enables us to predict whether the complex sentence antecedent has a positive or negative directionality, which in turn predicts whether the consequent q should be positive or negative in order to achieve sentence balance.

Goal-driven attentional control in analogical mapping

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**Introduction:** Goal-driven attentional selection of task relevant information during analogical mapping might be its missing explanatory factor. We aimed to load this mechanism by increasing a number of objects surrounding analogical structure in a modified scene mapping task, and to test how selection interacts with the coping with relational complexity (RC) and distraction. Moreover, we examined the poorly understood role of behaviorally salient stimuli (people). **Method:** We orthogonally varied RC, the occurrence of semantic distractors within analogical structure, and a total number of objects (TNO) in a scene, and measured accuracy of mapping. Either people or inanimate objects could satisfy analogical roles. In Experiment 1, people occurred among both irrelevant and relevant objects, while in Experiment 2 they were placed only among the latter. **Results:** In both experiments, the accuracy decreased when RC and the TNO increased, and when distraction occurred. Relations between people were more accurately mapped than isomorphic relations between inanimate objects. The relation between
RC and distraction was underadditive. Distraction reduced the TNO effect only when no people appeared in irrelevant roles. With people in irrelevant roles, increased RC enhanced the TNO effect. **Discussion:** Apart from replication of the RC and distraction effects, we showed the crucial role of goal-driven selection. Also, for the first time it was shown that behaviorally salient stimuli can facilitate (if in relevant roles) or impede (if in irrelevant roles) analogical mapping. **Conclusion:** The study shed light on the interplay between syntactic (RC), semantic (distraction) and, foremost, pragmatic (selection) constraints and mechanisms of analogical reasoning.

**Oscillatory model of individual differences in relational integration**

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**Introduction:** Recent research indicated that relational integration – the flexible binding of items held in working memory (WM) to the corresponding relational roles – may be the crucial underlying mechanism of reasoning. Although a few models successfully described WM storage as patterns of oscillations, little is known about possible neurocognitive mechanisms of relational integration, and especially about substantial individual differences in this process. Our aim was to shed some light on these phenomena with a novel oscillatory model. **Method:** Following others’ work, our model assumes that stored representations are separated by asynchronous oscillations, while elements of one representation are bound by synchrony. The new proposal is one simple equation that controls oscillations. Asynchrony is supported by lateral inhibition, while synchrony can be boosted by extra coactivation of elements. We simulated the task of finding of simple relations among syllables, and compared these data to the performance of 170 participants. **Results:** Substantial variation of results in the task, which also highly predicted scores on two inductive reasoning tests, was replicated by varying the strength of inhibition. Moderate inhibition led to maintenance of a few bindings, while increased inhibition led to their collapse. Increased coactivation compensated for too high inhibition. Several other effects were also predicted. **Discussion:** Relational integration hugely varies in population and it presumably relies on both the proper control over inhibition within WM, which may be related to attentional control in the parietal cortex, and the extra activation of bindings, which may be supported by the prefrontal cortex. **Conclusion:** Combining the research on computational, cognitive, and neuronal aspects of relational integration helps to understand low-level mechanisms of inductive reasoning.

**Effectiveness of gesturing in the learning phase: A mental model account**

Ilaria Cutica (University of Milan) and Monica Bucciarelli

**Introduction:** We advance a mental model account for the role of gestures in the construction of the meaning of a text: gestures might lead to the construction of representations that are easily incorporated into the mental model, alongside the representations constructed on the basis of the verbal information, enriching these and completing the model. In this paper we focus on gesturing at time of study. The current literature considers as indices of model construction the discourse-based inferences produced by the learner, and the loose of verbatim of the original text. **Method:** In Experiment 1, we invited adult participants to study scientific texts in two conditions: while representing with gestures the concepts they read, and while keeping their hands still. Their recall memory was evaluated with respect to: correct recollections; discourse-based inferences; erroneous recollections. In Experiment 2 we adopted the same materials and the same experimental conditions to evaluate participants’ recognition memory. **Results:** As expected, gesturing at time of study resulted in more correct recollections and discourse-based inferences (Experiment 1) and in a poorer memory for text verbatim (Experiment 2) at time of retrieval. **Discussion:** Results show that gesturing at time of study facilitate mental model constructions. This is consistent with our previous findings on the positive effect of co-speech gestures by the speaker on the hearer’s mental model. **Conclusion:** We argue that mental model theory is a good candidate for explaining the mechanisms underlying the role of gestures in discourse and text comprehension because of its emphasis on the non-discrete nature of mental models.

**Confirmation bias in argumentative reasoning**

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Argumentative approaches to reasoning have been recently revived by Mercier and Sperber (2011). But such accounts may come in different flavors, and here I propose an argumentative/dialogical account of the historical and conceptual origins specifically of deductive reasoning. On this account, argumentative practices can have a
debiasing effect: it is precisely the dialogical, adversarial nature of deduction that offers a counterbalance notably to confirmation bias. In particular, the property of logical necessity arises from the desideratum of formulating indefeasible arguments in debating situations, i.e. arguments which would compel the opponent to accept the conclusion because it is impossible for the premises to be true while the conclusion is false (absence of counterexamples). But the adversarial role of opponent was later absorbed by the deductive method itself, and counterbalance to confirmation bias now amounts to the fact that only indefeasible arguments count as deductively valid. Mercier and Sperber claim that their argumentative theory predicts that human reasoning would have a strong confirmation bias component, so my alternative account of the potential debiasing effect of argumentative practices can be viewed as a challenge to their proposal. Confirmation bias, undoubtedly a very pervasive phenomenon, is essentially related to the tendency to bring in external information when reasoning – what Stanovich (2003) has described as ‘a fundamental computational bias’. Argumentative situations may force the reasoner to confront different opinions and positions and re-think her prior beliefs, rather than only reinforcing them. Thus, Mercier and Sperber’s account of the relation between confirmation bias and argumentative reasoning may need to be revisited.

Eye Movements in Conditional Reasoning: ‘If then’ and ‘Only if’

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Introduction: An eye tracking study was carried out to investigate the time course processing of reasoning from ‘if then’ and ‘only if’ conditionals. Previous research shows people tend to endorse different rates of inferences from ‘if then’ and ‘only if’. Method: Participants were presented with a series of inference problems on a computer screen. Their eye movements were monitored as they completed the problems. Results: Participants endorsed the same rate of forward inferences (MP and DA) from ‘if then’ as ‘only if’ but were quicker from ‘if then’. They endorsed more backward inferences (MT and AC) from ‘only if’ than ‘if then’ and were quicker for MT from ‘only if’. The eye tracking data indicated no differences between ‘if then’ and ‘only if’ in the initial time spent reading each part of the problem. Time differences between ‘if then’ and ‘only if’ and between the different inferences tended to arise due to participants spending more time fixated on the conditional, as opposed to the minor premise, or the set of possible answers. Additionally, participants tended to fixate more on the antecedent of the conditional, rather than the consequent, for both ‘if then’ and ‘only if’. Discussion: The data support the idea that people keep two possibilities in mind when reasoning from ‘only if’ (B & A, not-B & not-A). Differences in the fixation durations for different components of the problem highlight which parts may require the most processing. Conclusion: Eye movement data may provide valuable insights into the course of cognitive processing during reasoning.

Inductive reasoning with emotional contents

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Introduction: We investigated the vastly ignored effect of emotion on inductive reasoning using the dual-systems framework (Evans, 2003). In two studies, we examined the impact of emotional content on statistical reasoning under experience-relevant and experience-irrelevant conditions. Method: 64 controls were recruited in Study 1. For Study 2, both controls (N = 74) and victims of sexual abuse (N = 23) were recruited. The impact of emotion on inductive reasoning was examined in three content types: generally emotional, sexual abuse and neutral. Results: Base rate task Control participants relied more on the anecdotal than the statistical information specifically for the sexual abuse problems in Study 1, and this was also observed for generally emotional problems in Study 2. The impact of anecdotal information was similar in all three content types for victims. Belief problem task Victims relied more on statistical information on the sexual abuse contents than controls. Discussion: As expected, the relative impact of anecdotal information was greater for the emotional contents compared to neutral contents for controls. This was different for victims who relied on statistical evidence more than controls for sexual abuse problems and showed no difference in reasoning about emotional compared to neutral base rate problems. Conclusion: Results are consistent with the proposition that irrelevant emotion generally impairs analytical processes while experience-relevant emotion has a beneficial effect.
Grounded rationality, epistemic relativism, and dual processing
Shira Elqayam (De Montfort University, Leicester), selqayam@hotmail.com

Normativism, the approach that judges human rationality by comparison against normative standards, has recently come under intensive criticism as unsuitable for psychological enquiry, and it has been suggested that it should be replaced with a descriptivist paradigm. A descriptivist paradigm focuses on instrumental rationality – i.e., behaving in a way that helps achieve one’s goals. In this paper I outline and defend ‘grounded rationality’: a new metatheoretical framework based on the principles of descriptivism, instrumental rationality, and epistemic relativism (i.e. the relativity of knowledge). Whereas bounded rationality takes into account universal biological and cognitive limitations on human rationality, grounded rationality adds cognitive variability. I see normative rationality as a special case of instrumental rationality regarding epistemic goals; hence, considerations of epistemic relativism are as relevant to norms as they are to mundane goals. Whether any specific behaviour is rational for a particular agent depends on the context, the agent’s relative cognitive resources, the effectiveness of the behaviour for the agent, and her normative and mundane goals. Hence, investing cognitive effort in Type-2 processing may be considered less instrumentally rational for agents who have low cognitive motivation – i.e., cognitive effort is not one of their epistemic goals. Similarly, behaviours that rely on Type-2 processing might be considered less instrumentally rational for agents who have fewer cognitive resources to invest. I conclude with a discussion of Panglossianism. Grounded rationality is not Panglossian, as agents can still behave in a way that is instrumentally irrational by their own lights.

The Dimensional Arrow: Agreement in Directional Mapping of Dimensions among Mandarin Chinese- and English-speakers
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Introduction: We examined the way in which people orient visual dimensions, such as size and clarity. Further, since several studies have demonstrated that language can affect perception, we questioned whether such dimensions are oriented in different ways by different language groups. If so, such differences in orientation might be predicted by differences in language use. Method: We invited native English-speakers and native Mandarin Chinese-speakers to rate items varying along a dimension on an unlabeled vertical scale. They did this in an environment absent of language, and instructions avoided mention of dimensions. Later, they were asked to use words to describe the difference between exemplar items (e.g., to fill in the blank: “one item was _____ than the other”), spontaneously choosing either bigger or smaller). The dimensions we developed were size, clarity, complexity, and darkness. Results: Most people mapped dimensional endpoints similarly. Using size as a standard, we found that the majority of participants mapped the clearest, most complex, and darkest items to the same end of the vertical scale as they mapped the biggest items. This indicates that all four dimensions have a weighted or unmarked end (i.e., all are directional). However, there were group differences on the lexical task; there was little cross-language agreement about how to describe the relations between stimuli. Discussion & Conclusion: We found compelling evidence for the directional organisation of perceptual dimensions: both language groups mapped dimensions directionally. We found no evidence that this processing is influenced by language: mapping patterns were not predicted by spontaneous word choices.

Overthinking our Choices: Individual Differences in Gathering Information about Options
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Introduction: Many reasoning and decision-making problems benefit from deliberation, while others appear to favor intuition. We explored whether decisions that rely on information gathering are affected by a deliberative thinking style (Need for Cognition [NFC]) or fluid intelligence. Method: In two studies, we presented participants with simplified choice scenarios in which they must gather information (positive or negative “smiley” faces) about two options before choosing one. We measured the time spent gathering information (equivalent to the amount gathered), participants’ NFC and Raven Matrices (fluid intelligence) scores, confidence, improvement, accuracy focus, and social desirability. In Study 2, we also instructed one group to focus on speed, in order to test whether high-NFC individuals require spending extra time in order to achieve baseline accuracy. Results: In both studies, we found that higher NFC is related to spending more time gathering information – without any significant gain in accuracy. This relationship was independent from fluid intelligence. We also found no evidence that high-NFC
individuals require more time to achieve basic accuracy, as they performed equally well in the speeded condition. In both studies, we found that high-NFC individuals were significantly more focused on accuracy, and in Study 2, we found significant mediation of the NFC-time effect by social desirability. Discussion & Conclusion: High-NFC individuals appear to be “wasting” time on this task, as they spend more time than their low-NFC peers, and without significantly improving their accuracy. Possible reasons may include a general focus on accuracy and/or a desire to impress positively by spending more time thinking.

Equally Supported Hypotheses Reveal Biased Diagnostic Reasoning

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Introduction: During sequential diagnostic reasoning observed symptoms have to be integrated to arrive at a diagnosis. Ambiguous symptoms activate multiple hypotheses, which are subsequently updated during the reasoning process. We examined the effects of symptom order and the highlighting of alternatives on final diagnoses. Method: A series of experiments with quasi-medical problems was conducted. At the beginning of each experiment, participants learned about four chemicals and the symptoms that they could cause with varying causal strength. After this learning phase, four symptoms were sequentially presented within each trial and participants stated their diagnosis. Two experiments prompted stepwise ratings to explicitly highlight alternative hypotheses. A fourth experiment induced an implicit highlighting of alternatives via inconsistent symptoms. Results: Without highlighting of alternatives, a stable primacy effect favoring the hypothesis triggered by the first symptom was observed. If alternative hypotheses were explicitly highlighted, the primacy effect diminished for cases of two candidate hypotheses but partially remained for four candidates. Implicit highlighting of alternatives by inconsistent symptoms did not reduce the primacy effect. Discussion: Process models of information integration can account for the observed primacy order effect. They suggest that early symptoms frame the serial integration of later symptoms when multiple hypotheses are updated. An explicit highlighting of alternative hypotheses allows a full consideration of merely two candidate hypotheses. Conclusion: The observed order effect confirms the role of memory dynamics in diagnostic reasoning. The tasks with four candidate hypotheses indicated capacity limits because highlighting of alternatives did not eliminate the primacy effect.

Surprise is Sense-making Explanation

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Introduction: What makes some events surprising? Although surprise was originally classed as a basic emotion, recently, it is has been cast more cognitively as making sense of abnormal events. We propose that this sense making process uses given information (in the scenario description) and recruited prior knowledge (cued by the scenario) to explain the surprising event. From this perspective, some surprises are more surprising than others because it is harder to find an explanation for why an abnormal event occurred. Methods: An experiment is reported that tests this theory by systematically manipulating the given information in a scenario (enabling versus non-enabling information) and the prior knowledge recruited by the scenario (high- versus low-prior-knowledge), in a paradigm where participants make a surprise judgement. Results: The results show that both variables interact additively to affect surprise judgments, as predicted, and that prior knowledge reliably affects the productivity of people’s explanations (i.e., the number of alternative explanations produced to explain a surprising outcome). Discussion: Surprising events have to be explained in order to make them sensible. Every surprise scenario has a space of explanations that is dynamically constructed and shaped by both given information and prior knowledge. When these variables are systematically manipulated our results show that predictable effects occur. Conclusion: The consistent picture that emerges from this research is that ease of explanation, mediated by both given information and prior knowledge, influences why we judge an outcome to be surprising. Accordingly, the concept of explanatory scope may indeed hold the key to understanding surprise.

A theoretical model of delusional belief: Integrating reasoning, perceptual and emotional processes

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The current study aims to build on previous attempts to develop an integrative theoretical model of delusional belief, by incorporating emotional (e.g. Fowler et al., 2006) and perceptual processes (e.g. Maher, 2005) in addition to cognitive biases, such as liberal acceptance (Moritz et al., 2007), confirmation bias (Freeman et al.,
valuing different human lives

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Introduction: How do people value human lives of different ages? A life expectancy principle would predict that younger individuals should be prioritized over older individuals (e.g., Li & Chapman, 2009). However, this trend may reverse in the early years of childhood, partly because older individuals have had greater investment placed in their lives (e.g., Dworkin, 1999). We carried out several experiments to examine these competing predictions.

Method: In Experiments 1 and 2 participants were presented with a series of tragic choices between two individuals (differing only in age) and indicated which of the two should be saved, and whose death would be more tragic. Participants were instructed that each individual had an equal chance of survival if they were saved. In Experiment 3, participants thought aloud while making these decisions. Experiments 4-6 tested several possible explanations for a preference for older individuals. Results: The majority of participants (or in some studies, a substantial minority) indicated that the value of a life increased across the early years of childhood, only later declining. Experiments 3-6 provided support for several independent reasons why older individuals may be valued more highly – because they have more social connections; because more effort has already been invested in their life; and because they can more readily appreciate the meaning of death. Discussion: and Conclusion The present results document a previously neglected phenomenon – the perceived value of a human life increases throughout the early years of childhood. We discuss implications for moral psychology and medical decision-making.

