2002 - July 10/11/12 University of Cambridge

CAMBRIDGE MEETING 2002

A scientific meeting will be held at the Department of Psychology, University of Cambridge on 10-12 July, 2002. The local organisers will be Professor Tony Dickinson and Dr Ian McLaren.

The meeting will be preceded by an EPS Workshop for Professor N J Mackintosh
Associative learning and representation
Tuesday 9 July, 9-6 in Emmanuel College. There is no charge to attend the Workshop, but please send in the booking form if you wish to attend so that the organisers can estimate numbers.

Thirtieth Bartlett Lecture
Professor Alan Cowey (Oxford University)
Fact and artefact about blindsight
The Bartlett Lecture will take place at 5.45pm, Thursday 11 July in Physiology Lecture Theatre III, Downing Site

Symposia:

Wednesday 10 July 2.30-5.30

Back to the future: Mental time travel in animals and humans
Organiser Dr Nicola Clayton

Friday 12 July 9.00-12.30

Two hemispheres, one reading system: Early cortical representations of print during reading.
Organiser Dr Michal Lavidor

Presentations

Sessions will be held in the Psychology Department Lecture Theatre and Physiology Theatre III. Both theatres have data projectors for Powerpoint presentations. The computers are Macs running Powerpoint 5 (believed to be equivalent to Powerpoint 97) If in doubt presenters are advised to bring their own laptops. Any queries about facilities in the theatres should be sent to the local organiser, Tony Dickinson (ad15@cam.ac.uk)

Coffee will be served in the Psychology Department.

There will be a drinks reception on Thursday evening in Emmanuel College after the Bartlett Lecture**.** The conference dinner will be at 7.30 at Emmanuel College. A booking form is enclosed.

TUESDAY 9 JULY 9am - 6pm
Emmanuel College, Cambridge

A Workshop For Professor N J Mackintosh
Associative Learning and Representation

WEDNESDAY 10 JULY am

Physiology Lecture Theatre III

9.00 Andrew J Calder, Jill Keane*, Tom Manly*, Reiner Sprengelmeyer*, Sophie Scott*, Ian Nimmo-Smith*, and Andrew W Young (MRC Cognition and Brain Sciences Unit, Cambridge, University of St Andrews, University College London and University of York)
The effects of ageing on recognition of emotion

9.30 R A McCarthy, N Kumar*, G T Plant* and M Galton* (University of Cambridge and National Hospital for Neurology and Neurosurgery, London)
Upside down but not out of order: configural processing in prosopagnosia

10.00 Kate Elgar*, Ruth Campbell, John Swettenham*, Janneke Terstegge*, Rebecca Akers*, Michael Coleman* and David Skuse* (Behavioural and Brain Sciences, Institute of Child Health, University College London, Human Communication Science, University College London and Department of Psychonomics, University of Utrecht, Netherlands)
Impaired processing of direction of gaze in Turner syndrome – evidence for amygdala dysfunction.

10.30 COFFEE

11.00 Elaine Fox (University of Essex)
What facial features produce the threat superiority effect?

11.30 George Georgiou*, Kevin Dutton*, Riccardo Russo and Elaine Fox (University of Essex)
Focusing on fear: Attentional disengagement from emotional faces

12.00 Jules Davidoff and Debi Roberson (Goldsmiths' College, University of London and University of Essex)
Development of animal recognition: A difference between parts and wholes

12.30 Richard Kemp and Jennifer Baldwin***** (University of New South Wales)
Composites of own- and other-race faces

1-2 LUNCH

WEDNESDAY 10 JULY pm

START OF PARALLEL SESSIONS

Session A

Physiology Lecture Theatre III

2.00 A Easton, A Parker, K Parker* and A M Derrington (University of Nottingham)
Spatial memory of marmoset monkeys in a t-maze: Comparison with the performance of macaques and rats at delayed non-matching to sample and the effect of fornix transection

Symposium: Back to the future: Mental time travel in animals and humans
Organiser: Dr Nicola Clayton

2.30 Thomas Suddendorf***** (University of Queensland)
What's so special about human mental time travel?

3.00 Nicola S Clayton* and Anthony Dickinson (University of Cambridge)

Elements of mental time travel in food-caching scrub-jays.

3.30 TEA

4.00 Richard G M Morris and Mark Day***** (Department of Neuroscience, The University of Edinburgh)
Episodic-like memory in the rat: Glutamate receptor-dependent encoding and recall of one-trial paired-associate learning

4.30 Nathan J Emery* and Nicola S Clayton***** (Sub-department of Animal Behaviour and Department of Experimental Psychology, University of Cambridge)
'Mental time travel' is essential for social cognition in scrub-jays.

5.00 Teresa McCormack***** (University of Warwick)
Episodic memory and the development of temporal concepts

5.40 Business Meeting (Psychology Lecture Theatre)

WEDNESDAY 10 JULY pm

START OF PARALLEL SESSIONS

Session B

Psychology Lecture Theatre

2.00 Benjamin J Dyson* and Philip T Quinlan (University of York)
Stimulus representations in an auditory same/different task.

2.30 Dorine Vergilino-Perez*, Cécile Beauvillain* and John Findlay (Centre for Vision and Visual Cognition, Department of Psychology, University of Durham and Laboratoire de Psychologie Expérimentale, CNRS UMR 8581, Université René Descartes)
Which the co-ordinate system is used in the planning of inter- and intra-object saccades ?

3.00 Jane L Morgan* and Antje S Meyer (Behavioral Brain Sciences Centre, School of Psychology, University of Birmingham)
Use of peripheral information in multiple-object naming

3.30 TEA

4.00 Sarah J White* and Simon P Liversedge (University of Durham)
Foveal and non-foveal processing difficulty influence where the eyes move in reading.

4.30 Roger P G van Gompel*, Martin J Pickering and Jamie Pearson***** (University of Dundee and University of Edinburgh)
Subcategorisation information in syntactic ambiguity resolution: Evidence against lexically driven models

5.00 Simon P Liversedge, Martin J Pickering, Emma L Clayes* and Holly P Branigan* (University of Durham, University of Glasgow and University of Edinburgh)
Thematic preferences in adjuncts.

END OF PARALLEL SESSIONS

5.40 Business Meeting (Psychology Lecture Theatre)

THURSDAY 11 JULY am

Physiology Lecture Theatre III

9.30 Rainer Spiegel***** (University of Cambridge) (Introduced by I P L McLaren)
Sensory-motor sequence learning in humans.

10.00 Amanda Parker, Chris J Vincent*, Gareth L Williams*, Alex Easton, Ngoc J Thai*, Mark J Buckley* and Andrew M Derrington (University of Nottingham and University of Oxford)
Novelty and memory: activations associated with encoding visual objects and scenes

10.30 COFFEE

START OF PARALLEL SESSIONS

Session A

Physiology Lecture Theatre III

11.00 Donna Bayliss*, Christopher Jarrold, Deborah M Gunn* and Alan D Baddeley (University of Bristol)
Constraints on children's complex span performance: Partly processing efficiency, partly storage capacity and partly something else.

11.30 Satoru Saito, Christopher Jarrold and Deborah M Gunn* (Department of Cognitive Psychology in Education, Kyoto University, Japan and University of Bristol)
Working memory span is constrained by more than simple temporal decay: Evidence from a reasoning span test

12.00 Wilma Koutstaal (University of Reading)
Age, retrieval intention and memory for detail: Dissociable effects of aging on false recognition, repetition priming, and meaning-based recognition

12.30 Patrick Rabbitt and Christine Lowe (Age and Cognitive Performance Research Centre, University of Manchester)
Loss of memory in old age: Specific and general declines and markers for dementias

1-2 LUNCH

THURSDAY 11 JULY am

Session B

Psychology Lecture Theatre

11.00 Paul Pope*, Jill Whitall* and Alan Wing (Behavioural Brain Sciences Centre, The University of Birmingham and Department of Physical Therapy, University of Maryland, USA)
Spatial and temporal characteristics of optimally selected finger movements: What defines a comfort mode?

11.30 Roderick I Nicolson and Angela J Fawcett (University of Sheffield)
Eyeblink conditioning indicates cerebellar abnormality in dyslexia

12.00 Angela J Fawcett and Roderick I Nicolson (University of Sheffield)

Children with dyslexia are slow to articulate a single speech gesture

12.30 Barbara Howarth* and Anne H Anderson (University of Glasgow)
Referential form and word duration in video-mediated and face-to-face dialogues

1-2 LUNCH

THURSDAY 11 JULY pm

Session A

Physiology Lecture Theatre III

2.00 EPS/BAAS Undergraduate Prize

Marisa Taylor-Clarke (Institute of Cognitive Neuroscience, University College London)
Vision modulates somatosensory cortex processing.

