

2001 - July 11/12/13 University of Manchester

A scientific meeting will be held at Ashburne Hall, The University of Manchester, Old Hall Lane, Fallowfield, Manchester, M14 6HP on 11/12/13 July, 2001. The local organiser will be Professor Patrick Rabbitt.

Twenty-ninth Bartlett Lecture

James L McClelland: (Department of Psychology, Carnegie Mellon University and the Center for the Neural Basis of Cognition)

Semantic memory: A parallel distributed processing approach

The Bartlett Lecture will take place at 6.00pm, Thursday 12 July in Lecture Theatre 3, Stopford Building, University of Manchester Medical School. (see map back cover)

Symposia:

Wednesday 11 July 2-5.30

Transcranial magnetic stimulation (TMS) and experimental psychology Organised by Vincent Walsh

Thursday 12 July 9-1

Development and breakdown of verb morphology: A window on the neural representation of language

Organised by Karalyn Patterson and Dorothy Bishop

Friday 13 July 9-1

Connectionist modelling in psychology: Localist representations or distributed representations throughout?

Organised by Mike Page

Presentations

Sessions (except the Bartlett Lecture) will be held in Ashburne Hall. Both lecture rooms at Ashburne Hall have OHP and slide projector facilities, and data projector available for Powerpoint presentations. Presenters must provide their own laptops. In case of queries about projection arrangements, please contact the Hon Sec, Elizabeth Gaffan, e.a.gaffan@reading.ac.uk.

Transcranial Magnetic Stimulation Demonstration

A TMS demonstration will be given at the end of the Symposium on Wednesday afternoon and The Magstim Company will provide a display of equipment during the meeting.

Wednesday 11 July

The scientific session will start at 2pm.

Drinks will be available in the Library after the Wednesday afternoon session.

Thursday 12 July

There will be a drinks reception at 7.00 after the Bartlett Lecture. The conference dinner will be at 7.45, at the Yang Sing, 34 Princess Street, Manchester, M1 4HB. A booking form is enclosed.

Wednesday 11th July

START OF PARALLEL SESSION

Session A: Lees Room – Room A

Symposium - Transcranial magnetic stimulation (TMS) and experimental psychology

Organised by Vincent Walsh

2.00 Vincent Walsh (University of Oxford)

Introduction: Magnetic Stimulation in studies of cortical function.

2.30 J C Rothwell* (Institute of Neurology, London)

Transcranial magnetic stimulation as a tool for probing and manipulating motor cortical organisation

3.00 Janet Eyre* (University of Newcastle Medical School)

Tracking developmental change in the human motor system with TMS.

3.30 TEA

4.00 Alan Cowey (University of Oxford)

Visual awareness studied by transcranial magnetic stimulation in blindsight and in retinal blindness

4.30 Patrick Haggard (Institute of Cognitive Neuroscience, University College London)

Unravelling movement and action with TMS

5.00 Matthew Rushworth* (University of Oxford)

Using TMS to study attention

5.30 Transcranial Magnetic Stimulation Demonstration

Demonstration of Magnetic Stimulation equipment and localisation on subjects' MRI scans. The demo will include: finding motor cortex; producing phosphenes; effects of coil positions for motor, visual and association cortex; effects of intensity; sham TMS.

Drinks reception in the Library

Wednesday 11th July

START OF PARALLEL SESSION *Session B: Lees Room – Room B*

2.00 Evan Heit, Noellie Brockdorff* and Koen Lamberts (University of Warwick)

The time course of false recognition memory

2.30 Wilma Koutstaal* (University of Reading) (Introduced by Elizabeth Gaffan)

Increased vulnerability to false positive memory errors in older adults: Notable exceptions and the conceptual detraction account

3.00 Ben R Newell* and Sally Andrews* (University of New South Wales) (Introduced by Mike Burton)

Levels of processing effects on implicit and explicit memory tasks: using question

position to investigate the truncated processing hypothesis.