Temporal predictability facilitates elemental causal induction
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Introduction: When encountering repeated instances of causes and effects, we also experience multiple cause-effect temporal intervals. Where this interval is constant it becomes possible to predict when the effect will follow from the cause. Greville and Buehner (2010) demonstrated that in instrumental action-outcome learning tasks, enhancing temporal predictability by holding the cause-effect interval constant elicited higher judgments of causality in human subjects compared to conditions involving variable temporal intervals. However, Young & Nguyen (2009) found that temporal predictability resulted in a higher percentage of incorrect selections when choosing between multiple causal candidates. The research presented here aimed to address this discrepancy.

Method: Two experiments were conducted that were essentially observational analogues of Greville and Buehner’s instrumental studies. In both experiments, temporal predictability was manipulated by varying the length of the interval separating a candidate cause from its effect. Results: Both experiments demonstrated that participants’ judgments of causality were significantly higher when the temporal interval was fixed than when it was constant. Discussion: The results clearly indicate that temporal predictability facilitates causal discovery in elemental causal induction. We examine various potential reasons why Young & Nguyen obtained differing results, and consider the implications of our findings for various theoretical perspectives including associative learning theory, the attribution shift hypothesis and symbolic representation of causal structure. Conclusion: We conclude that temporal predictability facilitates elemental causal induction, but that variability of temporal intervals may have different effects in other kinds of causal reasoning.

Sunk cost effect - psychological, cultural or just economically rational?

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The sunk-cost effect (SCE), where goods or opportunities are valued not according to their future benefits but according to the resources previously consumed to acquire them, is a commonly observed fallacy in behavioural economics that has important consequences for financial markets, business decisions and consumer behaviour as well as development economics. The consequences of the fallacy include overinvestment in loss-making projects, an unwillingness to "cut losses", and more generally suboptimal decision-making, which takes into account factors that are formally irrelevant in that they cannot affect future utility. It can affect financial decision-making in a way that is detrimental both to the individual, the broader economy and society as a whole. Psychological explanations for this phenomenon differ: it has been theoretically linked to regret, loss aversion and to the endowment effect, where people value goods more highly once they own them. However, some economists (e.g. McAfee et al. 2007) have suggested it may not be a bias at all but a rational behaviour intended to send a reputational signal that the agent’s commitments are credible. Building on the pioneering work of Levinson and Peng (2006), we explore the existence and potential causes of this effect in different cross-cultural contexts with a questionnaire approach on c. 250 subjects across six countries in Europe, North America and Asia to assess how the SCE correlates with other variables. We replicate the work of Arkes and Blumer (1985) to measure the strength of SCE and related escalation errors in individuals. We ascertain within-subject and within-culture correlations between the SCE and materialism, conscientiousness, willingness to defer gratification, action/state orientation, cultural importance of "face" and economics education in the context of Hofstede's cultural dimensions. We also ascertain correlations between the SCE and econometric data from the countries in question, on long-term versus short-term investment and stock market volatility. Our findings illuminate the question of whether, independently of individual psychological traits, cultural factors have an impact on the SCE. Furthermore, they provide empirical support for subject-level relationships between susceptibility to the SCE and other psychological variables. Finally, they suggest some economic consequences of these psychological and cultural effects.

Euclid's Diagrammatic Logic and Cognitive Science

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For more than two millennia, Euclid’s Elements set the standard for rigorous mathematical reasoning. In present day cognitive science, aspects of Euclidean geometry have been investigated independently in the _elds of mathematical cognition and the psychology of reasoning, but a uni_ed approach to geometrical reasoning is lacking. In this talk, we will suggest that recent theoretical work on Euclid’s geometric reasoning with diagrams might help us understand what such a uni_ed approach should be. To this end, we will review empirical and theoretical works in mathematical cognition and the psychology of reasoning in the light of these new logical developments. Our investigation is organized around two issues: (i) the interpretation of diagrams and (ii) the
reasoning with diagrammatic information. We will argue that cognitive intuitions of Euclidean geometry might play a role in the interpretation of diagrams, insofar as interpretation of diagrams requires an abstract conceptual system with normative geometrical concepts such as circle and infinite line. We will then evaluate the capacities of the Mental Rules Theory (MRT) and the Mental Models Theory (MMT) to represent geometrical reasoning with diagrams. We will argue that: (i) the MRT can represent geometrical inferences, but fails to represent construction on diagrams and (ii) the MMT can represent construction operations on diagrams, but fails to account for the precise way inferences can be drawn from diagrams. We conclude that a cognitive framework for investigating geometrical reasoning empirically will have to account for both the interpretation of diagrams and the reasoning with diagrammatic information, and that the framework developed by Stenning and van Lambalgen appears as a good candidate for this purpose.

The effect of state shame and guilt on perception of risk

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Affective state plays an important role in determining the level of risk people perceive in various situations. Johnson and Tversky’s (1983) seminal work showed that experimentally induced negative states were associated with heightened perceived risk, whereas positive states were associated with decreased perceived risk. The importance of taking an emotion-specific approach to this area has since been highlighted by Lerner and Keltner’s (2001) work on fear and anger. This study furthers this emotion-specific work by identifying the unique effects of two further negative emotions on risk perception – shame and guilt. Fifty-four undergraduate psychology students were assigned to either a state shame induction, state guilt induction or a neutral control group, before completing a questionnaire designed to assess how risky participants perceived a series of different risky behaviours to be (Domain-Specific Risk-Taking Scale; Blais and Weber, 2006). The results showed that high state guilt was significantly associated with heightened perceived risk, whereas state shame had no effect on perceived risk. We propose a cognitive appraisal-based approach to the explanation of these findings, in which guilt is associated with adaptive modified behavioural action, whereas shame is associated with powerlessness and withdrawal. These findings extend those of previous emotion-specific work, by showing that two arguably similar moral emotions can have very different effects on perceived risk. They also contribute to our previous work on shame and guilt, which has shown that these emotions have differing effects on risk-taking in gambling tasks.

Is social reasoning special? Social reasoning and perspective shifts amongst typically developing and children with Autistic Spectrum Disorder.

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Introduction: It is often argued that social reasoning is special; that is humans have evolved specialised modules for dealing with social information. An alternative view is that social reasoning arises from the interaction of a number of brain regions which are also involved in general processing across domains. In this paper we examined conditional reasoning within social and non-social contexts amongst Typically Developing (TD) and Children with Autistic Spectrum Disorder (ASD), where the latter group are assumed to have specific difficulties processing social information. We also examined children’s capacity to reason from differing social perspectives. Method: The TD (N=39) and ASD groups (N=19) were matched on the British Picture Vocabulary Scale. Experiment 1 required participants to identify the conditions that violated conditional rules of the following kind: If you eat your dinner then you can have a desert participants were asked to either take the perspective of a child or a parent. Experiment 2 examined conditional reasoning on the reduced array selection task (RAST). The conditionals contained either non-social or social content. Results: Experiments 1 and 2 showed an advantage of social over non-social problem content for the TD group only. The ASD group performed at a similar level on both problem types. However, the TD and ASD groups did not differ in their capacity to identify rule violations from differing social perspectives. Discussion: The findings are consistent with the view that social reasoning draws on domain specific reasoning mechanisms that develop differently amongst children with ASD. However, the evidence that ASD children are able to readily switch social perspectives suggests a more complex picture. The findings are discussed in the context of recent accounts that emphasise the importance of information integration in the processing of complex social material.

An application of professional decision making research in the social care and health sectors: Identifying expert judgement consensus for a web based training aid
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Introduction: Cases of financial abuse present complex challenges for professionals, but there is little guidance to support decision making in such cases. The research aim was to establish the judgement approach of experienced professionals to develop a web based decision aid. **Method**: Secondary analysis of existing factorial survey data was conducted. The factorial survey consisted of social care and health professionals (n=152) responses to 65 online case scenarios, including 15 repeated cases, where they indicated their certainty of abuse in each case. Cluster analysis of raw judgement scores was conducted, using regression analysis and incremental F-tests to compare cue weightings by cluster. Judgement consistency was also examined. **Results**: Cluster analysis identified four groups showing a wide variation in judgement patterns. The ‘Confident & Active’ group (n=33) showed the greatest judgment consistency. Incremental F-tests demonstrated that certainty of abuse was significantly influenced by the nature of the financial problem suspected and the older person’s mental capacity. In order to illustrate the impact of each cue category on certainty of abuse, an approach outlined by Suits (1984) was adopted. **Discussion**: The approach used to translate the findings from the regression analysis into materials for the on line training aid offers a potential solution to the difficulties of representing the findings of regression with dummy variables, as well as how they can be meaningfully represented in a practical context. **Conclusion**: The effectiveness of the decision aid is currently being tested using a randomised controlled trial.

**Memory Indexing of Sequential Symptom Processing in Diagnostic Reasoning**

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**Introduction**: Explaining symptoms by the most likely cause is a process during which hypotheses are activated and updated in memory. Initial focal hypotheses frame subsequent symptom processing. **Methods**: In a learning phase, participants acquired knowledge about four chemicals and the symptom categories that each could cause. There were three symptom categories per chemical, two levels of causal strength, and symptoms were ambiguous. In the same session and in a session one week later, sequences of four symptoms were presented auditorily and participants had to indicate the most likely cause. By letting participants learn about causes and symptoms in a spatial array, we could apply eye tracking during diagnostic reasoning to trace the activation level of hypotheses across a sequence of symptoms. **Results**: Fixation proportions on the emptied spatial array were computed separately for intervals of symptom sequences. Fixation proportions on the former locations of possible causes reflected the causal strength of initial symptoms, a bias towards focal hypotheses, and the final diagnosis. **Discussion**: Looking-at-nothing revealing memory activation consistent with process models of diagnostic reasoning was stable even after one week. Particularly for sequences, in which the initial focal hypothesis was not the final diagnosis, gaze behaviour provided valuable information not available from responses and response times. **Conclusions**: Memory Indexing affords process tracing of complex cognitive tasks by employing the looking-at-nothing phenomenon that proved stable over one week.

**Testing Bayesian and Plausible models of argumentation using linked and convergent arguments**

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**Introduction**: Informal logicians have identified several alternatives to the deductive/inductive dichotomy for the evaluation of arguments (Blair, 2007). In this regard, the notion of plausibility can provide one of those viable alternatives (Rescher, 1977; Woods & Walton, 1982; Pollock, 2006; Walton, 1992; Walton, 2001). However, recent developments on the Bayesian approach to argumentation claim that the idea of plausibility can be encompassed within this framework (Hahn & Oaksford, 2006; Hahn, Harris & Corner, 2009). Walton (1992) maintains that there are argumentation rules that cannot be properly understood in probabilistic terms, but require an alternative way of conceiving the judged strength of the argument: plausibility. The aim of this paper is to present experimental work pitting these explanations, Bayesianism and plausibilism, against each other. **Method**: Forty-eight participants were presented with five linked and five convergent arguments, whose strength can be modeled either as a case of Bayesian updating or as the application of the MAXMIN rule. In the first case, the probability of the conclusion is a function of the probability of the premises. In the second case, the probability of the conclusion matches the strength either of the most or the least plausible premise, depending on the argument structure. **Results**: In order to compare the adjustment of Bayesian and plausible models to data, multiple measures were
calculated based on participants’ argument evaluations (e.g. “noisy-or”, MAXMIN rule’s calculation, and part-whole differential (PWD) (Yanal, 1991)). Whilst PWD varied between linked and convergent arguments as predicted by a plausibility-based evaluation, MAXMIN rule and “noisy-or” did not fit the pattern predicted.

Discussion & Conclusion: Overall, structure does determine the perceived strength of the argument. Still, results suggest that predicted differences between Bayesian and plausible models are not equally manifest in participants’ evaluations of linked and convergent arguments.

Backtracking counterfactuals: probability and structure

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Introduction: Counterfactual reasoning has recently been understood using the logic of intervention (Pearl, 2000, Sloman & Lagnado, 2005), where modifying the value of a variable allows the reasoner to cascade down the consequences of the intervention. This idea captures an important aspect of the usefulness of counterfactuals (Lewis, 1986), but leaves out other uses of counterfactuals in reasoning (Hiddleston, 2005). Backtracking conditionals can be valuable for helping to diagnose problems upstream in a causal system. This work examines some of the factors that determine the evaluation of backtracking conditionals, causal structure and the nature of the connection between the variables. Method: Participants were presented with a description of three mechanisms, each with a different structure, and asked to judge backtracking counterfactuals. In the first experiment, the link between the events described was deterministic. In the second experiment, the link was probabilistic. Participants were asked to answer yes or no, or to rate the probability of the counterfactuals, respectively. Results: Participants were effective at judging backtracking conditionals, whether deterministic or probabilistic, and their judgments depended on the causal structure of the situation considered. Discussion & Conclusion: People can correctly assess the consequences of backtracking on a counterfactual modification if prompted to do so. However, it is not clear that they would spontaneously engage in this type of reasoning, nor what factors influence this occurrence. A discussion of the results is presented in terms of minimal network theory (Rips, 2010) and a ‘need for explanation’ account (Dehghani, et al., 2012).

The evaluative implications of force dynamics

Abstract for Nagel, J. & Waldmann, M.R. (University of Göttingen, Germany)

Introduction: The importance of automatic moral intuitions has been emphasized in recent moral psychology. However, to date there is no worked-out theory of the automatic processes leading from the observations of specific actions to the generation of specific moral intuitions. We propose that our moral intuitions might be grounded in force-dynamic concepts (Talmy, 1988). Method: We presented subjects with simple animations of two abstract entities moving and colliding in specific ways, instantiating different basic force-dynamic patterns. We then had the participants intuitively evaluate the movements of both entities on separate 7-point scales ranging from -3 (negative) to +3 (positive). Results: The evaluation of the entities can be predicted by their agent vs. patient role in different force-dynamic patterns. When the agent causes the patient to change its initial tendency (i.e., cases of onset causing of motion), the agent is reliably evaluated more negatively than the patient. By contrast, whenever the patient maintains its pre-collision tendency after the collision (e.g., cases of despite), the agent is evaluated at least as positively as the patient. Discussion: We exclude several alternative interpretations of this reversal in terms of more superficial features (e.g., sustained post-collision contact) and in terms of a different force-related account (Wolff, 2007). Conclusion: The present study is an encouraging first step in the quest of finding the representational bases of our automatic moral intuitions. Force-dynamic concepts are a plausible candidate as they are quasi-perceptual (i.e., easy to map onto observed interactions) and at the same time general (i.e., applicable to a wide variety of actions).

Delusional Ideation and Probability Estimations of Delusional and Neutral Stimuli

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Introduction: Previous studies (Colbert & Peters, 2002; Galbraith, Manktelow & Morris, 2008; LaRocco & Warman, 2009; Linney, Peters & Ayton, 1998) have demonstrated that those who are high in sub-clinical delusional ideation exhibit reasoning biases similar to those displayed by people with delusions. The current research aimed to investigate how people in the general population who are high and low in delusional ideation reason about narratives with delusional and neutral content. Method: Using a mixed design, the Peters et al. Delusions
Inventory (PDI; Peters, Day & Garety, 1996) was used to place undergraduate students into high and low delusion-prone groups (Exp. 1 N = 81; Exp. 2 N = 101). Narratives with either delusional or neutral content were presented to participants and they were asked to assign probability estimates of how likely the narrative was true, how bizarre they believed it to be, the probability of it happening to them and the probability of it happening to someone they know (Exp. 1). Additionally, participants were asked how disturbing and exciting they believe the narratives to be, as well as how bizarre, disturbing and exciting the narratives would be to most other people (Exp. 2). **Results:** Overall, results revealed that the high delusion-prone group rated neutral narratives as more likely to be true and more likely to happen to them or someone they know than the low delusion-prone group. The high delusion-prone group rated delusional narratives as more exciting to someone they know compared to the low delusion-prone group. **Discussion:** Findings are discussed in the framework of a liberal acceptance bias (Moritz & Woodward, 2004) and provide tentative support for a liberal acceptance bias in those that are high in delusional ideation. **Conclusion:** In conjunction with other reasoning biases that have previously been identified in delusion prone individuals, this may have implications for the development and maintenance of delusions.

**What can (not) improve our understanding of probabilities of precipitation?**

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**Introduction:** We focused on how people interpret probabilities of precipitation (PoP) and why they often misinterpret them. Previous investigation showed that people often believe that PoP refer to a proportion of time where it will rain or a proportion of area that will receive rain instead of a proportion of “days like tomorrow” where rain was observed. This study aims to understand which aspect of probabilities triggers wrongful interpretations (i.e., 1 or 2) and to test new formats hypothesised to promote a correct interpretation (i.e., 3). Moreover, this study also aims to test the effect of exposure to PoP, as a mean to increase PoP understanding. **Method:** The effect of different communication formats (such as traditional format, reference class explicit format or non-polysemous probability quantifier format) on PoP was tested in a between subject design. The effect of exposure to probability was tested by comparing interpretation of PoP in the United States (N = 339) and the United Kingdom (N = 614). **Results:** Overall, only 441 participants out of 953 understood correctly a PoP. The different formats of presentation of the forecast did not determine PoP interpretation. Results support the exposure hypothesis by showing for example that Americans better understood PoP than British (53% vs. 41%). **Discussion:** The explicit mention of the reference class or the use of verbal probabilities did not enable a better identification of a PoP’s reference class. Results gave credence to the exposure effect. **Conclusion:** This result clearly calls for a greater attention on how people understand probabilities.