2.30 Neil Todd and James Galley* (University of Manchester)
On the electrophysiology of groove.

3.00 A M Derrington, J A Tinsley*, A Parker, C J Tinsley*, B S Webb*, N E Barraclough*, A Easton and K Parker* (University of Nottingham)
Orientation discrimination in the marmoset: Behavioural discrimination and neural selectivity.

3.30 TEA

4.00 H E Smithson* and J D Mollon (SUNY College of Optometry, New York and University of Cambridge)
Locating the tritan confusion line

4.30 Arnold Wilkins (University of Essex)
Improving fluency with coloured filters - prevalence and mechanisms

5.00 G T Plant*, M Galton* and R A McCarthy (National Hospital for Neurology and Neurosurgery, London and University of Cambridge)
Mindsight: pathological completion in a case of occipital damage without neglect.

END OF PARALLEL SESSIONS

5.45 Thirtieth Bartlett Lecture - Professor A Cowey (Oxford University)
Fact and artefact about blindsight
(Physiology Lecture Theatre III)

RECEPTION (Emmanuel College)

7.30 CONFERENCE DINNER (Emmanuel College)

THURSDAY 11 JULY pm

Session B

Psychology Lecture Theatre

2.30 Richard J Crisp* (University of Birmingham) (Introduced by Glyn Humphreys)
Malleability of automatic evaluation in person perception

3.00 Andy Wills, Lyn Ellett* and Stephen Lea (Exeter University)
Polymorphous category acquisition: reasons for difficulty

3.30 TEA

4.00 Roland Baddeley, Carl Jones* and Daniel Osorio* (School of Biological Sciences, Sussex University)
Optimal learning and forgetting in humans and birds

4.30 Klaus Lober*, Harald Lachnit, and David R Shanks (Philipps-Universität Marburg, Germany and University College London)
Within-compound associations in retrospective revaluation and in direct learning: A challenge for performance and inference models

5.00 Mike Oaksford (Cardiff University)
Causal conditional inference and constraint satisfaction: Reconciling probabilistic and mental models approaches?

END OF PARALLEL SESSIONS

5.45 Thirtieth Bartlett Lecture - Professor A Cowey (Oxford University)
Fact and artefact about blindsight
(Physiology Lecture Theatre III)

RECEPTION (Emmanuel College)

7.30 CONFERENCE DINNER (Emmanuel College)

FRIDAY 12 JULY am

Physiology Lecture Theatre III

Symposium: Two hemispheres, one reading system: Early cortical representations of print during reading.
Organiser: Dr Michal Lavidor
Chair: Dr Marc Brysbaert

9.00 Alex Leff* (MRC Cyclotron Unit, Hammersmith Hospital, London)
A brisk review of the anatomy of the visual cortex

9.30 Michal Lavidor* (University of Hull)
A virtual lesion examination of a split-processing model of visual word recognition.

10.00 Padraic Monaghan* (Institute for Adaptive and Neural Computation, University of Edinburgh)
Environmental influences in single-word reading: Emergent asymmetries in an implemented split-fovea model.

10.30 COFFEE

11.00 Carol Whitney* (Computer Science, University of Maryland, USA)
An account of hemisphere-specific patterns of letter perceptibility based on a split-fovea model.

11.30 Tatjana Nazir* (Institute for Cognitive Science, Lyon, France)
Reading habits, perceptual learning, and recognition of printed words.

12.00 Martin H Fischer (University of Dundee)
A place for spatial cognition in reading.

End of Symposium

12.30 Bettina Mohr* (MRC Cognition and Brain Sciences Unit, Cambridge) (Introduced by William Marslen-Wilson)
Interhemispheric cooperation in higher cognitive processing

1-2 LUNCH

FRIDAY 12 JULY pm

Physiology Lecture Theatre III

2.00 Jamie Ward and Julia Simner* (University College London and University of Edinburgh)
Phoneme-taste synaesthesia: Linguistic and conceptual factors

2.30 Chris Lee* and Neil Todd (University of Manchester)
Application of a model of the auditory primal sketch to cross-linguistic differences in speech rhythm: Implications for the acquisition and recognition of speech.

3.00 C J Fussell*, D A Hall and A Q Summerfield (MRC Institute of Hearing Research, University of Nottingham)
An fMRI study of the cortical processing network involved in speechreading.

3.30 F Pulvermüller* and Y Shtyrov* (MRC Cognition and Brain Sciences Unit, Cambridge) (Introduced by William Marslen-Wilson)
Matching language and the brain using the mismatch negativity

End of Meeting

ABSTRACTS

The effects of ageing on recognition of emotion

Andrew J Calder[1], Jill Keane[1], Tom Manly[1], Reiner Sprengelmeyer[2], Sophie Scott[3], Ian Nimmo-Smith[1] and Andrew W Young[4]
1. MRC Cognition and Brain Sciences Unit, Cambridge
2. University of St. Andrews
3. University College London
4. University of York
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We report a series of experiments investigating the effects of ageing on the recognition of emotion from facial, prosodic and musical cues. On tests of facial expression recognition, increasing age produced a progressive reduction in the recognition of fear and, to a lesser extent, anger and sadness. In contrast, older participants showed no reduction in recognition of facial expressions of disgust, rather there was some evidence of an improvement . For the auditory tasks, older subjects also showed reduced recognition of fear and sadness from musical sequences, and reduced recognition of all emotions on the test of emotional prosody recognition. The results are discussed in terms of neuropsychological research that indicates that separate brain regions may be involved in processing fear and disgust. We suggest that while the results of the emotion prosody task may reflect the adverse effects of ageing on pitch processing, the

dissociable effects found for fear and disgust are consistent with the differential effects of ageing on brain regions underlying the recognition of these emotions.

Upside down but not out of order: Configural processing in prosopagnosia

R A McCarthy[1], N Kumar[1], G T Plant[2] and M Galton[2]
1. University of Cambridge
2. National Hospital for Neurology and Neurosurgery, London
rm107@cam.ac.uk

Some writers have claimed that prosopagnosia an be attributed to impaired perceptual analysis of facial configurations, while others have claimed that it is due to a more central deficit affecting the experience of facial familiarity. We describe our investigations of configural facial perception in two cases of prosopagnosia using Thompson's "Thatcher Illusion". The illusion affects normal subjects' ability to detect local feature inversions (e.g. eyes, mouth) in the context of global face inversion. Our two cases of prosopagnosia were able to judge facial anomaly (feature rotation) at an above chance but differed in their sensitivity to the illusion. One case was unaffected by global rotation whereas the other showed a substantial and normal global rotation effect. Response to the illusion was related to the subject's ability to perform other tasks involving the perceptual matching of faces but unrelated to their ability to judge face familiarity. We argue that our findings are consistent with the hypothesis that prosopagnosia is a heterogenous syndrome and that a severe disorder of face familiarity can arise in some cases with intact configural face processing.

Impaired processing of direction of gaze in Turner syndrome – evidence for amygdala dysfunction.

Kate Elgar[1], Ruth Campbell[2], John Swettenham[2], Janneke Terstegge[3], Rebecca Akers[1], Michael Coleman[2] and David Skuse[1]
1. Behavioural and Brain Sciences, Institute of Child Health, University College London
2. Human Communication Science, University College London
3. Department of Psychonomics, University of Utrecht, Netherlands
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Turner syndrome (TS) is a sporadic genetic disorder of females caused by loss of all/part of one X-chromosome. Despite normal verbal intelligence, 30% have social communication problems, including abnormal eye-contact in interaction. Using structural neuroimaging we recently showed bilaterally increased amygdala volumes in TS adults. Functional imaging work in healthy volunteers suggests the amygdala is differentially activated by direct and averted gaze. We tested the hypothesis that TS women would be relatively poor at judging gaze direction. We studied TS adults with X-monosomy (45,X). Using still photographs, the head and eyes of a model were oriented congruently, or the eyes alone were oriented, to markers laterally aligned at 5 degree intervals in the fronto-parallel plane below the plane of direct eye gaze. Participants were required to indicate where the person was looking. Participants were then asked to judge ‘is the person looking at you?’ when the model’s eyes were directed to a line co-incident with the subject’s line of gaze. TS women were unimpaired at judging line of sight when head and eye direction were congruent, but were poorer than verbal IQ-matched controls

when relying on the eyes alone (p=.003). They were also impaired when judging direct social gaze (p=.000).Group differences were not eliminated by covarying for PIQ, which was significantly lower in TS than in controls. These deficits in gaze processing are consistent with other evidence of amygdala dysfunction in TS women and may contribute to their impaired social cognitive skills.