3.30 TEA

4.00 Brendan Weekes, Anna Saenz de Miera* and Jose Manual Igoa* (University of Sussex and Univesidad Autonoma de Madrid)

Age-of-Acquisition effects on reading and picture naming in Spanish and English.

4.30 Chris Jarrold, Caroline E Phillips*, Alan D Baddeley, Julia Grant* and Annette Karmiloff-Smith* (University of Bristol)

Comprehension of spatial and non-spatial language in Williams syndrome

5.00 C M Marshall*, M J Snowling and P J Bailey (University of York)

The effect of a verbal labelling strategy on rapid auditory processing: Evidence from normal and dyslexic readers

5.30 Transcranial Magnetic Stimulation Demonstration (Room A)

Drinks reception in the Library

Thursday 12th July

Session A: Lees Room – Room A

Symposium - Development & breakdown of verb morphology: A window on the neural representation of language

Organised by Karalyn Patterson and Dorothy Bishop

9.00 Harald Clahsen*, Fraibet Aveledo* and Iggy Roca* (University of Essex)

Regular and irregular verb inflection in Spanish child language

9.30 Asma Siddiki*, Kim Plunkett* and Paul Harris* (University of Oxford)

Alternative-route model? Children's acquisition of English verb morphology

10.00 L K Tyler, C Longworth*, B Randall* and W D Marslen-Wilson (University of Cambridge and MRC Cognition & Brain Sciences Unit, Cambridge)

Past tense morphology: evidence for separable neural systems

10.30 COFFEE

11.00 Helen Bird, Matthew A Lambon Ralph, Karalyn Patterson, Mark S Seidenberg* and James L McClelland* (MRC Brain & Cognitive Sciences Unit, Cambridge, Psychology, Linguistics, and Computer science, Neuroscience Program, University of Southern California and Department of Psychology, Carnegie Mellon University and the Center for the Neural Basis of Cognition)

Deficits in phonology and regular past-tense morphology

11.30 Karalyn Patterson, Matthew A Lambon Ralph, John R Hodges and James L McClelland* (MRC Cognition & Brain Sciences Unit, Cambridge and Department of Psychology, Carnegie Mellon University and the Center for the Neural Basis of Cognition)

Impaired processing in quasi-regular domains of language: the case of English past-tense verbs

12.00 Kate Nation, Paula Clarke* and Margaret Snowling (University of York)

Semantic and phonological contributions to past tense morphology in children with poor

language comprehension

12.30 James L McClelland* (Department of Psychology, Carnegie Mellon University and the Center for the Neural Basis of Cognition)

Double dissociations: do they implicate separate modules or Differential sensitivity to damage of contributing components?

1-2 LUNCH

Thursday 12th July

Session B: Lees Room – Room B

9.00 Derek Besner (University of Waterloo, Canada)

Basic processes in reading: Results requiring change in Coltheart and colleagues computational dual route cascaded model

9.30 Angus Gellatly and Geoff Cole* (Keele University)

Visual masking and/or release from masking can be feature specific

10.00 Ellen Poliakoff*, Lydia Kirby-Robertson*, Carl Macrae*, Donald O'Boyle and Frederick Cody* (School of Biological Sciences and Department of Psychology, University of Manchester)

Developing a new test of tactile selective attention: dihaptic tactile monitoring (DTM)

10.30 COFFEE

11.00 Salvador Soto-Faraco, Alan Kingstone and Charles Spence (University of British Columbia, Canada and University of Oxford)

Crossmodal integration of dynamic information

11.30 Jeff Nelson* (The University of Western Australia) (Introduced by Patrick Rabbitt)
Age, task-switching, and adaptation to novelty.

12.00 Matthias M Müller* (Cognitive Neuroscience and Neuropsychology, University of Liverpool) (Introduced by Marco Bertamini)

Time course of cortical attentional shifting and allocation of attentional resources in multi-element stimulus arrays.