**Children’s understanding of the fantasy-reality distinction: looking at real, near real and fantasy entities**

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Distinguishing between what is real and fantasy, namely the fantasy-reality distinction, is an important skill that develops within an individual over time. The standard task involves the child having to sort real and fantastical entities into categories of ‘real’ and ‘pretend’. Previous studies have only included real and make-believe entities, however in this study we include a novel category of “near real” entities, which have both real and fantastical properties (e.g., a character played by a real human actor, as opposed to a cartoon). In the current study, 16 5-6-year-old children, 11 7-8-year-old children and 25 adults sorted three groups of entities (real/make believe/near real) into categories of real, make believe or not sure. For each entity, they also completed a 6 item property attribution task (e.g., does this entity feel sad some days?). We found a developmental progression in categorisation of real and near real entities with adults performing the best, next to 7-8-year-olds and lastly 5-6-year-olds. In contrast, all groups performed equally well when categorising make-believe entities. In the property attribution task, younger children (5-6-year-olds) made more property attribution errors than adults, however slightly older children (7-8-year-olds) did not, which suggests that a developmental progression in correct response occurs in children between the ages of 5 and 8. Overall, a developmental progression exists in both fantasy-reality categorisation and property attribution tasks from young childhood to adulthood.

**“But that’s your role”: Social Models and Autistic Reasoning**

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Until quite recently, it was believed that people interact with each other as effectively as they do is because they are able to predict and explain each other's actions in terms of mental states, such as beliefs, desires, and intentions; in other words, using theory of mind. An alternative is that in certain situations full-blown theory of mind is not needed, but is in fact an impediment. At times, theory of mind is not only cumbersome and superfluous, but also open-ended. When this is true, people instead represent social structures of agent roles embedded within environmental settings. Expectations and predictions are formed on the basis of the social roles that the person and those around her assume. This allows people to engage in appropriate social interactions without imputing psychological states to others. For instance, a person meeting with his accountant need not know anything about her internal mental states to be able to appropriately interact with her. All he needs to know is that she is an accountant and will do his taxes. We think that this area of reasoning about social interactions has been underexplored and has applications that have not yet been considered. We develop the proposal in more detail here and argue that it explains the social interactions of those with autism spectrum disorder. Where people usually deploy a mix of models—including theory of mind ones—to understand each other and plan interaction, people with autism instead use social models as a primary source of information.

**Investigating semantic networks: A computational analysis of “association clouds”**

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**Introduction:** Semantic memory has generated much research. As such, the majority of investigations have focused on the English language, and much less on other languages, such as Hebrew. Furthermore, little research has been done on search processes within the semantic network, even though they are abundant within cognitive semantic phenomena. **Method:** We examine a unique dataset of free association norms to a set of target words and make use of correlation and network theory methodologies to investigate the global and local features of the Hebrew lexicon. The global features of the lexicon are investigated through the use of association correlations – correlations between target words, based on their association responses similarity; the local features of the lexicon are investigated through the use of association dependencies – the influence words have in the network on other words. **Results:** Our investigation uncovered Small-World Network features of the Hebrew lexicon, specifically a high clustering coefficient and a scale-free distribution, and provides means to examine how words group together into semantically related ‘free categories’. Our novel approach enables us to identify how words facilitate or inhibit the spread of activation within the network, and how these words influence each other. **Discussion:** we suggest that the global and local features we uncovered may have significant implications for the understanding of various semantic cognitive search processes, such as the Remote Association task, which measures semantic creativity. Finally, we propose our method can be implemented in clinical research, to investigate the underlying semantic network causes to semantic deficiencies.

**Learning with an interactive physics programme**

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**Introduction:** Our goal was to study how learning from a graphical physics programme is affected by prior knowledge and the amount participants interact with the graphics. Research has demonstrated that prior knowledge is an important predictor for learning (e.g., Hattie, 2008) and that animated graphics foster learning (Höffler & Leutner, 2007). We investigated how these factors interact particularly through the collection of verbal protocols and measures of performance. **Method:** Twenty-eight psychology students first had their prior knowledge on torques tested, then they learned about torques using a computer programme for 35 minutes. Finally, we tested their knowledge again. The computer programme consisted of 12 interactive graphics in which they could manipulate the levers’ lengths. While doing this, participants were asked to think aloud. **Result:** Analysis of verbal protocols is not yet complete, but even with this small sample we can examine the effects of prior knowledge and graphic use (how often levers were manipulated). Participants with low prior knowledge and high graphical use had more knowledge at the end of the task than those with low graphical use ($M=25.29$ vs. 22.14, $d=0.38$), but this effect was larger for participants with high prior knowledge ($M=39.29$ vs. 29.57, $d=0.75$). **Discussion and Conclusion:** The study suggests that the more prior knowledge, the more interaction with the programme led to greater final knowledge. This is consistent with the claim that the effectiveness of graphical presentation depends on prior knowledge, but analysis of the protocol data will be necessary to investigate this further. Main themes: graphic use, knowledge acquisition, verbal protocols We accept also a poster format.
Controlling one's own thinking underwater: routine material preparation as a psychological tool

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Linking psychological models of human reasoning to empirical accounts of human reasoning in action is a challenge for researchers, with potential strong social impacts. For our part, we are interested in what we can learn on a theoretical level from the wide empirical literature on professional reasoning. This paper will bring to the attention of our colleagues from the psychology of thinking community, real examples of everyday thinking in a risk-taking activity, Technical Diving. Video sequences of structured dialogue between experienced divers show how problem solving under water is timesensitive and influenced by the “state of mind” of the divers. It shows how experienced divers attempt to control their problem solving skills under water by conducting a careful material preparation before the dive. It therefore shows how elements, like the temporal or material structure of the preparation sequence, are used as psychological tools by the divers to control their own internal dialogue and thinking under water. This empirical situation will enable us to (a) briefly discuss the neo-Vygotskian Dialogue Thinking paradigm (Fernyhough, 1996); (b) discuss the potential of empirical researches on everyday reasoning in vocational or recreational practices for questioning theoretical models of reasoning. This paper could be presented either in the symposium on “new paradigm for the psychology of reasoning”, or in a symposium on “everyday reasoning”.

Adaptive Anchoring Model: How holistic and analytical processing induce judgements and predictions

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When attempting to predict future events, people commonly rely on historical data. One psychological characteristic of judgemental forecasting of time series established by research is that that when people make forecasts from series they tend to underestimate future values for upward trends and overestimate them for downward ones, so-called ‘trend damping’ (modelled by anchoring on, and insufficient adjustment from, the average of recent time series values). Events in a time series can be experienced sequentially (dynamic mode) or they can also be retrospectively viewed holistically (static mode) – not experienced individually in real time. In one experiment, we studied the influence of presentation mode (dynamic and static) on three sorts of judgment: (i) predictions of the next event (forecast), (ii) estimation of the average value of all the events in the presented series (average) and (iii) judged satisfaction of workers, given that the series represented their monthly income (satisfaction). Relative to the static mode participants’ responses in dynamic mode were anchored on more recent events for all three types of judgments but with different consequences – hence dynamic presentation improved prediction accuracy, but not estimation. These results are not anticipated by those theorists, who propose rational adaptive rules for making judgments and forecasts. We present a new process model – Adaptive Anchoring Model (ADAM) to account for the difference between ‘analytical processing’ and ‘holistic processing’ of perceptually encountered stimuli. ADAM captures how variation in psychological processing produces variation in responses (and the accuracy of these responses) in both forecasting and judgement tasks.

Adverse inferences about alibi evidence

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Introduction: How do people draw conclusions from complex bodies of interrelated evidence? This talk outlines a novel framework for evidential reasoning using causal idioms. These idioms are based on the qualitative graphical component of Bayesian networks, and are tailored to the legal context. Using this approach we propose a novel analysis of alibi evidence, and clarify the conditions under which ‘adverse’ inferences are legitimately drawn from false alibis. The key idea is that a false alibi should only incriminate the suspect when (i) the alibi provider is motivated to lie to protect the suspect, and (ii) the veracity of the alibi provider depends on whether the suspect is guilty. An empirical study assessed whether people’s intuitive judgments conform to this analysis. Method: Participants were presented with crime cases that hinged upon alibi evidence. The content of the alibi was held constant, but the relation between suspect and alibi provider (e.g., relative or stranger), and the alibi provider’s knowledge of the suspect’s guilt were varied between-subjects. In all cases the alibi was undermined by CCTV evidence. Participants’ judgments of guilt were compared with a control condition with CCTV evidence but no alibi. Results: In line with the model, participants only drew adverse inferences from a false alibi when the alibi provider was motivated to lie, and knew whether the suspect was guilty. In these cases participants also judged that the veracity of the alibi provider depended on whether the suspect was guilt. Discussion and Conclusions: People's
Strategic changes in problem solving

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Introduction: This paper presents a theory that elucidates the reasoning processes underlying problem solving: when individuals solve problems, they start by deducing the consequences of their tactical moves, whether or not these moves are successful. Deduction enables them to acquire tactical knowledge; it is not necessary to actually carry out those moves. A strategic shift then occurs in which this deduced knowledge comes to constrain their generation of moves. Method: Three experiments investigated how individuals tackled series of “matchstick problems”, in each of which participants were given an array of squares constructed out of matchsticks, and had to remove a specified number of squares and pieces. Experiment 2 tracked participants’ development of problem solving strategies through recording their moves as well as their thinkaloud, whereas Experiments 1 and 3 investigated factors that were likely to bias participants’ choice of tactics. Results: Results supported the predictions that participants’ choice of tactics was guided by the following factors: whether the initial configuration was symmetric or not, whether it contained salient pieces or not, and whether applicable tactics had appeared in previous trials or not. Crucially, Experiment 2 showed the participants made the predicted strategic shift as they solve the problems: the consequences that they have deduced from making moves shifted to guide their future generation of moves. Discussion and Conclusion: The current account provides a complementary perspective on problem solving to traditional accounts that depend on production systems, by explicating the reasoning processes underlying problem solving, through investigating how participants tackled problems in a novel domain.

But how do we reason with it?

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Introduction: We investigated “p but q”-utterances, constructed as distancing-contrastive connections, in which “but” connects two parts of a complex speech act. The second part is disassociated from the first part, without denying what is being expressed in the first part. By use of the word „but“, an inference from p can not be accepted. The word “nevertheless”1 following a “p argumentative-but q”-utterance is used as a conjunctive adverb and has the purpose of reversing the argumentative orientation again and thus directing the reader towards the conclusion stemming from p (e.g., „The milk is sour, but I am thirsty. Nevertheless I will not drink.”). Method: Fifty-one participants were presented with 16 context-stories, followed by “p but q”-constructions and constructions where the arguments are simply juxtaposed”. After each argumentative construction, participants had to choose between “so conclusion from p” and “so conclusion from q”. Results and conclusion: Our results showed that participants follow the contrastive instruction of the conjunction „but“, even though they are often guided by the specific content of the arguments rather than by the structure of the sentence. We also found that “nevertheless”-conclusions are more difficult than “so”-conclusions and we found no effect of our WM-manipulation which implies that inferences stemming from the words “but”, “so” and “nevertheless” are reasonably automated processes.

Covariation Estimates of Continuous Variables

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Introduction: Research on covariation judgments has mainly relied on tasks where variables are dichotomous and focused on how people arrive at their judgments while leaving out the issue of whether the choice of dichotomous over continuous variables influences judgments. This possibility is suggested by the tendency of people to experience the world in nuances rather than as on/off categories. Method: In three experiments participants sequentially experienced two blocks of 70 pairs of X-Y-values and estimated covariation and causal strength for
each block and chose which of the two blocks that had the strongest covariation/ causal link. Experiment 1 manipulated variable type (Dichotomous/Continuous) and correlation (.30/.70). Experiment 2 held correlation constant (.70) and varied X-Y-mean and standard deviation. In Experiment 3 all participants judged a control set ($r=.70$) of values and the same set linearly transformed parallel or perpendicular to $y=x$. **Results:** Estimates of covariation were sensitive to factual correlation (Low: $M=.21$; High: $M=.45$) but not influenced by variable type. For continuous variables estimates might, however, be sensitive to levels of mean and standard deviation. Experiment 2 revealed an influence of level of mean (High: $M=52$; Low: $M=.39$) suggesting that people perceive large values to co-vary more than small values. Experiment 3 found no difference for estimates of the control set ($M=.48$) but estimates in the parallel condition were higher ($M=61$) than in the perpendicular condition ($M=.43$), supporting the conclusion that the effect in Experiment 2 was indeed an effect of mean value. **Discussion and Conclusion:** The results indicate that people are sensitive to the factual correlation of both continuous and dichotomous variables. Judgments of continuous variables, however, vary with the choice of statistical properties suggesting that people’s perception of covariation can be changed by linear transformations.

**Representations and Compressions**

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Simple models can be many a manager’s undoing. Managers are trained to act on simplicity, but that simplicity is opposite to the complexity of the world in which such businesses operate. Efficiency it seems can be the enemy of resilience. And, in our ever changing complex world resilience is often needed to deal with change. Two types of explanatory models are often evoked as the context underlying change. Models based on labels and categories we shall refer to as “representations.” More complex models involving stories, multiple algorithms, rules of thumb, questions, ambiguity we shall refer to as “compressions.” Both compressions and representations are reductions. But representations are far more reductive than compressions. Representations can be treated as a set of defined meanings - coherence with regard to a representation is the degree of fidelity between the item in question and the definition of the representation, of the label. By contrast, compressions contain enough degrees of freedom and ambiguity to allow us to make internal predictions so that we may determine our potential actions in the possibility space. Compressions are explanatory via mechanism. Representations are explanatory via category. Category based explanations may be efficient but they are not resilient. Resilience requires: narratives not labels, mechanisms not categories, a focus on experience and not on labels and a need to be aware of when representations work and when they fail. Retrospective explanation based on representation often fails when mistakenly used as a predictive model devoid of context and compression. This paper highlights the risk which occurs when we confuse the evocation of a representation (category inclusion) as the creation of a context of compression (description of mechanism). In the drive for efficiency such substitutions are all too often proclaimed - at our peril.

"Attention as the Outcome of a Dynamic Reasoning Process"

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**Introduction:** Given that people can process only so many pieces of information, one key aspect of learning is learning which stimulus aspects are goal relevant in the current context. In addition to injecting noise into the decision process, gathering unnecessary information can have costs in terms of time, effort, money, etc. **Method:** To address these challenges, we develop a model that selectively encodes information during learning as a function of the learner’s goals, task demands, and knowledge state. The model consists of two components that are both normative, but lead to apparent non-normative behaviours when linked. One component determines the value of potential sources of information. The value of a piece of information depends on the decision maker’s goals and assumptions about (i.e., knowledge of) the world, as well as the cost of the information. The second component of the model reflects the decision maker’s knowledge of the world, which is used by the first component to direct information gathering. This learning component of the model is updated by the information samples selected by the first component, completing the cycle of mutual influence. **Results:** Several existing datasets using eye movement measures are successfully modelled. **Discussion:** One suggestion is that disparate phenomena, ranging from confirmation bias to blocking phenomena, arise from the proposed mechanism. **Conclusion:** Attention is best seen as the result of a dynamic decision process that computes the value of information based on current knowledge and task goals. Knowledge accrues from this biassed sampling process.
Restructuring as interpreting in insight problem solving. The *logos* as the interrelationship between language and thinking

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**Introduction:** Language and thinking share a cognitive activity *-logos* - addressed by an interpretative function, which reveals the assonance between the attribution of meaning to an utterance and the discovery of a solution via restructuring in insight problem solving. We investigated the interrelationship between language and thought in insight problem solving, by a *psycho-rhetorical* approach, for both its positive (Experiments 1) and negative effects (Experiment 2). We hypothesized that *restructuring* in insight problems, is a productive re-*interpreting* of the relationship between data and the aim of the task, guided by the principle of relevance. Then a relevant reformulation of two classical insight problems should produce an increase in *restructuring*. **Method:** We examined: the “Square and parallelogram” and the “Pigs in a pen” problems (Experiment 1), by adopting a new pertinent formulation. In Experiment 2 the concurrent “verbalization” procedure was adopted to further investigate the kind of reasoning involved in the above problems. **Results:** Our results are coherent with recent revisions of dual process theories. In Experiment 1, the new formulations of the problems rendered the restructuring process possible. In Experiment 2, the results showed that concurrent verbalization impairs solutions. **Conclusion:** Reasoning involved in insight problem solving overcomes dichotomies, since it results in an analytic not only sequential, but also parallel process. It always processes the context relevant to the aim of the task, as does language in its communicative function. It works on a conscious explicit and unconscious implicit layer, and is therefore able to afford the novel.