What facial features produce the threat superiority effect?

Elaine Fox
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Recent research using a visual search paradigm has reinstated the so-called 'threat-superiority effect'. This is the finding that facial expressions indicating potential danger or threat (fear, anger) are detected faster in visual arrays, relative to happy or neutral expressions. Several experiments are reported aimed at discovering the particular features of the face critical to this result. It was found that the eye-regions of fearful and angry expressions were detected faster than the eye-regions of happy and neutral expressions, while no between-expression differences were found for the mouth region. A subsequent experiment demonstrated that the face as a whole did not increase the threat-superiority effect relative to just the eye-region. These results suggest that the eyes and eyebrows are strong markers of threat that are easily and rapidly recognized. The results suggest that the evolved neural systems of the brain, which facilitate the detection of threatening facial expressions, may be particularly sensitive to the eyes and/or eyebrows. An unexpected finding thrown up by the current experiments was that high trait-anxious people did not show an enhanced threat-superiority effect (for either faces or facial parts) relative to low trait-anxious people. The theoretical implications of these results will be discussed.

Focusing on fear: Attentional disengagement from emotional faces

George Georgiou, Kevin Dutton, Riccardo Russo and Elaine Fox
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Recent research suggests that anxiety appears to be associated with the enhanced detection of threat-related stimuli. This may result in a shift of visual attention to the location of such stimuli. In contrast, however, we have recently presented evidence that anxiety might also be characterized by an *extended dwell time* for threat-related stimuli (Fox et al., JEP:GEN, 2001, 130, 681-700). The present study further examines this delayed disengagement hypothesis. Results indicate that high trait-anxious individuals took longer to classify peripheral target letters when fearful facial expressions were presented at fixation relative to sad, happy, or neutral expressions. This pattern was not observed in the low trait-anxious group. The contrast between fearful and sad expressions singles out the fear-relevance of the expression, as opposed to the negative affect, as the critical factor in holding attention. This would seem to be in keeping with an evolutionary perspective. Problematically, however, such delayed disengagement from threat may also serve to maintain anxiety states by keeping attention focused on the source of stress.

Development of animal recognition: A difference between parts and wholes

Jules Davidoff[1] and Debi Roberson[2]
1. Goldsmiths' College, University of London
2. University of Essex
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A series of experiments examined children's recognition of animals by their features (Parts) and by the relative scale of the parts (Wholes). They were asked to identify the correct picture of an animal they could name from the original plus two computer generated alternatives. We examined the developmental trends associated with upright (Studies 1 and 3) and inverted presentations (Study 3). Both experiments confirmed children's superior ability in dealing with the recognition of animal Parts over animal Wholes especially for the younger ages tested (6- and 10-year-olds). It was not until the age of 15-16 that children demonstrated equal and adult-like performance on Whole and Part items. The late acquisition of animal Whole recognition is compared to the late acquired configural skills proposed for face recognition.

Composites of own- and other-race faces

Richard Kemp and Jennifer Baldwin
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The cross-race recognition effect describes the finding that it is easier to recognise same-race than other-race faces. Recent meta-analytic reviews have shown this to be a reliable effect, and it is likely that the effect is a significant factor in a number of the false convictions recently uncovered by DNA analysis. Most studies of the cross-race effect have measured recognition memory performance using a paradigm that is of limited ecological validity. This paper reports the results of research employing a facial composite construction task. Participants watched a video of an unfamiliar own- or other-race target person, and were then interviewed by a trained operator who used the E-Fit computerised composite construction system to produce a likeness of the target. Raters who were either of the same or other-race as the target then evaluated these composites. The results showed little evidence of a cross-race effect for this task. The possible reasons for this finding and its practical and theoretical implications are discussed.

Spatial memory of marmoset monkeys in a t-maze: Comparison with the performance of macaques and rats at delayed non-matching to sample and the effect of fornix transection

A Easton, A Parker, K Parker and A M Derrington
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The common marmoset (Callithrix jacchus) is a primate that is increasingly used in neuroscience research. However, the marmoset has been used much less for behavioural experiments than the macaque monkey. No direct behavioural comparison of spatial memory performance has previously been performed between the marmoset and either of the more commonly used laboratory animals, the macaque monkey and

the rat. A previous set of studies has provided a direct comparison between the performance of rats and macaque monkeys on a spatial delayed non-match to sample task in a T-maze. In the current experiment we replicated these studies using the marmoset, allowing for the direct comparison of the behavioural performance of the marmoset with both rats and macaque monkeys. Unoperated marmosets learned the task and performed well at the one minute delay version of the task, performing better than unoperated macaques, and at a similar level to unoperated rats. At five and fifteen minute delays the marmosets and macaques performed at similar levels, with little decline in accuracy, whereas rat performance declined significantly with length of delay. Lesions of the fornix in marmoset produced learning impairments at all delays.

Symposium: Back to the future: Mental time travel in animals and humans
Organiser Dr Nicola Clayton

What's so special about human mental time travel?
Thomas Suddendorf
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Humans regularly concern themselves with issues that are displaced in time. This observation that the human mind is not restricted to thought about the here and now, seems so obvious that its potential significance in the evolution of mind has been frequently overlooked. We (Suddendorf & Corballis, 1997) proposed that "mental time travel", that is, reconstruction of personal events from the past (episodic memory) and the mental construction of possible events in the future, is a uniquely human ability. The main advantage of this capacity, we argue, is that it allows humans to rapidly generate flexible, future-oriented behaviours. In general, behaviour can be adaptive when it benefits current, but also when it benefits *future* survival and reproduction. Thus, many organisms have evolved mechanisms that produce behaviour that is ultimately future-directed. However, it remains an empirical question whether or not animals other than humans have evolved mental time travel and this question has recently attracted the attention of comparative researchers. Here I discuss various characteristics of human mental time travel that may inform further investigations into the possibility that other animals share this ability.

Elements of mental time travel in food-caching scrub-jays.
Nicola S Clayton and Anthony Dickinson
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The mental time-travel hypothesis (Suddendorf & Corballis, 1997) posits that unlike humans, animals cannot travel backwards in time to re-experience and recollect specific past episodes *(episodic memory)* or travel forwards in time in order to anticipate future states of affairs *(future planning)*. In arguing for their mental time-travel thesis, Suddendorf and Corballis (1997) did not consider a natural behaviour that is explicitly based upon both past and future episodes. One potential behavioural candidate is food-caching in which food is hidden for future consumption, and successful cache-recovery relies on memory for specific caching episodes (Clayton & Dickinson, 1998). Recent

experiments on food-caching scrub-jays suggest that several features of mental time travel may not be unique to humans. Experiments will be presented which demonstrate that scrub-jays possess the behavioural criteria for episodic memory, namely the ability to form integrated representations of the "what-where-and-when" of trial unique events, and in a way that is inexplicable by relative familiarity. In the absence of any agreed behavioural markers of autonoetic consciousness in animals, this ability is referred to as "episodic-like memory" (Griffiths, Dickinson & Clayton, 1999). Experiments will also be presented that suggest that scrub-jays can anticipate the conditions at future recovery opportunities on the basis of past recoveries and use these anticipated conditions to control present caching.

Episodic-like memory in the rat: Glutamate receptor-dependent encoding and recall of one-trial paired-associate learning

Richard G M Morris and Mark Day
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Episodic memory refers to the human ability to recall unique past events and be aware that they happened in the past (Tulving, 1983). Efforts to model it in animals are necessarily tests of ‘episodic-like’ memory that reflect restricted aspects of past experience that exclude autonoetic consciousness. Scene-specific associative learning (Gaffan, 1994) and one-trial spatial event memory (Steele and Morris, 1999) have been proposed as examples, but the most convincing evidence to date is the recall of ‘what, where and when’ by scrub jays after food-caching (Clayton and Dickinson, 1998). We shall present a new behavioral protocol in which rats encode, on each day, two ‘paired-associates’ in successive single trials and then display above chance recall of one item of either pair (a spatial location) given the cue of the other (a specific foodstuff). The pairings of a particular foodstuff and its spatial location were never repeated, thereby ensuring unique ‘what-where’ attributes within a common spatial context. Recall of such one-trial paired-associates lasts about 60 min, and is impaired by blocking the AMPA subtype of glutamate receptors in the hippocampus with CNQX at a concentration that reversibly inactivates fast synaptic transmission. When NMDA receptor activity, critical for certain forms of activity-dependent synaptic plasticity thought to play a role in memory formation, was blocked by D-AP5, memory encoding was impaired but memory recall unaffected.