12.30 R Swainson*, G M Jackson, R Cunnington*, R Newport* and S R Jackson (University of Nottingham)

ERP correlates of executive control in language-switching

1-2 LUNCH

Thursday 12th July

Session A: Lees Room – Room A

2.00 Gordon C Baylis*, Leslie L Baylis* and Christopher Rorden* (University of Plymouth, University of South Carolina, Presbyterian College, South Carolina, and University of Nottingham) (Introduced by Elizabeth Gaffan)

Visual extinction following bilateral stimulation: The importance of interhemispheric timing.

2.30 Robert Logie, Nicoletta Beschin*, Sergio Della Sala* and Michel Denis* (University of Aberdeen and CNRS, Universite de Paris-Sud, France)

Mental representations in representational neglect

3.00 Michael J Greer*, Maarten van Casteren*, Stuart A McLellan*, Helen E Moss, Jennifer Rodd*, Timothy T Rogers* and Lorraine K Tyler (Centre for Speech and Language, Department of Experimental Psychology, University of Cambridge and MRC Cognition and Brain Sciences Unit, Cambridge)

How features determine concept categorisation: A computational model of semantic knowledge

3.30 TEA

4.00 Claudia Metzler* (University of Manchester) (Introduced by Roland Baddeley)
Effects of left frontal lesions on the selection of context appropriate meanings

4.30 Louise Phillips (Aberdeen University)

Positive mood and executive function: evidence from fluency and Stroop tasks.

5.05 Business Meeting (Members only) (Room A)

5.35 Approx COACH FROM ASHBURNE HALL TO BARTLETT LECTURE

6.00 Twenty-ninth Bartlett Lecture - James L McClelland (Department of Psychology, Carnegie Mellon University and the Center for the Neural Basis of Cognition)

Semantic memory: A parallel distributed processing approach

(Lecture Theatre 3, Stopford Building, University of Manchester Medical School)

7.00 DRINKS RECEPTION

7.45 CONFERENCE DINNER – YANG SING

Thursday 12th July Session B: Lees Room – Room B

2.00 Linda M Moxey* (University of Glasgow) (Introduced by Mike Burton)

Understanding quantity information in messages about contraceptive effectiveness

2.30 C O'Donnell* and V Bruce (University of Stirling)

Using "change blindness" to investigate face familiarisation.

3.00 Vicki Bruce, Hayley Ness*, Peter J B Hancock*, Craig Newman* and Jenny Rarity* (University of Stirling)

Four heads are better than one. Combining face composites yields improvements in face likeness.

3.30 TEA

EPS/BAAS Undergraduate Project Prize 2000

4.00 N P Holmes*, S Plainis* and I J Murray* and N Brady* (The Department of Optometry and Neuroscience, University of Manchester Institute of Science and Technology (UMIST) and University of Manchester)

The space-man cometh *or* Simple visual reaction time to lateralised sinusoidal gratings

4.30 J H Wearden (University of Manchester)

"..begins with a single step". Modular unification of timing tasks

5.05 Business Meeting (Members only) (Room A)

5.35 Approx COACH FROM ASHBURNE HALL TO BARTLETT LECTURE

6.00 Twenty-ninth Bartlett Lecture - James L McClelland (Department of Psychology, Carnegie Mellon University and the Center for the Neural Basis of Cognition)
Semantic memory: A parallel distributed processing approach
(Lecture Theatre 3, Stopford Building, University of Manchester Medical School)

7.00 DRINKS RECEPTION

7.45 CONFERENCE DINNER – YANG SING

Friday 13th July

Session A: Lees Room – Room A

Symposium - Connectionist modelling in psychology: localist representations or distributed representations throughout?

Organised by Mike Page

9.00 Kim Plunkett* (Oxford University)

Localist and distributed models: A developmental perspective

9.30 Glyn W Humphreys and Dietmar Heinke (Behavioural Brain Sciences, University of Birmingham)

Modelling attention in a quasi-modular, interactive system: The SAIM model

10.00 Jonathan Grainger (Laboratoire de Psychologie Cognitive CNRS and Université de Provence)

What we learn from connectionist modelling in psychology: The case of visual word recognition.