Reasoning and numerical ambiguities: a test of the mental model theory’s principle of truth

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**Introduction:** The principle of truth postulates that individuals think about what’s true, not what’s false. This study investigated whether it predicted performance in reasoning about numbers, e.g.: Either A is bigger than 22 or else A is bigger than 26. Is it possible that A equals 27? Reasoners should respond, ‘yes’, but the response is wrong, because in this case both clauses of the exclusive disjunction would be true. The inference contrasts with control problems in which the focus on truth does not yield errors. **Method** Participants responded to experimental and control problems -- disjunctions in Experiment 1 and biconditionals in Experiment 2. In Experiment 1 they drew their own conclusions about the numbers and in Experiment 2 they evaluated given numbers. **Results:** Experiment 1 yielded correct responses to 73% of controls but only 13% of experimental problems; the results for Experiment 2 were 76% and 6%, respectively. Discussion Both experiments showed that individuals tend to focus on the truth. They consider one clause in an exclusive disjunction and fail to think about the concomitant falsity of the other clause. Likewise, they think about the truth of both clauses in biconditionals, but not the possibility that both are false. This focus does not affect performance with control problems, but yields striking errors with experimental problems. **Conclusion:** The model theory’s principle of truth can be extended to reasoning about unknown numbers.

Logic or probabilities: the role of Bayesian argumentation in a theory of persuasion

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Developments in psychology of reasoning have suggested that Bayes’ theorem may be applicable as a normative theory of argumentation (Hahn & Oaksford, 2007a; Hahn & Oaksford, 2007b; Harris et al., 2012). This departs from traditional normative accounts of argumentation based on the premises of truth—conditionally dichotomous logic (Priest, 2008) where structural assessments tend to convey applicability in argumentative situations (e.g. Eemeren & Grotendorst, 2004). Instead, the focus of a Bayesian account of argumentation focuses on the subjective estimation of priors to assess the strength of the argument. For a theory of persuasion, understood as manipulations of belief structures (Madsen, 2012), this provides a particularly interesting point of view since scholars from the tradition of rhetoric has understood persuasion to contain other appeals than logic. By examining theoretical and empirical evidence from the literature, I argue that subjective reasoning may relate on a theoretical level to a larger framework of a theory of persuasion incorporating language in context (Carston, 2002), mentalizing (Amadio & Frith, 2006), phenomenology of the contextual subject (Gallagher & Zahavi, 2008), joint action (Pezzulo, forthcoming), and Bayesian reasoning (Oaksford & Chater, 2006). By relating to these elements of persuasion, the talk discusses the potential theoretical worth of a Bayesian account of argumentation and
reasoning as a Bayesian approach a fundamental element of a contextual theory of persuasion. That is, subjective, contextual reasoning may provide an interesting alternative to traditional logical accounts of reasoning when trying to flesh out a contextual theory of persuasion. The most relevant themes would in my mind be: argumentation, and probability and logic.

**Counterfactual thinking and the mutability of internalized self-representations**

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**Introduction:** How we imagine what might have been, called counterfactual thinking, is influenced by several factors. This research suggests that more extensively studied situational factors (e.g., how normal/controllable/mutable an event was) do not fully explain counterfactual thoughts, and investigates the role of personality and individual differences in how we construct alternative simulations of the past. Self-regulatory individual differences in particular are examined in terms of their influence on the functionality of counterfactual thinking. **Method:** As associations between individual differences and functional counterfactual thinking were being investigated, participants engaged with tasks in which performance improving motives were salient. Participants completed a series of difficult cognitive tasks (e.g. anagrams) and were asked to consider how their performance might have been different. Individual differences were measured using a series of self-report measures. **Results:** Findings from the first phase of experiments indicate that individuals who have a strong internalized representation of the self (either because they have high self-awareness, high autonomy, or naturally self-affirm) tend to generate higher numbers of functional counterfactuals. When faced with uncertainty and self-doubt, these individuals initially assign causality to the self via counterfactual thinking. This in turn leads to a greater sense of control and impetus to take performance improving measures. **Discussion:** These results suggest that individual difference factors may influence both the activation and focus of counterfactual thinking. **Conclusion:** The experiments conducted to date have strongly documented the fruitfulness of an individual differences perspective in this domain.

**Thou Shalt Not Lie - Disclosing Or Concealing Unfair Benefits Is A Matter Of Principle Not Outcome Maximization**

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**Introduction:** Individuals who obtain an undeserved benefit face the dilemma of concealing (in order to avoid being excluded from future interactions) or revealing (in order to avoid being discovered as a deceiver). Drawing on the protected values approach we predicted that this dilemma would be solved by a fixed strategy rather than by a case-by-case cost benefit analysis. **Method:** In 5 experiments (N = 788), participants who had lost a contest received an undeserved reward, and chose either to conceal or to reveal it to the other player. Various payment schemes manipulated the financial incentive to reveal or to conceal, and various characteristics of the players (e.g., cognitive capacity, agreeableness) were used as covariates. **Results:** A meta-analysis showed that the majority of participants (between 54 and 60%) preferred to reveal, independently of financial penalties or incentives, and even though they tended to exaggerate to themselves the envy that the other player was going to experience. **Discussion:** To solve the conceal/reveal dilemma, a majority of participants used a fixed strategy resistant to monetary trade-offs, as well as situational and personal factors. Findings support a value-based approach to the dilemma, and suggest that transparency about undeserved benefits is a protected value yielding taboo trade-offs. **Conclusion:** Rational cost-benefit analysis might maximize an individuals’ outcome, but it is overridden by a principle of transparency when people decide whether

**The Metacognitive Advantage of Rational Thinkers: A Dual-Process Perspective on Overconfidence**

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**Introduction:** We hypothesized that the thinking mode – rational vs. intuitive – that people use to make judgments or solve problems influences their awareness of their own and others’ performance. Rational thinkers are aware of both the rational and the intuitive solutions, and realizing that the former is better than the latter, they are likely to feel more confident and be more accurate in how they assess their performance and that of others. Intuitive thinkers are aware only of the intuitive solution, and whenever this solution is incorrect, they are unaware of how
poorly their performance was. **Method:** In several studies, participants solved problems where reason and intuition are in conflict (Cognitive Reflection Test, base-rate problems, syllogisms) and then estimated how well they and others performed, and rated their confidence in their performance. **Results:** Rational thinkers were aware of both the rational and the intuitive solutions, whereas intuitive thinkers were aware only of the intuitive solution. Consequently, rational thinkers were more confident and more accurate in their absolute and comparative estimates of performance than intuitive thinkers. **Discussion:** Rational thinkers have a metacognitive advantage over intuitive thinkers, the implications of which are discussed. **Conclusion:** When there is a conflict between reasoning and intuition, and the rational solution is better than the intuitive one, intuitive responders are unskilled and unaware – they do not know and they do not know that they do not know – whereas rational responders are skilled and aware – they know, they know that they know, and they know that others might not know.

Do People discount low frequency events if the cost is held constant across event type and frequency? **Utility versus time discounting**

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**Introduction:** Research suggests that people judge the risks from high frequency hazards as higher than low frequency hazards, and take corresponding precautions. A key issue is the confound between the type of event and the cost and frequency of events. These studies examine if the preference for high frequencies remains if cost is held constant over different frequencies of two hazards: earthquakes and floods. **Method:** In two experiments, the insurance cost for floods and earthquakes was constant at $100 per year regardless of the hazard’s frequency (1, 4, 16 and 64 years – these were between subjects conditions, as the type of hazard). In Experiment 2, participants also indicated of they were preparing for floods and earthquakes and if how much they were saving for retirement. Participant judged the importance of obtaining the insurance. **Results:** Participants judged it more important to purchase insurance for high frequency hazards than low frequency hazards and more important to purchase for flood than earthquakes. These judgements were related to saving for retirement. **Discussion:** The results support the view that people’s greater preoccupation for high frequency events reflects a time preference such as time discounting rather than the nature or cost of events. The relation to actual preparations and retirement saving suggest that these judgements map onto actual behaviours relating to future outcomes and low frequency events. **Conclusion:** People’s greater preoccupation for high frequency events reflects a time preference such as time discounting rather than utility considerations such as cost.

**Numeracy, causal cues, and statistical reasoning**

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**Introduction:** Krynski and Tenenbaum (2007) claimed that poor statistical reasoning can occur because people are unable to construct a causal model that includes all of the relevant statistics. They argued that presentation of an alternative cause would help participants to construct such causal models, and showed that roughly 45% of responses on a causal version of the mammography problem (Eddy, 1982), which has previously been used to show base rate neglect in statistical reasoning, were Bayesian. In this project we examined the role of numeracy in their results. **Method:** In Experiments 1 and 2, Standard and Causal versions of the mammography problem were completed by students likely to be more or less numerate. In Experiment 3 we tested a sample of psychology students who also completed a measure of numeracy. **Results:** In Experiments 1 and 2 we replicated the causal facilitation effect in students of architecture and engineering (Expt. 1) and of sociology (Expt. 2). Comparison across the experiments revealed significantly fewer Bayesian responses, and significantly more Likelihood Neglect, amongst sociology students. In Experiment 3 where numeracy was directly measured, we found a significant causal facilitation effect for high numerates only. **Discussion and conclusion:** Although we have replicated the causal facilitation effect, our results suggest that rates of Bayesian responding are dependent on numeracy, and that highly numerate participants are more likely to show a facilitation effect. The causal facilitation effect is genuine but may not be as pervasive as originally appeared.

**Intracranial Recordings of Active Thought Processes**

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Introduction

Associative thought processes, believed to be strongly related to phenomena such as insight problem solving and creative thinking, have so far defied attempts to build an integrative model describing their neural underpinnings. Building on a model of neuronal "ignition" put forward by Fisch et al. (2009), we hypothesized that different types of active thought processes are mediated by qualitatively different cortical activations. Specifically, we hypothesized that associative processes are facilitated by widespread neuronal activation that is followed by the "ignition" of a specific percept: an abrupt, strong, and local neuronal activation which brings that percept to conscious awareness. Method We used intracranial electrocorticography (ECoG) recordings performed in human patients monitored for potential surgical treatment to examine active thought processes as they occur in the brain. With each electrode recording the combined electrical activity of several thousand cortical neurons, these recordings offer a unique opportunity to study neuronal activations in the human cortex with superior spatiotemporal resolution. Patients were shown visual stimuli and asked to find a connection between them (associative condition), make a comparison between them (comparison condition) or refer to some visual attributes of the images (visual condition). Results & Discussion We examined brain activity in hundreds of electrodes (separate recording sites) across the cortex, implanted in five patients. Our preliminary results show that the different conditions were associated with unique neural signatures, well localized in space and time. Thus, we show a direct link between different types of active thought processes and the specific neuronal activity that gives rise to them. Further work will focus on the distinctive neuronal characteristics of associative thought. Presentation The most suitable theme for this submission may be "Cognitive Neuroscience of Reasoning".

The integration of belief-based and rule-based information in reasoning: Evidence from liking ratings

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Introduction: When people evaluate syllogisms, their judgments of validity are often biased by the believability of the conclusions of the problems. Thus, it has been suggested that syllogistic reasoning performance is based on an interplay between a conscious and effortful evaluation of logicality and an intuitive appreciation of the believability of the conclusions (e.g., Evans, Newstead, Allen, & Pollard, 1994). However, logic effects in syllogistic reasoning emerge even when participants are unlikely to carry out a full logical analysis of the problems (e.g., Shynkaruk & Thompson, 2006). Similar findings have been reported regarding the consideration of base-rate information in the “engineers and lawyers” problem (based on Kahneman & Tversky, 1973; see e.g., De Neys & Glumicic, 2008). Method: In five experiments, participants were administered either syllogistic reasoning problems or different versions of the engineers and lawyers problem. However, instead of asking for judgments of validity or to choose from responses that correspond to probabilistic vs. belief-based information, we used a novel method (i.e., asking for liking ratings) to measure how much our participants were influenced by these two types of information. Results: We demonstrated that people intuitively detected the logicality of syllogisms, and they were also influenced by base rate information in the case of the engineers and lawyers problem. These effects emerged independently of participants’ conscious mindset and their cognitive capacity. In fact, the effect of base rates in the engineers and lawyers problem was stronger, when participants were instructed to reason intuitively about the problems. The logic effect was also unrelated to the superficial structure of the problems in the case of syllogisms. Additionally, we provided evidence that the logicality of the syllogisms was detected through slight changes in participants’ affective states. Discussion: These results indicate that both logic/probability-based and belief-based information affect reasoners’ choices, and that these effects emerge very early during the reasoning process. Conclusion: Our results provide new insight into the cognitive processes underlying reasoning about problems where beliefs conflict with the logical structure of problems, or with probability information. Our results also pose challenges to dual-process theories of reasoning.

Multiple-cue probability learning can predict airline pilot training success

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Introduction: Could the multiple-cue probability learning paradigm (Brunswick, 1952) be used to assess the ability of pilot candidates to deal with unpredictable environments? Three studies investigated this question at ENAC, the national French airline pilot training. Method: Each study comprised two parts. In part 1, the pilot candidates had to deal with an MCPL task that was added at the end of the psychological selection stage ($N=401$, $N=448$ and $N=589$). In part 2, we focused on the success/failure of the selected trainees ($N=44$, $N=74$ and $N=80$) during pilot training (5-10% of failures). The MCPL tasks consisted of predicting a continuous criterion from two or three continuous cues, with a mix of positive and negative cues (60 trials in limited time). Results: MCPL performance
was dichotomized in poor/good based on final achievement and number of fulfilled trials. Good MCPL performance was a “sufficient” condition of training success in 100%, 93% and 97% of the cases. Poor MCPL performance was a “necessary” condition of training failure in 100%, 50% and 50% of failures. Moreover, the hypothetical use of the MCPL performance at the selection stage would have rejected only 2.7%, 6.9% and 8.6% supplementary applicants. **Discussion:** Traditionally, cognitive ability and personality measures can at best predict around 30% of the variance of pilot training success (e.g., Carretta, 2011). MCPL performance could be complementary of other measures. **Conclusion:** A poor final MCPL performance could be used to alert pilot training organizations at the selection stage.

**Modal Un-differentiation in Children: In the Case of Modus Ponens**

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**Introduction:** Modus Ponens (referred to as MP) is an inference schema which deduces a conclusion q from a major conditional premise *if p, then q* and a minor premise *p* (*p* and *q* denote a proposition). This schema is the most fundamental in propositional reasoning and generally believed to develop at latest at 5, 6 years old (Rumain, Connell and Braine, 1983). This study examined the validity of this hypothesis experimentally. **Method:** Three age groups of sixty schoolchildren participated in this experiment individually and were asked MP inference and MD inference, that is, whether the *q* is true, false or ‘Can’t tell’, given a conditional *if p, then q* as true., ‘Can’t tell’ is logically correct because of the absence of the minor premise *p*. **Results:** While the great majority of them in all age groups endorsed MP inference, they also deduced the conclusion *q* directly from *if p, then q*. Almost all the first graders and more than half of the 5th graders endorsed MD inference. **Discussion:** It was suggested that the early acquisition of MP confirmed by the previous research might be spurious and that MP inference schema is acquired much later than it was previously thought and presumably beyond their reach for schoolchildren. **Conclusion:** These findings have profound implications for the interpretations and theories of propositional reasoning. Major theories of propositional reasoning so far proposed are built on the assumption that MP is an easy inference schema. Thus Braine, & O’Brien (1998), the representative mental logic theorists, postulate MP as one of the basic inference schemas presumed to be innate and Johnson-Laird & Byrne (1991), the representative mental model theorists, postulate models for a conditional as having only one explicit initial model which makes MP a trivial inference. Fundamental reformulation of these theories would be necessary in order to accommodate them to the new findings.

**Social discounting in n degrees of separation**

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**Introduction:** Social discounting refers to a phenomenon where allocation of money decreases as a function of social distance (e. g., Simon, 1995). Jones and Rachlin (2008) found that the amount of money a person is willing to forgo to give $75 to another person decreased as a hyperbolic function of perceived social distance, in the same way as intertemporal choice (Green & Myerson, 2004; Raineri & Rachlin, 1993). This study aimed to extend this finding to the domain of social network (Milgram, 1967; Barabasi, 2002) where social distance is defined by degrees of separation. **Method:** 119 participants responded almost the same tasks as Jones and Rachlin (2008), except that they were required to answer whether they prefer to receive amount of money for themselves or amount of money for the person who has *n* degrees of separation (“friend”, “friend of your friend”, “friend of friend of your friend”) up to six degrees. **Results:** The hyperbolic function fit to the data well, and suggest that two processes appear to contribute to the judgments required in the experimental tasks; consideration to the in-group and that to the out-group. **Discussion:** The above results demonstrate that hyperbolic function also can explain social discounting where perceived social distance is expressed by degrees of separation. **Conclusion:** This study extend finding in Jones and Rachlin (2006) to the domain of social network. We will argue theoretical suggestions of these results including a relationship between the two-process explanation and hyperbolic discounting.