‘Mental time travel’ is essential for social cognition in scrub-jays.

Nathan J Emery[1] and Nicola S Clayton[2].
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2. Department of Experimental Psychology, University of Cambridge
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The storage and recovery of food presents an opportunity for strategies and counter-strategies to develop between storers and pilferers. Abilities that may be important for the protection of caches or for successful pilfering of another’s caches are the capacity to predict the future intentions of conspecifics and recall aspects of their previous actions that may influence your own behaviour. Food-storing corvids display such behaviour in

the wild, the components of which suggest that they may possess a rudimentary 'theory of mind'. They delay caching until a competitor has out of proximity, cache at a distance from other individuals or behind occluding barriers, and re-cache food that was hidden in the presence of others when they have departed. We examined this in the laboratory using hand-raised Western scrub-jays (*Aphelocoma californica*) with controlled previous experiences. In this talk, we will present data from 4 experiments that examine how the social context (i.e. either when observed during caching or when allowed to cache in private) influences the recovery of caches in private after a 3 hr retention interval; whether the previous experience of being a pilferer influenced storers' protective mechanisms against potential pilfering by others; whether scrub-jays remembered the specific social context of previous events or the most recent event; and whether scrub-jays could update their 'social memory' when they had observed some of their caches being pilfered and some that remained intact. Our results suggest that 'mental time travel' (i.e. remembering past experiences and predicting future behaviour) is within the repertoire of scrub-jays, especially when related to complex social cognition.

Episodic memory and the development of temporal concepts

Teresa McCormack
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We can distinguish between two ways in which episodic memory might be related to temporal abilities. On the one hand, episodic memory might be thought to exploit certain timing or temporal encoding mechanisms or, on the other hand, it might be argued that episodic memory recruits particular temporal concepts or temporal reasoning abilities. If the latter is true, then any account of the development of episodic memory must involve a consideration of how the relevant temporal concepts develop. In this talk, it will be argued that such a consideration is indeed necessary, and some suggestions will be made as to the relation between the development of temporal concepts and episodic memory development. In particular, it will be suggested that an explicit grasp of the causal relations between temporally separated events is a developmental requirement. Some preliminary research findings on the relevant temporal/causal reasoning abilities in 4 and 5-year-olds will be reported.

End of Symposium

Stimulus representations in an auditory same/different task.

Benjamin J Dyson and Philip T Quinlan
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Three experiments are reported which explore the distinction between holistic and analytical representations in auditory stimulus processing. In Experiments 1 and 2, sequential pairs of auditory stimuli were presented which differed according to location (left and right headphone presentation) and frequency (high and low tones). Participants were required to categorise the pairs as same or different according to one dimension whilst ignoring irrelevant variation on the other dimension. Under conditions of 750 msecs ISI (Experiment 1), only same responses were sensitive to global change in the

stimulus pairs. Under conditions of 100 msecs ISI (Experiment 2), same responses were sensitive to global change whilst different responses were sensitive to dimensional change. Experiment 3 explored the possibility that dimensional sensitivity may be the by-product of an automatic representation by examining stimulus repetition effects across trials. The results are discussed in reference to the visual literature and with respect to a cognitive framework of stimulus representation which is modality independent.

Which the co-ordinate system is used in the planning of inter- and intra-object saccades ?

Dorine Vergilino-Perez [1,2] , Cécile Beauvillain[2] and John Findlay[1]
1. Centre for Vision and Visual Cognition, Department of Psychology, University of Durham
2. Laboratoire de Psychologie Expérimentale, Université René Descartes, France
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We report several eye-movement experiments designed to reveal which co-ordinate systems are used in the planning of saccades directed to, or within objects. Subjects had to execute a sequence of saccades toward one or more objects, the second saccade being directed to a new object (inter-object saccade) or to a second location on the fixated object (intra-object saccade). We examined how the spatial information about objects is converted into a motor plan for the second saccade of the sequence. Our results show that the reference frames used for the motor plan of the saccade differ as a function of the action to be performed on the object. That is, to aim for a new target object or to explore the same object with a second saccade. When the saccadic system selects a new object as a target for the next saccade, the saccade, coded in a retinocentric co-ordinate system, is updated with respect to the eye position to aim for a precise position in the next object. When the second saccade is directed within the fixated object, the saccade is coded in an oculocentric coordinate system as a fixed-motor vector executed regardless of the first fixation position on the object.

Use of peripheral information in multiple-object naming

Jane L Morgan and Antje S Meyer
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Earlier research showed that speakers naming several objects as part of one utterance usually look at each object until they are about to initiate its name. This suggests that they retrieve the objects' names in sequence. However, this only follows if an object's name is only retrieved after fixation, not while the object is still in the visual periphery.

We report on two series of experiments investigating whether this assumption holds. In the first series, objects first seen in the periphery (interlopers) changed into different objects (targets) during the speakers' saccade towards them. Interloper and target could be identical, unrelated, or have phonologically related names. Targets preceded by identical interlopers were processed faster than the other two types of targets, which did not differ from each other.

In the second series of experiments we examined how likely speakers were to name objects without fixating them. We varied the size (and thereby the peripheral visibility) of

the objects and whether they were repeated across several trials. Repetition strongly affected the likelihood of naming without fixation, but size did not. We conclude that objects in the visual periphery are processed to some extent but that their names are retrieved in sequence.

Foveal and non-foveal processing difficulty influence where the eyes move in reading

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Previous experiments by the authors have shown that orthography influences where words are first fixated in the reading of English sentences. One explanation for this effect is that processing difficulty narrows the perceptual span and consequently shortens saccades (Hyönä & Pollatsek, 2000). The experiment reported here aimed to test this hypothesis by investigating the relationship between foveal and non-foveal processing difficulty. Participants' eye movements were recorded whilst they read sentences including phrases such as "the local accountant" or "the inept accountant". Foveal difficulty was manipulated by word frequency (e.g. "local" or "inept"). Non-foveal difficulty was manipulated by spelling (e.g. "accountant" or "ajcountant"). Landing positions were significantly nearer the beginning of the critical string ("accountant") if the previous word was low frequency compared to if it was high frequency. Landing positions were significantly nearer the beginning of the critical string if it was misspelled compared to if it was spelled correctly. The results will be discussed in terms of the processing difficulty hypothesis and current models of eye movements in reading.

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Subcategorisation information in syntactic ambiguity resolution: Evidence against lexically driven models

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An important question in sentence processing research is when the processor employs subcategorisation information (e.g., Mitchell, 1987). We investigated this issue in an eye-movement study, using sentences such as (1):
1a. The nurse heard the man the radio in the opposite room kept annoying in the corridor.
1b. Not surprisingly the man the radio in the opposite room kept annoying complained a lot.
In (1a), subcategorisation information of the monotransitive verb "heard" rules out the analysis in which "the radio" is its direct object. This contrasts with ditransitive verbs such as (2):
2. The nurse gave the man the radio in the opposite room.

We compared (1a) with (1b), where "the radio" is the subject and cannot be attached to a preceding verb. First-pass reading times for the region "in the opposite room" showed that (1a) took longer to read than (1b). This indicates that readers initially ignored subcategorisation restrictions of the verb "heard" and attempted to analyse "the radio" as its direct object. Our results support models that claim that lexical information is ignored during syntactic ambiguity resolution (e.g., Frazier, 1987) and are inconsistent with lexically driven models (e.g., MacDonald et al., 1994).

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MacDonald, M.C., Pearlmutter, N.J., & Seidenberg, M.S. (1994). The lexical nature of syntactic ambiguity resolution. *Psychological Review*, 101, 676-703.
Mitchell, D.C. (1987). Lexical guidance in human parsing: Locus and processing characteristics. In Coltheart, M. (Ed.), *Attention and performance* XII (pp. 601-618). Hillsdale, NJ: Erlbaum.

Thematic preferences in adjuncts

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Liversedge, Pickering, Branigan and Van Gompel, (1998) investigated thematic assignment preferences in sentences containing a prepositional phrase that is ambiguous between an argument and an adjunct interpretation. We report two new eye movement studies that extend this work. The current studies investigate thematic processing in sentences containing an adjunct prepositional phrase that is ambiguous between a locative and temporal interpretation (see Example 1).

1. The maid peeled the vegetables in the kitchen/morning, with great care.

We manipulated both whether the target sentence was a temporal or a locative and whether the context included a *wh*-word (*where* or *when*) that induced a temporal or locative thematic expectation. In the first experiment we repeated the main verb in the context and target sentence, whereas in the second we used different verbs that conveyed the same meaning across contexts and targets. Results showed that context dictated participants' thematic expectations. Thematically congruent target and context pairs were read faster than incongruent pairs. This effect was not modulated by verb repetition. We argue that wh-words cause readers to lodge semantically vacuous thematic roles in their discourse representation that bias a reader's interpretation of subsequent thematically ambiguous adjuncts.