**Role of Left Hemisphere in Inductive Inference Is Modulated by Beliefs**

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**Introduction:** Despite a common perception that inductive inference is localized in the right hemisphere, very little patient data is available to inform this issue. In fact, the few neuroimaging studies and split-brain patient studies of
induction implicate left hemisphere dominance. **Method:** We administered an inductive inference task to neurological patients with unilateral focal lesions to either left hemisphere (N=55) or right hemisphere (N=66), and to healthy controls (N=50). The task required participants to determine the plausibility of a conclusion given certain information (e.g. snakes are cold-blooded; snakes are reptiles; therefore all reptiles are cold-blooded). To address the role of beliefs in inductive reasoning, we compared trials involving familiar and unfamiliar material. Participants classified each argument as plausible or implausible and later also provided believability ratings for each conclusion. **Results:** All participants were more accurate when reasoning about familiar material than unfamiliar material. A significant group × familiarity interaction showed a selective impairment for patients with left hemisphere lesions on familiar arguments compared to normal controls and patients with right hemisphere lesions. There were no group differences in accuracy on unfamiliar trials. **Discussion:** While all participants show improved accuracy when they can utilize prior beliefs in inductive reasoning (compared to when content is unfamiliar), patients with left hemisphere damage benefit less from content familiarity. This supports a role of the left hemisphere in the use of beliefs during inductive reasoning. **Conclusion:** These results extend and clarify previous literature by emphasizing the role of prior beliefs in left hemisphere-based inductive inference processes.

**Risk taking and decision making in children**

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**Introduction:** Risk-taking and decision-making under uncertainty can be framed through processes, tendencies, desirability, probabilistic thinking, emotionally and biologically oriented mechanisms, age and sex related factors, personality traits as well as social influences. During the last years a great multiperspective focus has been directed towards preschool years aiming to enlighten how young children represent, and process information and randomness in an effective way, while making decisions. **Method:** In the current study it is examined whether children, aged 4-6 years old (N = 300), express strategies in a laboratory based risk-taking task with points and probability estimations. Based on the Cups Task (Levin and Hart, 2003) children’s choices and preferences were recorded in decision trees, through three successive trials in order to trace their thinking under loss and gain conditions. **Results:** It was found that children estimate the probability of an event and take into account risky vs riskless choices. Additionally, they tend to risk in cases of loss rather than in cases of gain, z = 15, p<.05; under these lines they show the preference shift effect. **Discussion:** Findings imply that children at this age possess characteristics of probabilistic and intuitive thinking in laboratory-driven tasks with points. They can inference the possible outcomes and select options aiming at their benefit. **Conclusion:** The schematizations of children’s decisions constitute basic aspects in the way young children think of risk and probabilities through games. Indeed, by combining computational and intuitive reasoning skills children from this age take decisions and conquer the world.

**From Intuition to Insolvency: Intuitive Decision Making in Adolescence Negatively Predicts Financial Well-Being in Adulthood**

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**Introduction:** Decision making researchers have long debated the merits of relying on intuitions and "gut feelings" to make choices (i.e., ‘System 1’ cognition). However, studies examining the effectiveness of intuitive decision making have mainly been carried out in artificial laboratory settings and the impact of relying on intuition has usually been evaluated over very short time periods. In contrast, there have been few longitudinal studies examining how early individual decision making tendencies (e.g., whether someone tends to approach decisions in an intuitive manner) are related to important outcomes later in life. **Method:** Using a unique multi-wave longitudinal dataset of 15,000 respondents, we measure the impact of intuitive decision making styles on later financial wellbeing (up to 15 years in the future). **Results:** We find that adolescents who reported relying on their “gut feelings” when making decisions later had lower personal earnings, were more likely to receive public assistance, had more difficulty paying bills, and were more likely to have gambling problems, even after controlling for a host of variables related to respondents’ characteristics and early environments. We further show that the negative relationship between intuitive decision making style and financial wellbeing is not the result of a rational self-selection process, whereby intuitive individuals deliberately self-select into lower-paying jobs. **Discussion & Conclusion:** Our results show that an intuitive decision making style in youth negatively predicts later financial wellbeing, even in the distant future (up to 15 years later). Our findings thus question the merits of relying on intuitions to make choices, at least for financial decisions.
On the need of simulating what is unspecified: negations in a visual world paradigm

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Introduction: Comprehension of negative sentences is sometimes assumed to involve compulsory simulation of the actual situations, even when they were underspecified (Kaup et al, 2007). To test this assumption we used a Visual World Paradigm in which participants heard affirmative and negative sentences while their eye-movements were monitored. Method: In four experiments, participants explored visual displays composed by arrays of four colored figures (e.g., red, green, brown, blue circles) while hearing affirmative (e.g., the figure is red) or negative sentences (e.g., the figure is not red). In two of these experiments, we used binary settings (found by a previous context-sentence), so that the actual situation for negatives was explicit (e.g., the figure could be either red or blue) and non-binary settings (e.g., the figure could be red, or blue, or yellow). In the other two, no sentence was offered as specification context. Results: Eye-movement patterns for negatives varied as a function of whether or not the actual situation was well specified. For specific (binary) settings, participants’ eye-movements fixed mainly on the object representing the actual object (e.g., the green circle). In contrast, for non-specific settings (non-binary conditions and no context experiments), fixations occurred mostly on the negated object (e.g., the red circle). Conclusion: Willingness to fix eye on objects representing the negated situation is at odds with the compulsory-simulation approach. Alternatively, it suggests that comprehension of negatives could sometimes involve symbolic representations favoring views of meaning-comprehension that allow for both iconic and symbolic representations.

Shifting labels: Coordination affects categorization

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Introduction: We study how the need to coordinate with others affects individual categorization outcomes. The thinking processes underlying interactive categorization deeply modify the ontological (objects vs. events) nature of categories used for labeling pictures. Method: In a between-subjects design, 400 undergraduate students at Ca’ Foscari University of Venice were randomly assigned to one of two conditions. In the individual condition, participants were administered a set of pictures and had to label each of them with a single word. The coordination condition differed in that subjects had an incentive to coordinate their answers with a randomly chosen partner, i.e., the probability of obtaining a reward was increasing in the number of matching labels. Results: Consistent with the “focal point effect,” fewer labels were used and the label distribution was more concentrated in the coordination (vs. individual) condition. Most importantly, “objects” were used relatively more often and “events” were used relatively less often in the coordination (vs. individual) condition. Moreover, any shift between conditions in the ontological nature of the modal answer was always from “event” in the individual condition to “object” in the coordination condition. Discussion and conclusions: Among candidate focal points, categories that are cognitively simpler, semantically more univocal, more stable and time-independent, and less related to subjective experience are privileged. Building on the fundamental distinction between objects and events, we showed that the former are relatively more likely to be focal points, and pave the way for further research on categorization as an interactive rather than merely individual process.

Pragmatic Implicatures: A Test of the Pragmatic Tolerance Hypothesis with Different Tasks

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Introduction: Adults appear to be more pragmatic in interpreting scalar implicatures than children. Yet, several studies have demonstrated that children can be more pragmatic by changing the nature of the task. Recently, Katsos and Smith (2010) introduced a Likert scale on which children and adults appear to respond very similar on. They proposed the pragmatic tolerance hypothesis to explain this. Method: We wanted to replicate the findings of Katsos and Bishop (2011), comparing children and adults with the use of a 5-point Likert scale. We compared the results on three different tasks, Euler Circles, Immediate Inferences and Drawings. Results: We found that the nature of the task makes a difference on overall performance but leads to a similar interpretation of scalar implicatures. We replicated the results of Katsos and Bishop (2011) between children and adults. Finally, we also found a certain type of items, called reversed scalar implicatures, which were not included in earlier research. For these items, children show a significant difference with adults, treating these items in a similar way as the regular
scalar implicatures. **Discussion:** First of all, we need to point out that the consistency of performance of children was very low. Secondly we find these reversed scalar implicatures a very interesting finding. These items cannot be explained by the pragmatic tolerance hypothesis and impeach the range of the hypothesis. **Conclusion:** In this study we replicated the findings of Katsos and Bishop (2011) but found some serious abnormalities concerning consistency levels and reversed scalar implicatures.

**Comprehending sentences with complex center embedded structure. Logical thinking or social skill?**

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Sentences with embedded relative clauses are hard to understand, especially when they have more than one clause (Bach, Brown, & Marslen-Wilson, 1986; Gibson, 1998). Indeed, they require a reasoning process that abstracts away from the meaning of the words in the sentence. However, semantic plausibility play an important role in processing these types of sentences, as we found in our lab (Lai & Poletiek, in preparation). Consider the sentence: *The girl the dog the man walks bites shouts*. Its meaning can be grasped by good grammatical parsing - a meaning independent logical process. This process can be very much hampered, however, when one particular meaningful interpretation of a sequence of words in the sentence is strongly preferred over the one dictated by its logical parsing, as in: *The dog the girl the man walks bites shouts*. I will present data suggesting first that the match between semantic and syntactical reasoning on a complex sentence affects processing difficulty as least as strongly as pure syntactical complexity (grammatical structure). Second the social discourse context also affects whether we go for a syntactical analysis of grammatical complex sentences or rely on semantic plausibility.

**First impressions judgments from facial appearance: who needs attention?**

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**Introduction:** Facial social judgments such as trustworthiness, indeed the processing of facial and emotional stimuli are fast (Bar, 2001) and are often proposed to take place in an automatic fashion, independent of top down factors such as attention (Jonides 1983). Here we present work that challenges the automaticity account of such judgements. **Method:** In a series of experiments we apply load theory (Lavie, 1995, 2010), within a signal detection framework, to investigate subjective judgements under load; employing a combined visual search and face judgement task, where the level of attentional load in the search task was manipulated (by varying the search set size). **Results:** The results indicated reduced accuracy for trustworthy social judgements under the effects of attentional (perceptual) load. In a 67euroimaging task (that is a pure signal response to facial stimuli) we again illustrate the effect of load, where high load modulates (at a neural basis) trustworthy faces. **Discussion:** These results provide support that social facial judgments are susceptible to perceptual load. While faces may enjoy a privileged status in our visual processing, perhaps due to the social signals they convey, that status is not completely immune to attentional or perceptual load modulations. **Conclusion:** By developing a fuller of the factors involved in social judgments from facial appearance, we can gain greater insight into the factors involved in first impressions assessments, with implications in scenarios ranging from eye witness testimony to social interactions and providing insights into the theoretical underpinnings of the mechanisms involved in attention and social judgements.

**Factors That May Moderate the Emergence of the Jump to Conclusions Bias in Sub- Clinical Delusional Ideation**

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**Introduction:** The aim of this research was to investigate the role of sub- clinical delusional ideation, cognitive motivational factors and probability judgment in the jump to conclusions bias. **Method:** In study one, 64 undergraduate student participants completed numerous cognitive measures and one of two versions of a computerised and realistic data gathering task. In the probabilistic version participants were required to assess probability ratios throughout the data gathering process and in the perspective condition, participants were encouraged to gather information for the purpose of generating a point of view. In the probabilistic and perspective tasks neither high nor low delusional ideation groups showed a jump to conclusions bias when completing a computerised data gathering task. In study two, 96 student participants completed either the probability or perspective data gathering task via computer, face to face or in face to face anxiety- inducing condition. **Results:** Moderated multiple regression analyses revealed a three- way interaction between belief
conviction, task content and task medium with respect to the quantity of information selected prior to a decision being reached. For the face to face probabilistic task, individuals that expressed a higher degree of confidence in their beliefs requested less information prior to forming a decision. However, the manipulation of task content and task medium produced various contrasting correlations inconsistent with the classic findings of the original probabilistic beads task (Huq, Garety and Hemsley, 1988). **Conclusion:** The results provide tentative support that task content (probability vs. perspective) and task medium (computer vs. face to face) along with belief conviction could be factors that may moderate the data gathering bias. These findings have implications for the study of the jump to conclusions bias in realistic contexts.

**On Rhetorical Syllogisms: How Enthymemes Work**

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**Introduction:** Enthymemes aim to produce belief changes in communicative contexts by three steps: credibility of facts (belief’s source) is transferred to claims (becoming believable) through rules (connector). Two experiments aimed to examine whether and how subjective probability (SP) of the premises (minor/facts-major/rule) affects conclusion’s credibility about future events by using ‘from-cause-to-effect’ argumentation schemes. **Method:** Experiment1 used a test-retest repeated-measures design. First, we measured isolated propositions’ SP, and later we measured them again presented as argument conclusions. Arguments contained conditional rules with high vs. low associated effect given a cause. Whereas for high-rule condition, conclusion’s belief should increase by means of transfer, for low-rule condition it shouldn’t. In experiment2 we constructed four premises conditions (premise-function: fact/rule; premise-credibility: high/low SP) for every conclusion in a latin-square repeated-measures design; we collected isolated conclusions’ SP in a control group as means of prior believability. We predicted that transfer process works as a premises’ product. **Results:** In experiment1, ANOVA showed an interaction effect of ‘time’ (test-retest) x ‘rule’ (high-low), confirming our prediction. In experiment2, ANOVA showed significant main effects for premise-function, for premise-credibility, and interaction effects. All conditions achieved significance in posterior paired-comparisons. They also differed from prior believability. Correlations between observed data and premises’ product were significant, ranging from 0.9 to 0.7 in conditions with at least one high SP premise and a total correlation of 0.97. Regression analyses showed that our variables account for 85% to 50% of the variance. **Discussion:** Results will be discussed in relation to uncertain reasoning, prior believability and argumentation theory. **Conclusion:** Syllogisms preserve both the truth from premises to conclusions (P(premises)=1) and the uncertain arguments’ SP (P(premises)=0-1). Results showed that a SP multiplicative process may be implied and that enthymemes can change beliefs, being useful in argumentative contexts.

**Individual Differences in Bayesian Reasoning: Ecological Rationality, Nested Sets and Beyond**

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**Introduction:** Two main accounts explain the facilitation effect of natural frequencies in Bayesian reasoning. From a processing point of view, the ecological rationality account (ERA) postulates an evolutionary-shaped ease of associative processing of natural frequencies, whereas the nested sets account (NSA) posits an analytically driven processing of salient nested sets. An alternative integrative account (IA) developed here posits an automatized rule selection and its effortful implementation. We tested the hypothesized effects of individual differences from the three accounts. **Method:** In addition to different versions of the Bayesian tasks, students completed the Cognitive Reflection Test (CRT; Frederick, 2005) and the Numeracy test (Lipkus et al., 2001) in Study 1 (n = 94), the CRT in Study 2 (n = 302) and tests of cognitive abilities and thinking dispositions in Study 3 (Raven et al., 1977/1991; Pacini & Epstein, 1999; Stanovich & West, 2006; n = 151). **Results:** Cognitive reflection predicted performance in natural frequency conditions and was not mediated by numeracy (Study 1). Cognitive reflection predicted performance in both whole and arbitrary parsed tasks with nested set structure (Study 2). Cognitive ability but not thinking dispositions uniquely predicted performance in a natural frequency condition (Study 3). **Discussion:** Natural frequencies wording triggers analytical reasoning that cannot be explained by an evolutionary shaped module-based reasoning. Findings showed that associative processes seem to be responsible for part of the performance, which is inconsistent with the ERA’s expectations. **Conclusion:** Our findings cannot be accounted for by the ERA and the NSA, but are consistent with the IA’s expectation.
Response Times and Confidence Ratings Support a Dual-Process Account

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Introduction: Dual-process theories propose that heuristic and analytic processes compete in influencing responses during deductive reasoning. ‘Conflict problems’, where, belief and logic are in opposition, evoke a clash of these processes and response-rate, response-time and confidence-rating data for such problems all triangulate in providing support for dual-process theories. The present study generalises these established belief bias findings to an alternative heuristic-analytic conflict in reasoning – that of matching bias – with premises and conclusions being matched or mismatched using doubly negated quantifiers (Roberts, 2005) or standard affirmative quantifiers. Method: A content manipulation was under taken to generate conflicts between the surface features of problems and the logical status of conclusions. Data were collected for 16 problems, with response rates, response times, confidence ratings and individual differences measured for valid and invalid problems with matched or mismatched surface features. Results: Matching bias effects in conclusion evaluation were replicated (Stupple & Waterhouse, 2009), revealing increased processing times for matching/logic ‘conflict problems’. Results paralleled chronometric evidence from the belief bias paradigm indicating that logic/belief conflict problems were more demanding than non-conflict problems (Stupple, Ball, Evans, & Kamal-Smith, 2011). Individuals’ response-times for conflict problems predicted the degree of overall normative responding. Acceptance rates, response times, metacognitive confidence judgements and individual differences converged in supporting dual-process theory. Conclusion: These data are noteworthy because dual-process predictions about heuristic/analytic conflicts in syllogistic reasoning were generalised from the belief bias to a paradigm where matching features of conclusions, rather than beliefs, were set in opposition to logic.