Liversedge, S.P., Pickering, M.J., Branigan, H.P. and Van Gompel, R.P.G. (1998), Processing arguments and adjuncts in isolation and context: The case of *by*-phrase ambiguities in passives. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 24, 2, 461-475.

Sensory-motor sequence learning in humans

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Associative aspects of human sequence learning have been studied extensively in the SRT-task where a person sits in front of a computer screen on which signals flash on at different locations. Each signal is assigned a key on the keyboard and the person is asked to press the respective key as quickly as possible. Connectionist models such as the simple recurrent network (SRN) were remarkably successful in simulating this kind of associative process. As has been discussed recently (e.g. Spiegel & McLaren, 2001), there is little doubt that cognitive learning mechanisms also play a role in human sequence learning and that it would be interesting to know how they interact with the earlier mentioned associative mechanisms. We report findings from the SRT-task that help us analyze how humans learn particular sequences and how they generalize to novel ones. In order to support our understanding of how both associative and cognitive processes interact, a new model was created that employed both associative and cognitive mechanisms. We have named this model SARAH (Sequential Adaptive Recurrent Analogy Hacker). The predictions of the model are compared with the empirical findings obtained from the SRT-task.

Spiegel, R. & McLaren, I.P.L. (2001). Human Sequence Learning: Can Associations Explain Everything? In J.D. Moore & K. Stenning (Eds.): Proceedings of the Twenty-Third Annual Conference of the Cognitive Science Society, pp.976-981. Mahwah, N.J.: Erlbaum.

Novelty and memory: Activations associated with encoding visual objects and scenes

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We scanned subjects performing a delayed matching task using either visual object stimuli or scene stimuli. Imaging data were collected using a 3 T MRI scanner (University of Nottingham) and analysed using SPM99. The visual object task used lists of unique 2-d visual objects made from randomly generated two layered fractals. The scene learning task used lists of black position dots which occupied positions in unique backgrounds, each of which had been generated using randomly chosen shapes. For both tasks, colour was manipulated. In each list one study item (the novel or *isolate* item) and its associated foil differed from the others (the *homogenous* items). Two color sets were used, one comprising blue hues, the other red hues. This was achieved by randomly selecting the luminances of the red, green and blue phosphors of the display screen within two different specified ranges. The critical behavioural measure was the comparison of the recognition performance rates for isolate and homogenous test items. We found that performance was better for isolates than for homogeneous items. We also found that the pattern of activations seen for isolate items and homogenous items

differed in object and scene memory. We conclude that a network of overlapping, but not identical areas in frontal and temporal cortices are necessary for object and scene memory, and that more frontal activation is seen with isolate when compared with homogenous items for both objects and scenes.

Constraints on children's complex span performance: Partly processing efficiency, partly storage capacity and partly something else.

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Working memory was examined among a sample of 74 8- and 9-year old children using four complex span tasks that crossed verbal and visuo-spatial processing with verbal and visuo-spatial storage. Independent measures of processing efficiency and storage capacity were also taken in order to examine the constraints that each imposed on complex span performance. An exploratory factor analysis suggested that the four complex span tasks measured a combination of domain-general processing and domain-specific storage resources. The results also showed that individual differences in both processing efficiency and storage capacity accounted for unique variance in complex span performance. Furthermore, residual task performance, which potentially reflects the ability to coordinate the processing and storage operations of the complex span task, contributed to the prediction of reading and mathematics attainment independently of the abilities involved in each operation alone. These findings present difficulties for resource-sharing models of complex span performance that assume that the processing and storage operations of complex span tasks compete for a limited pool of domain-general resources. In contrast, the results are more consistent with a multiple-component model of working memory in which separate resource pools support the processing and storage operations of the complex span task.

Working memory span is constrained by more than simple temporal decay: Evidence from a reasoning span test

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Previous studies have shown that reading span scores are greater when span lists start with a long sentence and end with a short sentence than when these sentences are presented in the reverse order (e.g., Towse et al., 2000). In Experiment 1, we obtained a similar sentence order effect in a reasoning span test, using reasoning sentences that were equated for length in terms of number of letters but which differed in processing complexity. Span scores were greater when lists began with a complex sentence and ended with a simple sentence compared to when this sentence order was reversed. In Experiment 2, the sentence order effect was found even when sentence complexity was varied while processing duration was held constant using a moving window presentation paradigm. These results suggest that a simple temporal decay hypothesis cannot fully account for the sentence order effect.

Towse, J. N., Hitch, G. J., & Hutton, U. (2000). On the interpretation of working memory span in adults. *Memory & Cognition*, 28 (3), 341-348.

Age, retrieval intention and memory for detail: Dissociable effects of aging on false recognition, repetition priming, and meaning-based recognition

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Investigations of memory deficits in older individuals have concentrated on the increased likelihood of forgetting events or details of events that were actually encountered (*errors of omission*). However, mounting evidence demonstrates that normal cognitive aging also is associated with an increased propensity to *errors of commission* -- shown in false alarms or false recognition. To examine the origins of this age difference, older and younger adults each performed three types of memory task where details of encountered items might influence performance. Each task involved three types of items: same exemplars (items presented at study and test), different exemplars (different "tokens" of items that were presented at study), and new items. Although older adults showed greater false recognition of related lures (different exemplars) on a standard ("identical") old/new episodic recognition task, older and younger adults showed *parallel effects* of detail on repetition priming and a meaning-based episodic recognition task (decreased priming and decreased meaning-based recognition for different than same exemplars) -- suggesting that details had been encoded but were less effectively used by older adults in the recognition context requiring their deliberate, controlled use. Implications regarding the ability to encode versus consciously use detailed perceptual and conceptual information are discussed.

Loss of memory in old age: Specific and general declines and markers for dementias

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Longitudinal Data on two different test batteries were obtained from 2560 Manchester residents, initially aged from 49 to 92 years, over a period of 12 years. Analyses identified individuals whose initial scores on 3 memory tests were more than 1.5 sd or more than 2 sd lower than sample average. These proved to be older than sample average, to enjoy less socio-economic advantage and to have unusually slow scores on all other cognitive tests than other of the sample. Consistent with these markers they also had much higher probabilities of drop-out than other sample members. An alternative analysis identified individuals whose initial memory test scores were 1.5 sd and 2.0sd lower than expectation from their concurrent scores on tests of fluid general intelligence. These individuals were also older and relatively less advantaged than the rest of the sample, but their scores on all other cognitive tests did not differ from those of other sample members. When tracked over 2 subsequent administrations of the same test battery, and 3 administrations of a different test battery their condition appeared to be stable, with marked memory impairment contrasting with average performance on all

other cognitive measures. The value of differential diagnosis of general memory impairment coupled with cognitive impairment, and of specific memory impairment as markers for dementia and mortality are discussed.

Spatial and temporal characteristics of optimally selected finger movements: What defines a comfort mode?

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In studies of motor coordination, participants are often instructed to make repetitive movements in 'comfort mode'. However, little is known about how such movements are selected and with what consistency. In the present study, participants (N = 46) made flexion/extension movements of the index finger with eyes closed which were recorded by optoelectronic motion tracking for 30 s. After an intervening task, participants repeated the trial. Times for a complete flexion/extension cycle ranged from 0.3-5.2 Hz (mean 1.1), and amplitudes ranged from 11-61 deg (mean 41 deg) over the two trials. Repeated measures analysis of variance was used to evaluate the effect of Trial (one or two), Direction of Movement (flexion or extension) and Trial Half (first or second). Mean flexion and extension cycle times were longer in the first half of each trial compared with the second half of each trial, where movement amplitudes were larger and less variable. The consistency of finger movements across and between trials was also tested, and revealed that participants transferred an approximation of their mean finger movement cycle time between trial one and two. We conclude that 'comfort mode' finger movements are characterized by an initial period of exploration, followed by smoother movements that approximate their mean cycle time.