Measure for Measure: Comparing methods of measuring causal models

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Introduction: Causal reasoning is central to many cognitive processes. However, existing experimental methods for eliciting participants’ beliefs about the causal relationships between variables remain preliminary and disjointed. In this paper, we compare 10 different methods for eliciting this information. Method: 384 participants reported their beliefs about causal relationships. They were randomly assigned to one of 10 different methods for eliciting beliefs – all of which are used in the causal reasoning literature. Methods included drawing arrows from causes to effects, selecting from pre-drawn diagrams with arrows, and answering multiple choice questions about each link. Results: Methods for eliciting causal knowledge led to systematic differences in the causal models reported. For example, participants reported significantly fewer causal links when drawing arrows (33% of all possible links) than when selecting from pre-drawn diagrams (41%, p<.001) or answering multiple choice questions (54%, different from both, p<.001). A range of specific differences across methods tested will be discussed in detail. Discussion: The data presented here demonstrate that the method for determining a participant’s causal model can alter relationships reported. Some commonly used elicitation methods may fail to accurately capture peoples’ beliefs about causal relationships. In some cases, the elicitation method may actually change these beliefs – influencing rather than measuring the variables of interest. Conclusion: Given reliance on participants’ reports of their causal knowledge for investigations of causal reasoning, and the growing recognition that causal reasoning is central to a variety of other cognitive processes, researchers should factor in differences in elicitation methods when designing experiments and interpreting results.

Is belief inhibition easier for good reasoners? The effects of reasoning ability and moral content on conflict monitoring in syllogistic reasoning

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Introduction: The interaction between intuitive and analytical processes is a hot topic in reasoning research. Default-interventionist dual-process models assume that analytical processes monitor the output of default intuitive processes, and intervene only in cases of conflict. Recent studies indicate that conflict monitoring is automatic and effective, even though analytical reasoning may fail at later stages of processing. For example, De Neys and Franssens (2009) found that on syllogistic reasoning tasks, access to topic knowledge was temporarily impaired if it conflicted with the logical validity of the syllogism, evident in longer lexical decision times for target words associated with the topic than for unrelated words. This result was found even when reasoners failed to solve the syllogism correctly, implying that conflict detection had occurred nonconsciously. Method and Results:
The present study (N = 56) replicated these overall results for syllogisms on neutral topics. However, a significant interaction was found between reasoning ability and the effect of conflict on target words: the best reasoners (who solved all neutral conflict syllogisms correctly) showed no effect of conflict on target words. Moreover, when syllogisms involved morally upsetting statements, even the best reasoners gave more belief-based responses and lexical decision times increased even in the absence of a conflict between moral status and logical validity. Belief-based responding was related to impulsivity on the Cognitive Reflection Test (CRT; Frederick, 2005) on neutral conflict syllogisms, but not on moral conflict syllogisms. **Discussion and Conclusion:** The results are discussed in terms of dual-process theories and recent findings on conflict monitoring.

**People Inductively Reason Causality by Calculating the Probability of De Finetti’s Biconditional Event – The pARIs Rule, Rarity Assumption, and Equiprobability**

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**Introduction:** How we perform causal induction from co-occurrence information remains an important problem. Here we introduce a new model, the pARIs rule. The rule is derived from the normative principles of the new paradigm psychology of reasoning (Over, 2009). **Method:** The pARIs rule, proportion of assumed-to-be rare instances, is the probability of defective biconditional or biconditional event (de Finetti), !!! !! ! !. We verify the validity of the rule by a meta-analysis (Hattori & Oaksford, 2007), two experiments, and a theoretical analysis. **Results:** Meta-analysis shows pARIs has the highest correlation and smallest error with the data set, among more than 40 models proposed ever. Two experiments indicate that the more cause and effect are both rare, the further we assume equiprobability (the occurrence probability of cause and effect are approximate by default), and that the !-cell type event (where the target candidate cause and the effect in focus both do not happen) is not faithfully but vaguely recognized. Theoretical analysis confirms the validity of pARIs as the best descriptive model. Experiments show that (1) the relationship between the rarity assumption (Oaksford & Chater 1994) and equiprobability hypothesis (Hattori & Nishida, 2009) and (2) an anomalous cognition of l-cell type event. The findings support pARIs in the form of biconditional event and explain some biases such as “weak !-cell effect.” Theoretical analysis shows that it is advantageous to adopt pARIs for scooping up causal relationships. **Conclusion:** The apparent bias of human in causal induction, e.g. the unfitness of “!”, is probably caused by our adoption of biconditional event, or pARIs rule. It is very plausible that we actually recognize !-cell type events as null or void. We propose that people interpret causal conditionals as biconditional events with adaptive rationality.

**Probability vs. confirmation judgments: A comparison in accuracy and test-retest**

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In the last fifty years, many studies have pointed out that human probabilistic reasoning is often far from optimal and yields typical patterns of biased judgment (e.g., Gilovich, Griffin, & Kahneman, 2002). Claims have been made, however, that such results are at odds with people’s good performance in real-life situations, where uncertainty is the rule (Evans & Over, 1996). We propose a novel approach to bridge this gap. In dealing with everyday uncertainty, we suggest, people may more effectively rely on detecting relations of inductive confirmation (i.e., the net impact of new evidence on the credibility of hypotheses of concern) than on computing values of posterior probability (i.e., the overall credibility of hypotheses as updated on all given evidence). In real life, these two kinds of assessments often yield similar results, allowing for high levels of accuracy. On the other hand, in some well-known experimental scenarios, confirmation and probability point into opposite directions, so that biased judgment arises (the conjunction fallacy representing a prominent example, see Crupi, Fitelson & Tentori, 2008; Tentori & Crupi, 2012). As a test of our proposal, we compared the accuracy and the reliability of confirmation vs. probability judgments in a test-retest experiment. In line with our prediction, we found that confirmation judgments are systematically more accurate and reliable than probability judgments in otherwise controlled conditions. Apparently, people can properly estimate the net impact of given evidence on a hypothesis even when their corresponding probability judgments are defective. This provides support to the suggestion that judgments of confirmation are psychologically prior than direct assessments of chance.

**Mortality Salience Makes People Less Utilitarian**
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**Introduction:** The dual-process theory of moral judgment postulates that utilitarian responses to moral dilemmas require to engage controlled processes that draw on limited cognitive resources. In parallel, Terror Management Theory postulates that these same resources are mobilized when one is reminded of one’s own future physical death to suppress these thoughts out of consciousness. Cross-pollinating these two perspectives, we predicted that people under mortality salience would be less likely to give utilitarian responses to moral dilemmas because resources that are required to compute the utilitarian response are no more available. **Method:** Three experiments (N = 346) were conducted to test our predictions. In Experiment 1 we manipulate the content of the scenarios. In Experiment 2 we use an exogenous mortality salience manipulation. In Experiment 3 we assess the amount of cognitive resources consumed by mortality salience, by comparing its effect to a three-level cognitive load. **Results:** Results highlight that participants under mortality salience were less likely to give utilitarian responses to moral conflicts as compared to participants in a control group and that the detrimental effect of mortality salience is comparable to that of an extreme cognitive load. **Discussion:** Mortality Salience makes people less utilitarian as compared to control participants, probably because cognitive resources are no more available to process utilitarian responses to moral conflicts when thinking about death. **Conclusion:** Our findings raise the worrying question of whether private judgment and public debates about these moral issues might be shaped by mortality salience effects, rather than by a full reflective attention to the available arguments.

**Effortful thinking: a remedy or a cause for the conjunction fallacy?**

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**Introduction:** Errors of probability judgments such as the conjunction fallacy are thought to occur because we are unwilling to engage in effortful deliberation and are often satisfied by plausible judgments arising from rapid intuitive thinking (Kahneman, 2011). An alternative view posits that intuitions may result from a combination of heuristic and logical processing (De Neys, 2012). This latter view implies that individuals’ judgements may be influenced by logic considerations, even in the absence of deliberation. **Method:** We present two experiments using “Conjunctive Probability Judgment (CPJ)” tasks where participants are presented with a series of probability statements varying in terms of their logicality (logical vs. illogical) and their congruency with heuristic considerations (congruent vs. incongruent) and are asked to judge whether each statement is correct or incorrect. Half of participants were asked to make their judgements under time pressure. We also measured individual differences in rational or experiential preferences. **Results:** Results showed that, although individuals were strongly affected by heuristic considerations, they were also less likely to accept a conclusion if it was illogical. Moreover, they consistently spent more time on conflicting situations (i.e., where heuristic and logical considerations pointed to different responses) compared to non-conflicting ones, even under time pressure. **Discussion and Conclusion:** These findings confirm that we may not need as much time, efforts, and resources as is often assumed to consider logical implications.

**Spatial representation in cognitive balance**

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**Introduction:** Heider’s (1958) principle of cognitive balance has been one of the most fundamental and long-term influential concepts in social cognition. This paper addresses the issue of cognitive representation of Heiderian balance. It is proposed that balanced, but not unbalanced, social triads are represented using the spatial metaphor of distance, as corresponding to the notion of “dislike” in a sentiment relation. **Method:** In a series of three studies, participants learn like-dislike relations between fictitious individuals, that form triads, e.g., A and B like each other, B and C dislike each other, A and C dislike each other. Triads are either balanced or unbalanced. Later on, participants are asked to place symbols referring to each pair of persons on a line representing a restaurant bar. Results: Study 1 provides evidence for a spatial representation of balanced triadic social situations, because pairs in a negative relation from balanced triads are reliably placed further apart than pairs in a negative relation from unbalanced triads. Study 2 replicates these results and rules out alternative explanations. Study 3 uses more subtle methods, addressing the ease of learning, and again replicates the basic results. **Discussion:** The main hypothesis is discussed in terms of approaches on consistency amongst social cognitions, and recent theories of embodiment. Spatial metaphors appear to be used in the construction of mental representations of balanced social situations. **Conclusion:** The results support the idea that spatial representations are an essential part of the Good Gestalt as stipulated to be a characteristic of balanced cognitive structures.
**Consistency versus Evidence in Probabilistic Causal Reasoning**

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**Introduction:** Theories of learning causal relationships are often concerned with bottom-up processes only, neglecting potential top-down processes like the consistency of a larger given representation. At least for probabilistic causal relationships bottom-up learning and consistency assumptions (like transitivity) can be brought into conflict (by violating the Markov assumption on the category level). **Method:** In two experiments we have investigated the induction of local causal relationships while varying the tested causal structures. We predict distortions of the empirical evidence based on the participants’ attempt to create consistency between local representations. We here focus on reporting trial trial-by-trial learning-tasks. **Results:** Experiment 1 shows a biased judgment of causal relationships in causal chains, even after repeated learning- and testing-phases. Experiment 2 corroborated that causal models lead to different structural implications. Despite using identical data patterns for all causal structures we obtained different results. **Discussion & Conclusion:** We briefly discuss the results in the light of models of causal induction and previous proposals concerned with transitivity. **Conclusion:** The findings support the idea that the attempt to create consistency plays an important role when people have to induce probabilistic causal relationships based on trial-by-trial data.

**Judging the probability of noisy-logical relationships in trial-by-trial learning-tasks**

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**Introduction:** Inducing propositions about logical relationships based on observations of co-occurring properties (using either trial-by-trial learning data or a frequency contingency matrix) is neither normatively nor descriptively fully understood. Normatively, one may want to use standard extensional versions of formal logic or probability theory as rational adequacy-criteria. The use of these norms, however, for logical prediction is beset with several fundamental problems, such as the problem of exceptions, the problem of sample size, and the problem of set inclusion. **Model:** ‘Bayesian logic’ (BL) has been proposed as a rational model to resolve these problems, by formulating a probability measure for noisy patterns of logical explanations (linked to the 16 connectives of propositional logic). BL has predicted several novel phenomena, when one judges the probabilities of logical predications given frequency information in contingency tables. BL also predicts a class of conjunction (von Sydow, 2010). **Method:** BL, as psychological theory, may be used to predict probability judgments about logical relationships in learning contexts as well. The reported experiments use trial-by-trial learning scenarios and trial-by-trial judgment tasks, without memory load. Besides investigating experience-based probability judgment, order effects are studied to assess the influence of the propositional level on the judgments as well. **Results:** The results in most aspects nearly corroborate the predictions of BL in the trial-by-trial learning context and judgment tasks. **Discussion and Conclusion:** Other models of contingency judgments as well as models of the conjunction fallacy cannot explain the obtained results. Some avenues of future research are proposed.

**The role of models in mind and science**

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During the last few decades, models have become the centre of attention in both cognitive science and philosophy of science. In cognitive science, the claim that humans reason with mental models, rather than mentally manipulate linguistic symbols, is the majority view. Similarly, philosophers of science almost unanimously acknowledge that models have to be taken as a central unit of analysis. Moreover, some philosophers of science and cognitive scientists have suggested that the cognitive hypothesis of mental models is a promising way of accounting for the use of models in science. However, once the importance of models in cognition as well as in science has been acknowledged, much more needs to be said about how models enable agents to make predictions, and to understand the world: What is the format of mental models? And what kind of computational processes do they allow? In this paper, our goal is twofold. We would like to further develop the notion of mental models, and to explore the parallels between mental models as a concept in cognitive science, and models in science. While acknowledging that the parallel move towards models in cognitive science and in philosophy of science is in the right direction, we think that: i. the notion of mental models needs to be clarified in order to serve as a useful tool, ii. the relation between the hypothesis of mental models and the use of models in science is still to be clarified. First, we will briefly recall a few points about the mental model hypothesis, on the one hand, and the
model-centred view of science, on the other hand. Then, we will present our parallel criticisms, and put forward our own proposals.

Improving the Past and the Future: A temporal Asymmetry in Hypothetical Thinking

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Introduction: When people experience failure in a task, they often think about how they might have done better (counterfactual thinking) or how they might do better next time around (prefactual thinking). Current views of hypothetical thinking implicitly assume that the content of imaginary thoughts about the past and future should be the same. Method: In two experiments, participants performed a task and failed. They were then asked to imagine how they could have done better in the past task which they had just completed or in an identical task in the future. Results: The results showed that counterfactual thoughts focused on uncontrollable features of their attempt (e.g., “Things would have been better, if the allocated time were longer / if I had better logical skills”). But their prefactual thoughts focused on controllable features of their ensuing endeavor (e.g., “Things will be better next time, if I concentrate more / if I use another strategy”). Discussion: The experiments provide the first demonstration that, given the same experienced failure, imagining a better past may differ from imagining a better future. The possibility to still realize a future outcome may constrain mental simulation of the future more than the past and therefore people are more likely to focus on controllable events in their prefactual thoughts than in their counterfactual thoughts. Conclusion: This temporal asymmetry challenges current views of hypothetical thinking. Specifically, it necessitates a reappraisal of the dominant view that counterfactual thinking mainly serves to regulate behavior and improve future performance.

Carry-over effects in moral judgments

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Introduction: Carry-over effects have been shown to have a huge impact on moral judgments. However, this phenomenon has not gained a lot of attention so far and the underlying psychological mechanisms are still opaque. Method: In several experiments each subject was presented with different moral scenarios in order to figure out under which conditions a moral judgment is influenced by a preceding moral judgment. Results: Only judgments of actions that are normally, i.e. if judged in isolation, regarded as morally acceptable were affected by carry-over effects, and this was only the case if the action to be judged was immediately preceded by a scenario in which the proposed action was not considered as morally acceptable. If there was such a constellation, ratings for actions normally regarded as morally acceptable decreased and approached the ratings of the previous judged action. Discussion: A systematic pattern was found that can account for previous found carry-over and order effects in the literature of moral judgments. Regarding the questions what causes carry-over effects we still do not have a full understanding of this phenomenon, but significant progress was made towards this aim. Some promising explanations like emotional engagement were ruled out and it was found that carry-over effects depend, among other things, on whether the scenario being influenced and its preceding scenario are sharing rather subtle structural similarities. Conclusion: Since the impact of carry-over effects was found to be as strong as or even stronger than factors of which it is naturally thought of to influence moral judgments (e.g., causal structure or personal force) further investigating this phenomenon seems to be necessary for a complete understanding of moral judgments.

A complex emergence solution to the reasoning systems’ interaction problem

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In a desire to account for experimental evidence that is said to indicate that human reasoning is subject to errors and biases, some scholars have championed dual systems theories of reasoning. These scholars have attempted to resolve the systems’ interaction problem by proposing either additional systems or one system dominating the other. Utilising modularity theory, I will outline a proposed solution that asserts that human reasoning consists of a multitude of modules that interact via dynamical emergent processes based on information input and output requirements. This proposed solution combines research from modularity, emergence and situated cognition theories.
Slips and Slippage: Analogy-Making in Perception and Action

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Analogy is typically thought of in terms of high-level reasoning and problem-solving. For the most part, influential models of analogy-making (e.g., the Structure-Mapping Engine, ACME, and LISA) have treated it as an abstract and disembodied cognitive process. Even alternative models such as Copycat (Mitchell 1993), which emphasize the role of “high-level perception” in analogy-making, have conceived of analogy-making as something largely independent of modality or embodiment. This disembodied view of analogy-making contrasts sharply with work on the related phenomenon of conceptual metaphor (Lakoff & Johnson 1981; 1999), which has been influential in advancing the view that meaning is grounded in spatiotemporal experience and bodily action. In this paper, I will survey the prospects for bringing research on analogy-making into contact with the embodied cognition. In doing so, I focus on the notion of slippage as a unifying theme. Specifically, I aim to highlight the continuities between conceptual slippage (Hofstadter 1995), action slips (Norman 1989), affordances (Gibson 1977), and what I call “perceptual slippage,” which shares much in common with Wittgenstein’s (1953) idea of “seeing as.” In highlighting these continuities, I draw on material from a range of sources, including studies of error-making along with examples from TV and film, advertising, design, and visual art. Finally, I compare this evidence with findings from recent psychological studies on the embodied aspects of analogy-making (e.g., Kokinov, Feldman & Vankov 2009). The goal is to reframe analogy-making as something that takes place not just inside our heads, but in our interactions with the world.

Causal reasoning and improvement planning during event analysis in healthcare

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Hospitals seek to identify the root causes of safety-threatening events in order to make improvements. As the causal structures of events become more complex, it is crucial to study what drives causal inquiry and improvement planning. In adopting a sensemaking perspective (Weick, 1995), we conceptualize those processes as driven by cognitive structures that help the individuals understanding an event based on their experience and anticipations of what happens after the analysis (perceived action repertoires, Weick, 1995), and by using internal mental models that store knowledge, assumptions and information related to safety improvement and accident causation. Thus, we propose three cognitive structures: (1) a habitual mental model about accident causation and safety, which interacts with (2) a perceived action repertoire (Weick, 1995) in constructing (3) a causal scenario. From this causal scenario, the improvement actions are designed to address selected causes. We expect these cognitions to be influenced by personal and situational factors, such as: professional identity - hospitals bring together different professional groups, e.g., physicians, nurses, risk managers, pharmacists, with different responsibilities and expertise; training and experience – what people consider as normal depends on their prior training and experience (Hilton, McClure, & Sutton, 2009); root cause analysis tools - there exist various approaches in practice for conducting event investigations influencing causal search and action definition (Nicolini et al., 2011); need for closure - people with a high need for closure (Kruglanski & Webster, 1996) direct their cognitive processes toward firm and clear representations of an event. To investigate the framework, we propose four studies: a survey and an interview study, both of which use a cognitive mapping technique to elicit causal thinking and action planning based on vignettes, an archival study to investigate mental models reflected within analysis reports and their organizational consequences, and an experimental approach for studying the effects of need for closure.

The interpretation of conditionals

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Introduction: Sentences preceded by the sentential adverb ‘sometimes’ expressed limited generalizations as compared to those expressed by indicative conditionals, e.g., English ‘if=statements.’ This study investigated how these different kinds of generalizations are computed on-line, in Mandarin Chinese. The research hypothesis was that the meanings of both expressions would contribute to anticipatory effects, such that these expressions would dictate which real-world objects would later be mentioned in the test sentences. Materials/Method: There were two types of ‘basic’ two-clause sentences, ones with ‘and’ and ones with ‘if’. There were also two kinds of ‘complex’ sentences with the adverb ‘sometimes’ added (sometimes and... and sometimes/if...) (see Figure 1). This enabled us to tease apart the effect of the presence of ‘if’ [± IF] from the presences of ‘sometimes’ [±
SOMETIMES]. To assess the on-line contributions of these expressions to sentence meaning, we recorded subjects’ eye movements using a visual-world paradigm. To determine anticipatory eye-movements, we analyzed fixations to targeted regions in pictures during the time subjects were hearing that portion of the test sentences that preceded the mention of the disambiguating objects. The disambiguating objects were either a pair of animals (goldfish) that received the same reward (bananas), or a pair of animals (swans) that received different rewards (a feather or a strawberry). **Results:** The main finding was an anticipatory main effect of [+ SOMETIMES] in the first clause before the relevant object was mentioned (see Temporal Frame in figure 1 & figure 3). That is, subjects fixated significantly more often on the animal with different rewards (the swans) in the sentences with ‘sometimes’ (regardless of ‘if’) even before the word swans’ was mentioned (see Figure 3 & Figure 4). **Discussion & Conclusion:** The findings suggest that the sentential adverb sometimes guides people’s search for objects with different properties, as compared to the logical connective if, which expresses fuller generalizations.

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**Introduction:** We investigated the role of domain-general cognitive resources in solving inferences by means of dual tasks. **Method:** Fifty eight adult participants solved a range of computer-administered tasks: questionnaires on folkbiology (ToB) and on folkeconomics (ToE), folkpsychology composed of inferring an emotion from a verbally presented situation (ToP) and false-belief tasks (ToM). Each domain was tested with questionnaires at two levels of difficulty. Half the participants performed, concurrently, a task designed to tax cognitive resources continuously. **Results:** Cognitive load both reduces accuracy and increases RT in main task, for ToM tasks (ToM2 more than ToM1) and nowhere else. Cognitive load reduces accuracy and increases RT in all tasks on secondary task. **Discussion:** These findings indicate that the appropriate generalization does not relate to content domains (such as folk psychology versus folk biology) but rather to the nature of the task under consideration, analytic or associative. For ToB ToP and ToE, the solution is generated by the associative system in LTM, and therefore full or divided attention does not affect the process. For ToM, response generation occurs in the analytic subsystem, and therefore is affected by cognitive load. In all domains, the harder questions impaired the secondary task more than the level-1 questions, both in terms of accuracy and of delay **Conclusion:** This suggests that the tasks of the associative system also consume domain-general resources.
The examination of the effect of ego-involvement on contingency judgement

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Arai (2008, 2009, 2011) has found that people judge differently in terms of causal induction depending on the presence or absence ego-involvement: a causal relationship is judged more strongly in the presence of ego-involvement than in its absence. The aim of this study was to see whether this effect is also observed in contingency judgement. The experiment had a 2 (ego-involvement; absent/present) X 2 (contingency: medium/high) design. Contingency was manipulated as within-subject factor, and ego-involvement, as between-subject factors. Participants were divided into two groups according to their condition—the presence or absence of ego-involvement—and were exposed to medium contingency conditions and high contingency conditions, respectively. They were all asked to the each strength of the contingency of the two events: cause and effect. As a result, when contingency was medium, the group of participants having ego-involvement judged the contingency more highly, compared to that not having ego-involvement. On the other hand, when contingency was high, the group of participants not having ego-involvement judged the contingency marginally more highly, compared to that having ego-involvement. This result is different from that obtained by the experiment investigating causal induction. Moreover, it indicates that people make a subjective judgement when they can’t confirm the relationship of the target events and they are in trouble, while when they can confirm the relationship, they make an objective judgement.

Counterfactual thinking and confidence for winning slot machine games: The counterfactual inflation hypothesis revisited

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Introduction: Previous research indicates that repeatedly generating counterfactual thoughts during recurring events (e.g. playing multiple games in a gambling context) can lead to overestimations of performance and overconfidence for winning in future playing. This study examines the interplay between different modes of counterfactual thinking and the level of near miss (NM) outcomes on gambling behaviour, whereby a high proportion of NMs (which promotes mental assimilation of winning outcomes) is expected to attenuate the counterfactual inflation effect. Method: Participants (N = 60) played a computer simulated slot machine game under either a high NM or a low NM condition. They were prompted to list evaluative counterfactuals, reflective counterfactuals, or any thoughts that came to mind after every fifth loss. Results: Thought listing conditions had no effect on participants’ estimations of performance. However, after controlling for accuracy in performance estimations, we found that participants who generated evaluative counterfactuals reported significantly lower confidence for winning future games than those who generated reflective counterfactuals or other thoughts, but this finding was evident in the low NM condition only. Interestingly, participants in the high NM condition reported significantly greater willingness for further playing. Discussion: Thus our results provide limited support for the counterfactual inflation hypothesis. In recurring events where the actual outcome is typically dissimilar to a desirable one, generating evaluative counterfactuals may deflate any unwarranted expectations of achieving desirable but uncontrollable outcomes. Conclusion: These findings have theoretical implications for the counterfactual inflation hypothesis, and practical implications for regulating the proportion of NM outcomes allowed in computerised gambling games.

Adolescents’ Susceptibility to the Gambler’s Fallacy in No-Gambling and Gambling Situations: Do Probabilistic Reasoning Abilities Matter?

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Introduction: Probabilistic reasoning errors could arise from the lack of the rule or from a failure in recognising the need for it. We aimed at investigating adolescents’ susceptibility to the gambler’s fallacy in no-gambling and gambling situations ascertaining the role of probabilistic reasoning abilities and dispositional factors. Method: Participants were 148 high school students having gambled at least one time in the previous year (62% Males, Mean Age = 15.94). They were presented a series of six coin tosses sequences and asked to indicate the likelihood of Tails at the seventh toss (No-Gambling Task) and then invited to bet money on the likelihood of Tails (Gambling Task).
Modes of Argument: To Win or to Learn

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Introduction: Argumentation is an important tool for discerning truth and a necessary feature for scientific progress. Arguing is always embedded in a social context and has been shown to help filter out weak arguments that could otherwise be accepted uncritically through biased individual reasoning. However, the filtering function might not always hold because of at least two distinct modes of argumentation. In one mode, arguers seek truth through productive discussions with others, and in the other mode, arguers seek to win by simply proving others wrong, often in ways that don’t advance knowledge and understanding. Methods: Three studies examined the factors that lead to these mindsets by investigating the type of person with whom participants choose to interact in either a public or private setting. Study 1 used hypothetical vignettes to assess participant preferences, Study 2 measured choices for an online chat---room discussion, and Study 3 examined the effect in a real world public or private argument. Results: Participants showed a preference to argue with the less knowledgeable person in public and a preference to argue with the more knowledgeable person in private. Discussion: We consider the implications for optimization of group reasoning. Promoting environments that facilitate arguing to learn could help make discussion more productive. Conclusions: These results suggest that arguing in private prompts a mindset of arguing to learn and arguing in public prompts a mindset of arguing to win.

Overcoming exclusivity in long-term spatial memory

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Memory for spatial information is often fragmented or error prone. For instance, recent work shows that under certain conditions multiple spatial memories for a given target object do not benefit the accuracy of a subject’s location memory. It is argued that this ‘exclusivity effect’ is the result of an inability to combine or integrate independent spatial memories. The current research sought to test the influence of learning on this phenomenon, specifically whether repeated exposure to target-anchor relations enabled aggregation of spatial memories. It also examined the experimental paradigm under which exclusivity was originally observed to ascertain if task difficulty was adding to the likelihood of exclusivity occurring. Two learning experiments were carried out, one over the course of a week (n=10) and the other over the course of two weeks (n=10). Across these experiments participants were randomly assigned to learning versus non-learning, or word versus non-word conditions. This meant participants became familiar with either the task or spatial location. Comparisons of three statistical models (exclusivity, independence, & additivity) allowed for the testing of any continued presence of exclusivity. Results indicate that reducing task difficulty, through familiarisation, had no impact on circumventing exclusivity. This suggests that task complexity was not a factor inhibiting the aggregation of spatial memories. More importantly it was demonstrated that familiarity of spatial relations allowed subjects to access two independent spatial memories at recall. This indicates that non-exclusive retrieval is possible under conditions of learning. It is argued that not only are participants able to access more than one spatial memory under repeated learning, but that it is only under such conditions when memory aggregation is plausibly required.

Chronometrical evidences in conditional reasoning: A first answer to the debate between suppositional and mental model accounts

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According to Evans’ (2007) suppositional account of conditional reasoning, the judgment of irrelevance on \( \neg p \) cases when adults have to evaluate the truth-value of a conditional “If p then q” statement result from heuristic processes. This assumption permits to clearly oppose the suppositional account and our dual process theory of mental models (Gauffroy & Barrouillet, 2009). Indeed, if “irrelevant” responses rely on heuristic processes then they should be rapid. By contrast, if these responses result from a demanding and time consuming fleshing out process, as we assume, they should be the slowest. In the present study, we analyze the time course of responses as a function of their nature and the interpretation of the conditional adopted by adult participants. As our account predicts, “irrelevant” responses are the slowest, and response times are a direct function of the number of models each type of response involves.

Is Modeling the Primary Activity of the Human Brain?

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This question arose after having thought about how novelists imagine their surrounding world - the reality - before (and during) “creating” their work which represents a piece of this reality. Then, this fact was extended to other “artistic producers” such as the painter, the musician, the sculptor, etc. Simply put, the question is: what happens in a creator’s mind before (and during) the process of creation, be him a novelist, a musician, a painter, etc. To the following question: “How do you make the shape of you piece of work appear from within the stone”? Michelangelo used to answer: “It’s already in there”. It is while thinking about the novel as a process of representation of reality that the following idea surfaced: modeling could well be the main process of thought of the human brain. We reason only on models, says Paul Valéry. We communicate only by models, echoes him Gregory Bateson. What could this mean other than there exists many kinds of modeling on the cognitive level: mathematical, schematic, graphical, etc. Could this mean that there is a modeling prototype, hence a modeling archetype? The answer to this question is far from being simple. I suggest in this article a way of opening up and a attempt for finding an answer based mainly on the human oral and textual productions, without neglecting other productions such as the graphical or the schematic ones. My major objective is thus the following: examine the various types of narrative ranging from myth to advertising including tale, saga, legend...; examine the various types of scientific representation such as Mathematics, Physics, Chemistry, but also the computer languages by focusing primarily on the concept of algorithm which is common to them; examine artistic works such as music, paintings, sculptures, sketches. But, as those examinations constitute a large program and could not be tackled in a short article, I will thus examine briefly some of the examples mentioned above within the general frame of modeling. What is modeling? The modeling I am referring to is akin to the systems thinking modeling, thus to that of complexity science. It is a technical process leading to a construct (in Levy-Strauss’ sense) - the model, i.e., the matching counterpart of the complex reality - which is designed to reproduce the perceived reality in order to better understand it, or even to act on it. Nowadays, a model can be studied on computers (elaboration and simulation) and it will not be the object of a mathematical demonstration as it is just confronted to reality of which it is the best rough copy.

Does omission bias relate with the difference of perceived intention?

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Introduction: In general, western people show omission bias, which is the tendency to judge acts of commission as morally worse than equivalent acts of omission when intentions and outcomes are held constant. However, little is known about whether the occurrence of omission bias relates with the difference of perceived intention between commission and omission. Method: Japanese undergraduate students participated in this study. Each task presented two stories with a similar structure but one key difference: the agent’s act was either commission or omission. In one story, the agent did something causing an outcome. By contrast, in the other story the agent did nothing causing the same outcome. Three types of tasks were prepared: Anti-social, neutral, and pro-social tasks. The moral evaluation questions, the intention evaluation questions, and the outcome evaluation questions were asked. Results: The results showed that, in all three tasks, participants tended to judge that the agent who did something was significantly morally worse than the agent who did nothing. They also perceived that the do-something agent had significantly stronger intention than the do-nothing agent in all three tasks. By contrast, there were no differences in the evaluation for the outcomes between commission and omission. Discussion: These results reveal that omission bias occurs in Japanese as well as western people. Furthermore, this bias may occur by
Verbal Analogy Training Improves Relational Reasoning and Interference Resolution

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Introduction Providing an explanation for the correct answer of a verbal analogy (STRONG : WEAK :: MORNING : EVENING) may bias attention on the relational abstraction and application component process of analogical reasoning. Likewise, providing an explanation for a semantically closer lure (EARLY) may bias attention on the interference resolution required during the response selection component process. Method Undergraduates completed a verbal analogy selection task (e.g., PEAR : BANANA :: HAMMER : _____; wrench, tool, pound, steel, wood) and a verb generation task, in which they responded with a verb for either a high interference noun having many possible related verbs (“throw, kick, bounce, toss, roll” for ball) or a low interference noun having one salient related verb (“cut” for scissors). In a second session, 78 of these participants completed one of three training conditions. They provided explanations either for the correct answer or for a semantically closer lure, or they simply selected the correct answer for the training analogies (i.e., no explanation condition). Immediately after training, they completed alternate lists for the same two pre-training tasks. Results Only the correct answer training condition improved performance on both the verbal analogy and verb generation tasks. Discussion Providing an explanation for the correct answer focused attention onto the analogical relation (opposites). In turn, this attentional bias led to general improvements on both relational abstraction and interference resolution. Conclusion Explanation-based training with verbal analogies improves relational abstraction and interference resolution in analogy and semantic memory (i.e., verb generation task).

The Role of Fixation and Incubation in Insight Problem Solving

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Sometimes when solving problems people suddenly become confident of a solution, a subjective experience frequently described as insight, or the aha or eureka moment. Some researchers have suggested that when solving problems frequently characterized by the experience of insight, a time away (i.e., incubation) can aid in overcoming fixation during problem solving. In this study we investigated how fixation and incubation may be related with respect to the experience of insight during problem solving. Participants solved Compound Remote Associates (CRA) problems after performing a secondary two-phras
task designed to manipulate CRA problem fixation. The time participants had to solve each problem was divided into two epochs. On some trials the second epoch was preceded by a 40-second incubation period during which the participants performed a simple working-memory distraction task. We found that the two-phrase task could manipulate CRA fixation, reducing solution rates particularly during the first solution epoch. Interestingly, when participants did solve problems during the first epoch they reported less insight if they were in the greater fixation condition. While there was only a trend towards incubation improving solution rates in the second solution epoch, participants were much more likely to report insight after incubation than when they continuously tried to solve the problem. Together these findings suggest that fixation does not appear to be necessary for the experience of insight, however, a time away from problem solving can make the experience of insight, if not problem solution, more likely.