Eyeblink conditioning indicates cerebellar abnormality in dyslexia

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There is increasing evidence that cerebellar deficit may be a causal factor in dyslexia. The cerebellum is considered to be the major structure involved in classical conditioning of the eyeblink response. In a direct test of cerebellar function in learning, 13 dyslexic participants (mean age 19.5 years) and 13 control participants matched for age and IQ undertook an eyeblink conditioning experiment in which for 60 acquisition trials an 800 ms auditory tone (conditioned stimulus - CS) was presented. On 70 % of the trials an 80 ms corneal airpuff (unconditioned stimulus - US) was presented 720 ms after the tone onset. The cerebellar deficit hypothesis, uniquely of the causal hypotheses for dyslexia, predicts that the dyslexic participants would show abnormal performance in the incidence and/or timing of the conditioned response (CR) of an eyeblink in response to the tone (and before the US). Three of the dyslexic group showed no conditioning at all. Furthermore, the dyslexic group showed significantly worse ‘tuning’ of the CR timing, together with significantly reduced habituation of the orienting response (OR) to the CS. Individual analyses indicated that 85% of the dyslexic group showed either: no

conditioning; abnormally poor CR tuning and/or abnormally low OR habituation. It is concluded that the findings provide further converging evidence of cerebellar abnormality in dyslexia, and for the first time demonstrate that there are fundamental abnormalities in the way that dyslexic people learn. Equally important, the eye blink conditioning paradigm provides a method of investigating further both homogeneity and heterogeneity in the learning deficits underlying dyslexia and other developmental disorders.

Children with dyslexia are slow to articulate a single speech gesture

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In addition to their well-established problems in phonological processing, children with dyslexia show reduced speed of articulation. Different causal theories for dyslexia attribute the slowing to different mechanisms - central/cognitive slowing (phonological lookup and speech planning) and/or motor speech output slowing.. These mechanisms may be dissociated by comparing ‘speed of gesture planning’ with ‘speed of gesture production’. Two groups of children with dyslexia, mean ages 13 and 16 years, participated together with two groups of normally achieving children matched for age and IQ, with 33 participants in total. Participants were asked to articulate repeatedly, as fast as they could, either a single articulatory gesture /p/ /t/ or /k/ or the sequence "putuku". The waveforms generated were analysed in two ways; the time per gesture excluding inter-articulatory pauses (articulatory duration); and the mean time including the pauses (gesture duration). No age effects were found, but dyslexic groups were significantly slower on all tests. Deficits were greater in relative magnitude for gesture duration than articulatory duration. The results suggest that children with dyslexia have significant problems in articulation, not only in gesture planning, but also in the speeded production of single articulatory gestures. The results are directly consistent with hypotheses that predict motor output difficulties.

Referential form and word duration in video-mediated and face-to-face dialogues

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It is widely believed that speakers adapt their speech to meet the comprehension needs of their listener. Yet recent work in face-to-face communication has shown that referential form is more sensitive to listener knowledge than word duration (Bard et al., 2000; Bard and Aylett, 2001). The nature of referring expressions in a collaborative problem solving task was explored in 2 experiments. Experiment 1 examined the duration of the names of landmarks on a map in video-mediated dialogues. It was found that second mentions of words were articulated less clearly than first mentions regardless of who said what. The same pattern of results has been observed in face-to-face communication which suggests that articulatory clarity is not influenced by video-mediation. Experiment 2 explored the impact of time pressure on referential form in face-to-face and computer-mediated dialogues. It was found that speakers responded to time

pressure by shortening the names of the landmarks but only when the task was video-mediated. These results suggest that referential form is more sensitive to the impact of time pressure in video-mediated communication than in face-to-face communication. The implications of these findings will be discussed in terms of a dual process model of speech processing in spoken dialogue.

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Bard, E.G., & Aylett, M. (2001). Referential form, word duration, and modeling the listener in spoken dialogue. *Proceedings of the Twenty Third Annual Conference of the Cognitive Science Society*, Moore, J.D., & Stenning, K. (eds.). Lawrence Erlbaum Associates, Mahwah, NJ.

EPS/BAAS Undergraduate Prize

Vision modulates somatosensory cortex processing.

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Over 150 years ago, E.H. Weber used the two-point detection threshold (2PDT) as a measure of the neural representation of tactile sensation. He speculated about the potentially multimodal nature of touch; that tactile acuity might be enhanced by viewing the body surface. In effect Weber was contemplating the existence of what psychologists today describe as crossmodal links between the senses. Drawing on introspection he concluded that no such link between vision and touch existed. We have demonstrated that Weber may have been premature in his dismissal of visuo-tactile interaction; visual information and tactile sensation do indeed interact. We have found that tactile acuity, as measured by the 2PDT, is enhanced by viewing the stimulated body site relative to viewing a neutral object in the same apparent location as the stimulated region. We then asked the question, what is the neural basis of this enhancing effect?
To investigate this issue, we recorded somatosensory event-related potentials (ERPs), whilst subjects received tactile stimulation around 2PDT while viewing the stimulated area. To control for effects of direction of spatial attention, a further visual condition presented subjects with a view of a neutral object that appeared to be in the same location as the stimulated body site. The tactile stimulation was relevant to only one of two behavioural tasks that the subjects performed. The P50 component of the ERP, reflecting the afferent input to the cortex, was unaffected by vision. However, two further components of the somatosensory ERP were affected by viewing the stimulated area: The N80 component, which reflects SI activity (primary somatosensory cortex), and the N140 component, which has been localised to SII (secondary somatosensory cortex). Interestingly, we found that viewing the stimulated body site only enhanced the N80 component when tactile stimulation was task relevant. In contrast, the N140 component was significantly modulated by vision of the body site for both tasks.
These results are consistent with a hypothesis that vision modulates cortical processing of tactile stimuli via back projections from multimodal cortical areas. Our results have

implications for research into the structure and function of somatosensory cortex as well as multimodal integration. Potential clinical applications include rehabilitation of somatosensory function following stroke through therapies involving viewing the impaired body site.

On the electrophysiology of groove

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In this paper we present some data from a study to look for the electrophysiological correlates sensorimotor planning in audio-motor synchronisation (Todd et al. 2002). The particular focus of the study was on brain events for missing beats, i.e. brain activity in the absence of an explicit stimulus. The principal stimulus used for this purpose was a click anapest rhythm, consisting of three clicks and a gap such that the relative inter-onset intervals are I, I, 2I. We predicted that if beat induction is a kind sensory-guided action, then even in the absence of any overt movement, brain potentials for predicted beats should exhibit premotor or motor characteristics similar to those of an actual movement. The stimuli were presented under three conditions: passive (listen only), active (synchronise finger extension) and active-passive (imagine beat). The results indicate that a series of reliable ERPs may be obtained which consist of two following complexes, N1/P2 and N2/P300, a predictive complex N-150/P-100/N-50 and a synchronisation positivity P0. Our interpretation of these data is that audiomotor synchronisation and beat induction consists of the following stages. (1) *Sensory Coding*. The N1/P2 complex most likely indexes a sensory registration and temporal coding process in auditory cortex (Todd, 1996). (2) *Attention*. The N2/P300 complex, we suggest, indexes an attentional process, possibly in posterior parietal cortex (Regan, 1989), for coordination between sensory and motor processes. (3) *Motor Preparation and Action*. The N-150/P-100/N-50 complex almost certainly is generated in the frontal cortex (Deeke et al. 1984) since it coincides with the onset and peak of EMG activity. (4*) Reafferance*. The coincident P0 we suggest corresponds to a somatosensory reafferance, consistent with the idea that synchronisation involves the integration of a somatosensory reafferance with an auditory click (Muller et al. 2000).
We conclude that the appearance of the N-150/P-100/N-50 complex even in the passive condition implies that a latent motor action is being prepared for the missing beat. The fact that P0 appears for the active/passive condition further strengthens the view that beat induction involves movement planning and a targeted reafferant signal. Further work is required, however, to localise precisely the dipole sources of the potentials we describe.

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Orientation discrimination in the marmoset: Behavioural discrimination and neural selectivity

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In marmosets (callithrix jacchus) we measured behavioural orientation-discrimination performance and the orientation selectivity of neurones in striate cortex. After training on 2-choice visual discriminations in a Wisconsin General Test Apparatus, marmosets were trained to discriminate between 2 displays. One had 9 Gabor patches containing identical vertical gratings (arranged in a 3x3 pattern) and the second had 9 Gabor patches identically arranged except that the grating in the central patch was rotated to the right by 45° and the gratings in the surrounding patches were rotated to the left by 45°. We then measured performance discriminating similar display pairs in which the rotations from vertical were 32°, 16°, 8°, 4°, 2°, 1°. In the best animals performance fell to 75% correct between 16° and 8°. We measured responses of single cells in striate cortex of anaesthetised paralysed marmosets to moving gratings of optimal size, temporal frequency and spatial frequency but of different orientations. Tuning curves (firing rate vs orientation) were fit by gaussians using a least squares criterion. The tuning curves of non direction-selective cells had full widths at half peak height from 11° to 151° (n=12). In direction-selective cells the range was 22° to 182° (n=35). Behavioural orientation discriminations appear to be slightly worse than one would predict from the tuning of the best neurones.

Locating the tritan confusion line

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Modern experiments on colour vision often seek to isolate one of the cardinal directions of colour space. We present here a new psychophysical method designed to locate – for an individual observer and for a specific position in the visual field – the tritan line (i.e. the axis of colour space that modulates only the excitation of the short-wave cones). A violet probe stimulus that is visible in the presence of an adapting yellow field may be rendered invisible for several seconds after the yellow field has been turned off. We assume that this 'transient tritanopia' reflects a temporary and selective loss of sensitivity in the S-opponent mechanism, and suggest that by determining the direction in colour space along which the loss of sensitivity is greatest we can locate the tritan line. To

validate our method, we check firstly that our estimate of the tritan line is not critically dependent on the chromaticity chosen for the adapting field, and secondly that our estimate varies with retinal eccentricity, as predicted from the distribution of macular pigment. These conditions are fulfilled and our data confirm that the transient tritanopia method is a reliable means of locating an individual's tritan confusion line. The method has several practical advantages over alternative procedures.

Improving fluency with coloured filters - prevalence and mechanisms

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More than 5% of the population show substantial improvements in reading fluency when the text is illuminated with coloured light. The improvements in fluency occur only when the appropriate colour has been individually selected to within a CIELUV colour difference of about 100. The mechanisms appear to be unrelated to conventional optometric and orthoptic abnormalities, including those of accommodation, to be post-receptoral, to involve the cones rather than the rods, and to occur at a level of the visual system where there is no colour opponency. The consequences of the specificity are discussed in relation to the spectral power distribution of common sources of artificial light.

Mindsight: pathological completion in a case of occipital damage without neglect

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Islands of blindness (scotomata) caused by damage to the visual regions of the brain may be accompanied by the subjective experience of completion of forms that "should" be occluded by the visual defect, a symptom termed Pathological Visual Completion. We report a single case whose experience of completion was systematically influenced by changes in the stimulus display. His disorder could not be explained by residual vision or an attentional disorder. Pattern masking, varying the contrast characteristics of stimuli and changing visible cues to structural symmetry all had precise effects whereas familiarity and structural coherence did not. We suggest that pathological completion may be a positive cognitive event implicating processes that underpin the normal experience of occluded forms.

Malleability of automatic evaluation in person perception

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In person perception, self-inclusive (‘ingroup’) categorization and positive attributes are associatively linked in memory. Similarly, self-exclusive (‘outgroup’) categorization is associatively linked with negative attributes. Such implicit links are consistent with response time facilitation for congruent group-attribute pairings and inhibition of incongruent pairings. This experiment examined whether the automatic congruency

effect could be moderated via changes in the nature of the activated category representations. The structural coherence of ingroup versus outgroup categorization was systematically manipulated via false feedback from a ‘self-attribution’ task. A recall measure of category representation in memory revealed greater inter-category (versus intra-category) errors when coherence was low (versus high). This weakening of categorical distinctions in memory was expected to correspondingly reduce the automatic congruency effect for category-attribute pairings. Findings from a speeded judgement task, in which participants indicated the valence of target words following subliminal ingroup and outgroup primes, supported this prediction. Compared to a distinct category structure in memory, when coherence was reduced positive attributes were facilitated following the activation of the out-group category label. Changing the nature of categorical representation in memory thus moderated implicit links with evaluatively associated material. These findings have implications for existing social cognitive models of person perception.

Polymorphous category acquisition: reasons for difficulty

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Polymorphous categories are those defined by *m* out of *n* rules. For example, one polymorphous category for stimuli varying in size, colour and shape would be "at least two of large, green and round". Undergraduates have considerable difficulty acquiring polymorphous categories - an intriguing result given often supposed prevalence of polymorphism in natural categories. Results of our recent experiments indicate that pre-training on individual dimensions can facilitate the acquisition of polymorphous categories compared to an equal number of trials on the polymorphous problem itself. Further experiments provide preliminary information about the processes underlying this effect.

Optimal learning and forgetting in humans and birds

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Bayesian statistics provides simple set of procedures for going from a set of assumptions about the world, to an optimal way of classifying, estimating, or predicting in that world. These algorithms not only provide the optimal means of classification and prediction, but also 1) provide a systematic way of approaching many problems in vision, learning and motor behaviour 2) often have simple neural implementations, and 3) for sensible assumptions about the world, many standard psychological models can be seen as approximations to the true Bayesian solution. We demonstrate two Bayesian models, one for classification (of colours) by chicks, and one for learning and forgetting items over time in humans. Both provide an excellent fit to the data, and explain aspects of performance that have not been captured in previous non-Bayesian models. We argue that in trying to understand how such successful creatures as humans and chicks operate in the world, it is best to start with the assumption that the animal is operating

optimally, and then look for the critical assumptions they appear to be making about the world in order to predict, estimate, and classify in it.

Within-compound associations in retrospective revaluation and in direct learning: A challenge for performance and inference models

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Retrospective revaluation refers to the observation that a cue may change its associative strength although it is not present on a learning trial. Different theoretical approaches agree that within-compound associations are important for learning about absent cues, i.e., for retrospective revaluation. They differ, however, with regard to whether within-compound associations are also important for learning about present cues, that is for direct learning. Two human causal learning experiments investigated the role of within-compound associations by means of a memory test. In Experiment 1, AB+ and CD+ trials were presented during the first stage of the retrospective revaluation condition and A+, C- trials were presented during the second stage. For the direct learning condition, the order of the two stages was reversed. Retrospective revaluation but not direct learning was correlated with within-compound associations. In Experiment 2, AB+, BC+ and DE+, EF+ trials were presented during stage 1 and C+, F- trials during stage 2. Higher-order revaluation, i.e., higher ratings of cue A than of cue D were again related to memory performance. The overall pattern of results is at variance with performance and inference models but is in agreement with the suggestion that retrospective revaluation is due to rehearsal processes.

Causal conditional inference and constraint satisfaction: Reconciling probabilistic and mental models approaches?

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A simple implementation of the probabilistic approach to causal conditional inference is proposed using a constraint satisfaction network. The default activation levels of nodes in the net correspond to the default mental model of the conditional. Further inference in the network involves clamping on or clamping off various nodes corresponding to the cause, its effect, possible defeaters and alternative causes. The act of clamping these nodes on or off coresponds to considering other structural possibilities in the mental models theory. Various phenomena can be explained in this way, for example, the suppression of the standard inferences associated with conditionals; the fact that strongly associated defeaters lead to more suppression of the valid inferences; the different behaviour observed when information about possible defeaters and alternative causes is given explicitly vs. implicitly. This simple model also explains the dissociation in the effects of possible defeaters and alternative causes shown by people who score highly on measures of schizotypy (Sellen, Oaksford, & Gray, in press). In sum, in the causal conditional inference task, mental models may be an emergent property of an

implementation of the probabilistic approach in a neural network.

Symposium: Two hemispheres, one reading system: Early cortical representations of print during reading.

Organiser: Michal Lavidor
Chair: Marc Brysbaert

A brisk review of the anatomy of the visual cortex

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Both animal and human studies have contributed to the current understanding of the macro- and microanatomy of the visual system. Human lesion studies have tended to depend on the (variable) anatomy of the blood supply to visual cortex, although more recent studies have made use of functional imaging techniques. I will emphasize those studies that have attempted to address the problem of macular sparing and splitting within a historical framework.

A virtual lesion examination of a split-processing model of visual word recognition.

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Repetitive transcranial magnetic stimulation (rTMS) over the left and right occipital cortex was applied during a lexical decision task to investigate the extent to which word recognition processes could be accounted for according to the split fovea theory. Unilateral rTMS significantly impaired lexical decision latencies to centrally presented words, supporting the suggestion that foveal representation of words is split between the cerebral hemispheres rather than bilateral. Behaviourally, words that have many orthographic neighbours sharing the same initial letters (‘lead neighbours’) facilitated lexical decision more than words with few lead neighbours. This effect did not apply to end-neighbours (orthographic neighbours sharing the same final letters). Crucially, rTMS over the RH impaired lead-, but not end-neighbourhood facilitation. The results support the split fovea theory, where the RH has primacy in representing lead neighbours of a written word.

Environmental influences in single-word reading: Emergent asymmetries in an implemented split-fovea model.

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The split-fovea model of reading has demonstrated a close fit with normal and impaired reading performance. In neural network versions of the model we have implemented the splitting of the human fovea, with left and right visual fields initially projecting exclusively to right and left hemispheres, respectively. We report here asymmetric hemispheric effects in language processing that emerge spontaneously from the model. We report

asymmetries in processing orthographic, phonological and semantic aspects of words. These asymmetries are a result of the model interacting with asymmetries in the information profile of words in the lexicon of English, and present a challenge to current theories of hemispheric asymmetries in language processing.