A Comparison of Metacognitive Judgements Across Task: The Task-Specificity of Retrospective Confidence Judgements

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Introduction: Whether metacognitive monitoring is a task-general or task-specific skill has important implications for education and cognitive science. Previous studies exploring differences across academic domains and tasks have produced inconclusive results, and no study has made a direct and extensive comparison of monitoring across tasks, with most theoretical positions developed via studies in metamemory. Method: This study used a within-subjects design, and collected metacognitive judgements – ease-of-learning judgements (EOLs), judgements of learning (JOLs), retrospective confidence judgements (RCJs) and RCJs on aggregate – for memory and problem-solving tasks. The judgements were computed into measures of absolute and relative accuracy. Results: Findings demonstrated task-specificity, particularly pronounced in RCJs, where the memory task had significantly greater
accuracy across all metacognitive measurements. There was a general pattern of task-specificity in the bias index scores, with the problem-solving task exhibiting overconfidence and the memory task exhibiting underconfidence. **Discussion:** These task-specific differences throw doubt on the homogeneity of metacognitive judgement processes, and suggest that monitoring may vary across task, if not domain. The differences might be due to cognitive difficulties in applying skills across tasks, either because of the nature or complexity of the task at hand. **Conclusion:** The findings suggest that further development of theoretical thinking on metacognitive judgement processes, and their domain-specificity, is required. They also have wider implications for how metacognitive monitoring is applied by students in educational settings, and contribute to the debate about whether cognitive development is domain-specific or domain-general.

**Insight and CRA problems**

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**Introduction:** The paper illustrates a study on the appropriateness of CRA problems, in which participants are asked to classify their responses as insight or not—insight on the basis of a definition of insight based on the suddenness and obviousness of the response. **Method:** The hypothesis is that the particular definition of insight proposed to the participants is a weak definition, which can be adapted also to a lexical recognition task, into which task type CRA problems would appear to fall. We have therefore formulated two Italian versions of the task: a control version, similar to the original, and the experimental version, in which the definition of insight is modified and the response categories pass from two responses (insight/not—insight) to three (automatic/procedural/insight). **Results:** The utterances of the control task revealed the difficulties that the participants encountered in discriminating between the available thought alternatives (insight/not—insight), as emerges from the individual differences in the selection criteria adopted and the wide range of response times. Moreover, the percentage of responses which are judged as insight decreases dramatically when the participants are offered three response options (from 56% to 13%), showing a preference for the “automatic” option. **Conclusions:** The definitions used in classical studies with CRA problems seem vague and misleading, as they induce the participants to consider as insight processes which have little genuine creative and productive content (factors which distinguish the phenomenon), focalizing on the suddenness and obviousness of the response, which seem to better characterize a type of automatic thought process.

**Analogical reasoning in preschoolers: A matter of both relational knowledge and executive control**

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There are two major accounts of the development of analogical reasoning (AR) in children. The first one argues that relational labeling is critical, specifically for children whose relational knowledge is not fully developed. The second view considers that analogical reasoning is constrained by the development of executive control. Two kinds of tasks are frequently used to assess AR: the relational—matching—to sample task (RMTS) and the four terms analogical task (A:B::C:D). Whereas A:B::C:D is a task of analogy production, the RM task assesses recognition of analogies between pairs –AB and CD1, CD2,..., and is used in very young children and apes. We contend that confronting these two tasks could be a good test of the executive account since they differ in control required for their resolution. In this study, we tested the interaction hypothesis between development of relational knowledge and executive control. Two groups of preschoolers were tested either on A:B::C:D or on RMTS task using the same relations. Half of the participants were asked to label the relation between A and B before giving their analogical response. As expected, performance on A:B::C:D were significantly worse than on RMTS. In the younger group, labeling enhanced performance only on the more demanding A:B::C:D task. Performance of the older group were affected by neither variable. These results showed that both executive control and relational labeling modulate preschoolers’ performance and have to be considered interdependently when accounting for analogical reasoning development.

**Logic, models, and paradoxical inferences**

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**Introduction:** Paradoxical inferences are valid in logic, but individuals tend to reject them. Some theorists argue that they are invalid for everyday conditionals. But, the theory of mental models implies that they are valid, but unacceptable because their conclusions refer to a possibility inconsistent with their premises. Hence, individuals
should accept them if the conclusions refer only to possibilities consistent with the premises. Two experiments tested this hypothesis. Method: In Experiment 1, 22 participants evaluated conclusions for the two sorts of conditional paradox (\(\text{Not } B \); therefore, if \( A \) then \( \text{not } B \); and \( \text{Not } A \); therefore, if \( A \) then \( B \)). In Experiment 2, 20 participants did the same task with the disjunctive paradox (\( B \); therefore, \( A \) or \( B \)) and an analogous conditional paradox. The experiments manipulated the contents so that half the inferences had only possibilities consistent with the premise (the modulated case), e.g., Luisa didn’t play soccer; therefore, if Luisa played a game then she didn’t play soccer; and the other half did not (the paradoxical case), e.g., substitute music for a game in the previous example. Results: The participants accepted many more inferences with modulated contents than with the paradoxical contexts for all three sorts of paradox. Discussion: The present results corroborate the model theory. Other studies have found the same results, but only for the first sort of conditional paradox (Bonnefon and Politzer, 2011; Pfeiffer and Kleiter, 2011). Conclusion: In sum, individuals accept the paradoxes when the possibilities of the conclusion are consistent with the premise.

**Does Moral Content Matter When Judging Intentionality?**

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**Introduction:** Three studies compared explanations of the side-effect effect, whereby side-effects of actions are judged intentional when negative but not when they are positive (e.g. Knobe, 2003). The Intuitive Moralist account assumes that moral valence is critical to intentionality judgments. The Rational Scientist account assumes the effect arises from perceptions of norm violation. In legal domains those with a mental illness are often deemed to be free of standard norms of social responsibility. Hence, we examined whether the side-effect effect would hold when the agent was known to have a psychiatric disorder. Method: In each study participants were presented with four vignettes in which moral agents acted in a manner that led to positive or negative social side-effects. In Experiment 1a (N = 64) agents were or were not labelled as having a psychiatric disorder. Experiment 1b (N = 33) strengthened the labelling manipulation by adding a physical illness. Experiment 2 (N = 32) replicated Experiment 1a using trainee clinical psychologists as participants. Results: In all studies participants were more likely to attribute intentionality when the side-effect was negative than when it was positive, regardless of labelling. Discussion: These results support the intuitive moralist account as sensitivity to the moral content of the side-effect was unaffected by varying perceived norms of social behaviour. Conclusion: These results illustrate the robustness of the side-effect effect in the attribution of intentionality. Attributions were affected by moral valence, even when the agent was described as having a mental illness. Keywords: Side-effect effect; Knobe effect; moral reasoning; theory of mind.

**TBA**

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**Introduction:** We report an experiment incorporating dispositional and working memory measures to investigate individual differences in belief bias. Method: Participants (N = 160) attempted belief-oriented syllogisms as well as the Cognitive Reflection Task (CRT; Frederick 2005), to assess abilities to override intuitively compelling answers, and the Automated Operation Span task (Ospan; Unsworth et al. 2009) to measure working memory capacity. Response latencies were recorded for these tasks. Participants also completed the Actively Open Minded Thinking scale (AOMT; Stanovich & West, 2007) and the Rational-Experiential Inventory (REI-40; Pacini & Epstien, 1999). Results: Conclusion endorsement rates showed standard main effects of logic and belief and a logic by belief interaction. Higher AOMT and CRT scores were associated with increased endorsement rates for valid-unbelievable conflict syllogisms (\( r = .164; r = .300 \)) and decreased endorsement rates for invalid-unbelievable conflict syllogisms (\( r = -.167; r = -.184 \)). Rational ability on the REI-40 correlated positively with endorsements for valid-unbelievable conflict problems (\( r = .181 \)) and Ospan scores correlated with response latencies for conflict syllogisms (\( r = .225 \) for valid-unbelievables; \( r = .270 \) for invalid-believable). Discussion: Individuals who apply open-minded thinking and who override intuitive responses reason more normatively when logic and belief conflict. In addition, individuals with a higher working memory capacity take longer over conflict syllogisms, suggesting an attempt at analytic processing. Conclusion: More effective normative responding to logic/belief conflict problems is most closely associated with dispositional tendencies toward open-minded thinking and the resistance of intuitive responses, placing the concept of the “reflective mind” (Stanovich, 2010) at centre stage in accounting for belief-biases in reasoning.

**Cognitive Style Predicts Supernatural Belief**
**Introduction**: An analytic cognitive style denotes a propensity to set aside highly salient intuitions when engaging in problem solving. We assess the hypothesis that an analytic style is associated with a history of questioning, altering, and rejecting (i.e., unbelieving) supernatural claims, both religious and paranormal. **Method**: In two studies, we examined associations of God beliefs, religious engagement (praying, etc.), conventional religious beliefs (heaven, miracles, etc.) and paranormal beliefs (extrasensory perception, levitation, etc.) with performance measures of cognitive ability and analytic cognitive style. **Results & Discussion**: An analytic cognitive style negatively predicted both religious and paranormal beliefs when controlling for cognitive ability as well as religious engagement, sex, age, political ideology, and education. Participants more willing to engage in analytic reasoning were less likely to hold supernatural beliefs. Further, an association between analytic cognitive style and religious engagement was mediated by religious beliefs, suggesting that an analytic cognitive style negatively affects religious engagement via lower acceptance of conventional religious beliefs. Results for types of God belief indicate that the association between an analytic style and God beliefs is more nuanced than mere acceptance and rejection, but also includes adopting less conventional God beliefs, such as Pantheism or Deism. **Conclusion**: Our data are consistent with the idea that two people who share the same cognitive ability, education, political ideology, sex, age and level of religious engagement may acquire very different sets of beliefs about the world if they differ in their propensity to think analytically.

**Property Induction in Chemistry Reasoning**

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**Introduction**: Previous property induction studies across a variety of domains suggest that domain-—general strategies influence people’s inductive generalisations, such that people generalise what they know about one item to similar looking items and to items from the same category. However, none of these studies have investigated whether these strategies appear in chemistry reasoning. **Method**: Following standard property induction methods, twenty adults saw a target substance (e.g., granulated brown sugar) mixing in water leading to some outcome (e.g., dissolving). Next, they predicted whether four randomly ordered probe items would generate the same outcome, with 12 sets of unique targets/probes/outcomes (order counterbalanced across participants.) The probes varied by substance and form: 1) same---substance / same---form (e.g., granulated brown sugar); 2) same---substance / different---form (e.g., brown sugar cube); 3) different---substance / same---form (e.g., sand); and 4) different---substance / different---form (e.g., rock). **Results**: The results replicated the general pattern of findings in other studies with ‘yes’ predictions being significantly different for each probe, with same---substance / same---form > same---substance / different---form > different---substance / same---form > different---substance / different---form. However, some sets of targets and probes showed different patterns of generalisations. **Discussion**: The results indicated that participants are using both substance and form when making predictions about simple chemistry reactions. However, since this overall pattern is not replicated for each kind of substance, it is likely that they are using other information about the items to inform their judgements. **Conclusion**: Based on the current findings, it seems likely that chemistry reasoning involves both domain-—general and domain-—specific strategies.

**Reasoning about causal strength in binary and continuous relations**

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**Introduction**: In binary causation P(e|c)=1 means that the effect is certain to be present given the presence of the cause and poses a natural upper limit. Such a limit is not necessarily present in continuous causation where causes influence the effect magnitudes (as opposed to probabilities). Unlike probabilities, magnitudes need not have an upper limit. We explored causal judgments in continuous scenarios where effect magnitudes had clearly defined upper limits. Specifically, we employed magnitudes that represented direct mappings from comparison probabilistic scenarios. This allowed investigation of whether causal judgments involving continuous effects are rooted in the same principles as evaluations of probabilistic causation. **Method**: Fifteen conditions of various combinations of causal power and ΔP, for each generative and preventive causation, were tested on thirty participants via a web---based experiment. **Results**: Causal judgments from continuous scenarios followed the
same patterns as judgments of probabilistic causation, replicating well—established influences of causal power (Cheng, 1997) as well as non-normative biases of ΔP when power was held constant. Discussion: Reasoners appear to judge causal strength of continuous relations in a similar way as in binary relations when the upper limit of the effect magnitude is clear. The limit, being the maximum possibility of the effect magnitude, may be used by reasoners as a reference of the maximum causal strength during judgement. Thus, knowing the limit enables the reasoners to make proportional causal judgments according to the principles of causal power (Cheng, 1997). Conclusion: Clear limits of effect magnitude are important for causal judgment of continuous causation.

How do experts and novices construct arguments in a complex and uncertain task?

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Introduction: This study aimed to discover how arguments or chains of reasoning were constructed by novices and experts when resolving labour disputes. Study 1 elicited their thought processes using a think aloud protocol. Based on these findings, a reasoning aid was developed and used in Study 2 to support reasoning and evaluate any changes in reasoning processes and outcomes. Method: Six scenarios, which replicated actual labour cases, were developed and used to elicit the arguments generated by experts and novices on a realistic task. Based on this analysis, a reasoning aid was developed and evaluated in Study 2. Both studies employed a ‘think aloud’ method. There were 22 participants in Study 1 and 28 in Study 2. Participants’ verbal protocols were recorded, transcribed and coded based on their chains of reasoning. Results: Six higher-order codes were developed based on argument elements proposed by Toulmin’s (1979) argument model: claims, grounds, warrants, backing, modal qualifier and rebuttals. For each scenario, common protocol codes used by experts and novices were drawn into argument maps. Discussion: In study 1, experts drew more accurate conclusions, omitted less evidence and offered more justification than novices. The reasoning aid in Study 2 improved novices reasoning; however, experience was also crucial for reaching the correct outcome. Conclusion: Whilst the reasoning aid reduced differences between experts and novices, experience still played a crucial role in ensuring the correct outcome. Toulmin’s argument analysis approach made a valuable contribution to understanding reasoning in this realistic and complex task.

Diagnostic reasoning: abduction vs plausible deduction

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Introduction: The new paradigm states that causal conditionals such as Cause ® Effect are represented in the human mind by the conditional probability P(Effect|Cause). Causal conditionals are involved in many forms of plausible reasoning, nonmonotonic reasoning, counterfactuals, abduction, probabilistic reasoning. In diagnostic situation two major diagnostic patterns may be involved: classical abduction [Effect Cause ® Effect => Cause] i.e. affirmation of the consequent) and/or plausible deduction [Effect, (Effect ~> Cause) => Cause] i.e. defeasible Modus Ponens. We tested in an experiment if there were preferences on these two patterns according to the initial value of P(Effect|Cause). Method: Two diagnostic situations were created: in one scenario there was P(Cause|Effect) < P(Effect|Cause) and in the second, P(Cause|Effect) > P(Effect|Cause). The task was to present in both situations the minor premise (Effect) and the conclusion (Cause), participants were then asked a preference judgment on the major premises, (Cause ® Effect) vs (Effect ~> Cause). Result: Whatever the initial probability distribution P(Cause|Effect) < P(Effect|Cause) vs P(Cause|Effect) > P(Effect|Cause), the major premise Effect ~> Cause is preferred to Cause ® Effect. On the other hand, around _ _ of the subjects did not indicate any preference. Discussion: In diagnostic situation, participants seem to reason from defeasible Modus Ponens pattern Effect, (Effect ~> Cause) => Cause. Conclusion: The initial distribution of probability does not seem to influence the preferences of participants, however it would be interesting to test scenarios where P(Cause|Effect) is differentiated more clearly from P(Effect|Cause).

How and What Diplomats (Really) Think? Wikileaks as a Database for Social Sciences

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Introduction: In analyzing how diplomats thing two types of data are being used. On one hand official statements and documents are being used. On the other hand researchers use personal information - interviews with insiders and their memoirs. Present paper analyses new set of data that is available to researchers through Wikileaks cables releases. Method: We assume that while interviews and memoirs can contain rationalizations and PR techniques, cables show more accurately how diplomats work and how they think. The paper provides a
qualitative and quantitative analysis of cables showing the patterns of how diplomats think about international relations. We show what they focus on, what metaphors they use when describing the world, to what extent their descriptions involve emotional statements etc. **Results:** Results of the analysis show that despite frequent news on “new quality” in international relations diplomats thinking is really directed towards creating cognitive oppositions between countries, interests etc. Research shows that the picture of how diplomats think derived from cables differs from popular picture of diplomacy. **Discussion:** We have to remember that released cables are already filtered by the Wikileaks members. We have to underline that this picture is not the general picture of diplomacy but a general picture of diplomacy that can be derived from Wikileaks. **Conclusion:** Present paper shows that Wikileaks cables are inspiring data to use in analyzing how diplomats think. This source shouldn’t be overestimated and should join other methods of analyzing international relations and diplomats cognitive perspective.