An account of hemisphere-specific patterns of letter perceptibility based on a split-fovea model.

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I will present a model of letter-position encoding in which it is assumed that words are foveally split. This assumption results in processing that differs with cortical hemisphere. I will discuss how the proposed processing accounts for a variety of experimental results on letter perceptibility. In the model, a decreasing activation gradient across letter position induces a temporal encoding. I will focus on how this gradient is formed. For English, gradient formation requires strong directional inhibition within the right hemisphere, because the slope of the desired gradient is in the opposite direction as the perceptual acuity gradient. In contrast, much less inhibition is required in the left hemisphere because the slope of the desired gradient is already present in the acuity gradient. I will show that these assumptions explain how letter perceptibility varies with letter position, visual field, and reading direction (Hellige et al., 1995; Marks and Hellige, 1999; Eviatar, 1999; Hellige and Yamiguchi, 1999) and with retinal location (Wolford and Hollingsworth, 1974). They also explain the strange case of a patient with posterior left hemisphere damage who experienced visual neglect on the right side of space, but made reading errors primarily involving the first letter of words (i.e., from the left side of space) (Katz and Sevush, 1989).

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Reading habits, perceptual learning, and recognition of printed words

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Although there is little doubt that the perception of print involves the sensory cortexes of both hemispheres, large parts of the distributed cortical network that supports reading is

lateralized to the left hemisphere (e.g., Cohen et al. 2000; Dehaene et al. 2001; Leff et al., 2001). Our research aims at the understanding of how different components of the reading network interact during the perception of printed words. In the present paper we focus on early visual processes to demonstrate that visual training associated with the act of reading modifies the way we perceive words. We will show how different types of visual pattern memories develop during reading acquisition and how lexical top-down may modify the lower level information processing.

However, despite the fact that reading related perceptual learning is most likely to take place in the visual cortex of both hemispheres, these learning effects are only functional as part of the entire (left-lateralized) network. To support our view we will present data from skilled readers of different scripts, from children at different levels of reading acquisition, and from different types of reading impaired patients.

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A place for spatial cognition in reading

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Reading is a spatial activity with the reader's eyes moving from one fixation location to the next to pick up spatially distributed visual information. Current models of reading seem to largely ignore spatial cognition in reading: They do not provide a cognitive mechanism that stores spatial information about a text. Thus, they cannot explain how we remember where on a page we picked up information, or how we plan long-range regressions. I will discuss recent findings related to spatial cognition in reading and outline possible research strategies to address this theoretical deficit.

End of Symposium

Interhemispheric cooperation in higher cognitive processing

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Meaningful stimuli presented simultaneously to both visual half-fields are processed significantly better compared to unilateral presentation to either the left or the right visual half-field in healthy participants. In several experiments we could demonstrate that this *bilateral gain* or *redundancy gain* only occurs for words and familiar faces, but not for

unlearned stimuli like pseudowords or unfamiliar faces. The *bilateral advantage* can be interpreted in terms of hemispheric cooperation and has recently been investigated in an event-related EEG study with unilateral and bilateral presentation of words and pseudowords. ERP data showed a fast, asymmetric interhemispheric transfer time (IHTT) from the right to the left hemisphere only for words and not for pseudowords as well as left-lateralized ERP topographies at posterior electrode sites during bilateral word presentation. The data suggest interhemispheric cooperation due to fast right-hemispheric transfer and exchange of information in pre-existing cortical networks. No cooperation between the two cerebral hemispheres is obvious for unlearned stimuli. The data are discussed and interpreted in a neurocognitive framework assuming interhemispheric cortical networks for learned material.

Phoneme-taste synaesthesia: Linguistic and conceptual factors

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This study documents an unusual case of developmental synaesthesia in which phonemes induce an involuntary sensation of taste that is subjectively located in the mouth. Phonemes, rather than words (and indeed, rather than graphemes) appear to be the critical determinants and the synaesthesia is not found for environmental sounds. There is a highly structured, non-random relationship between particular combinations of phonemes and the resultant taste. This is influenced by certain phonemic properties (e.g. allophony) and other phonological rules (e.g. voicing, order of phonemes). The synaesthesia is likely to have originated during vocabulary acquisition, since it is guided by learned linguistic and conceptual knowledge. The phonemes that trigger a given taste tend to also appear in the name of the corresponding foodstuff (e.g. /l/ and /s/ can trigger a taste of mince /mIns/) and there is often a semantic association between the triggering word and taste (e.g. the word "blue" tastes inky). The results suggest that synaesthesia does not simply reflect innate connections from one perceptual system to another, but that it can be mediated and/or influenced by a symbolic/conceptual level of representation.

Application of a model of the auditory primal sketch to cross-linguistic differences in speech rhythm: Implications for the acquisition and recognition of speech

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It has long been noted that the world’s languages vary considerably in their rhythmic organisation. Different languages seem to privilege different phonological units as their basic rhythmic unit, and there is now a large body of evidence that such differences have important consequences for crucial aspects of language acquisition and processing. The most fundamental finding is that the rhythmic structure of a language strongly influences the process of spoken-word recognition (Cutler *et al*.1992). This finding, together with evidence that infants are sensitive from birth to rhythmic

differences between languages (Nazzi *et al.* 1998), and exploit rhythmic cues to segmentation at an earlier developmental stage than other cues (Johnson and Jusczyk, 2001) has prompted the claim that rhythm is the key which allows infants to begin building a lexicon and then go on to acquire syntax. (Jusczyk, 1999). It is therefore of interest to determine how differences in rhythmic organisation arise at the acoustic/auditory level. In this paper, it is shown how an auditory model of the primitive representation of sound (Todd and Brown, 1996), which we refer to as the "auditory primal sketch" by analogy to Marr's theory of edge detection, provides just such an account of rhythmic differences. Its performance is evaluated on a data-set of French and English sentences, and the English, Dutch, French and Italian sentences in Nazzi *et al.* (1998) used in Ramus *et al.*(1999), and compared with the results yielded by the phonetic accounts of Frank Ramus and his colleagues (Ramus *et al.*, 1999) and Esther Grabe and her colleagues (Grabe and Low, to appear).

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An fMRI study of the cortical processing network involved in speechreading

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The current study identifies the processing network involved in speechreading using functional magnetic resonance imaging (fMRI). Experiment 1 consisted of 3 visual conditions; a talking face, a gurning face, and a static face, plus a blank-screen baseline condition. The static-, and gurning-face conditions involved a sequential button press task. During the talking-face condition, subjects had to identify a number in each sentence and press the button that corresponded to that number. In Experiment 2, the same sentences were presented auditorily. We found a network of activation that increased systematically with the complexity of the experimental condition. The static-face condition produced activation bilaterally in motor (BA 6) and visual (BA 18/19) areas, when contrasted with the baseline condition. Gurning recruited additional visual motion areas (BA 37/19) when contrasted with the static face. When contrasted with the gurning face, the talking-face condition recruited additional language (BA 44/45),

auditory (BA 22), and sensory association cortex (BA 21), implicated in semantic processing. These three areas overlapped with those activated by the auditory speech in Experiment 2. These results demonstrate that speechreading is a cognitive process that involves a widespread cortical network, including temporal lobe areas also involved in processing auditory speech.

Matching language and the brain using the Mismatch Negativity

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The Mismatch Negativity, MMN, and its magnetic correlate, MMNm, can indicate the existence of memory traces for language sounds, phonemes, of one's own language . One may speculate that the brain basis of various linguistic representations and processes can fruitfully be explored using the MMN as the dependent measure. We have explored the cortical correlates of spoken words and grammatical morphemes using the MMN and found that

1. the amplitude of the MMN(m) can reflect the existence of memory traces for words,
3. the latency of the MMN can reflect the point in time when a word is being recognized,
2. the cortical topography of the MMN(m) can differ between individual words,
3. the cortical topography of the MMN differs between inflectional morphemes and word stems,
4. the MMN reflects the occurrence of syntactic violations.

The MMN signatures of words, of affixes and of syntactic correctness occurred early, usually between 100-200 ms after the point in time when subjects can first recognize the critical words from the acoustic input. Between-word differences and between-context differences appeared near-simultaneously, consistent with the view that different types of linguistic information (e.g. lexical and syntactic) become available for cortical processing at about the same point in time when spoken language is being comprehended . The differential topographies of the MMN may be helpful for specifying the cortical organization of different types of memory traces involved in the processing of language.