10.30 COFFEE

11.00 Edmund Rolls (University of Oxford)

Sparse distributed representations in perceptual and memory systems in the brain.

11.30 David C Plaut* (Departments of Psychology and Computer Science, Carnegie Mellon University and the Center for the Neural Basis of Cognition)

Discovering representations

12.00 Mike Burton (University of Glasgow)

What counts as a model?

12.30 James L McClelland* and Mike Page (Department of Psychology, Carnegie Mellon University and the Center for the Neural Basis of Cognition and University of Hertfordshire)

Discussion

1-2 LUNCH

END OF PARALLEL SESSION

Friday 13th July

Session B: Lees Room – Room B

9.30 Kevin Dent and Mary M Smyth (Lancaster University)

Two forms of representation in spatial short-term memory: Evidence from location

change detection

10.00 David G Pearson* and Arash Sahraie* (University of Aberdeen) (Introduced by Robert H Logie)

The role of oculomotor control during the maintenance of location in spatial short-term memory

10.30 COFFEE

11.00 Richard A Heath* (University of Sunderland) (Introduced by Elizabeth Gaffan)
Undefined variance in experimental data: Evidence against the Gaussian Hypothesis

11.30 Marco Bertamini and Camilla J Croucher* (University of Liverpool)
Comparing contours across surfaces and across apertures.

12.00 Neil P McAngus Todd* (University of Manchester) (Introduced by John Wearden)
Evidence for a primitive acoustic sense in humans

12.30 Mike Anderson*, Ted Nettelbeck* and Patrick Rabbitt (The University of Western Australia, Adelaide University and Age and Cognitive Performance Research Centre, University of Manchester)

The relationship between age, intelligence, and stimulus response compatibility in a sample of children and elderly adults

1-2 LUNCH

END OF PARALLEL SESSION

Friday 13th July

Session A: Lees Room – Room A

2.00 Alex R Carmichael* (Age and Cognitive Performance Research Centre, University of Manchester)

(Introduced by Patrick Rabbitt)

Real-time suppression of background noise for television broadcasts: The impact on elderly viewers.

2.30 Neil Pendleton* (Department of Geriatric Medicine, University of Manchester)
(Introduced by Patrick Rabbitt)

Investigation of candidate genes for cognitive decline in older adults

3.00 Christine Lowe and Patrick Rabbitt (Age and Cognitive Performance Research Centre, University of Manchester)

Detection and analysis of "abnormal" memory in a "normal" aged population

3.30 Patrick Rabbitt (Age and Cognitive Performance Research Centre, University of Manchester)

Global and modular models of cognitive ageing.

End of Meeting

ABSTRACTS

Introduction: Magnetic Stimulation in studies of cortical function.

Vincent Walsh

University of Oxford.

Magnetic stimulation of the human brain is one of many techniques available for studies of perceptual, motor and cognitive functions. The main advantages claimed for TMS are the reversible nature of the interference, its brevity and the ability to selectively interfere with different cortical functions. I will discuss the unique problem space occupied by studies using TMS, outline the main methodological modes in using it and discuss the spatial, temporal and functional resolution. I will give examples of the use of TMS in studies of learning, cortical interactions and speech which serve as examples of the kinds of contribution use of the technique can make to studies of cortical function.

Transcranial magnetic stimulation as a tool for probing and manipulating motor cortical organisation

J C Rothwell

Institute of Neurology, London

Transcranial magnetic stimulation is now commonly used in experimental psychology as a method of inducing a temporary functional "lesion" in parts of the cerebral cortex. Here, I will summarise three new pieces of work that use TMS in a different way, to study and manipulate the excitability of connections between two areas of cortex. All three studies examined the connection between the premotor areas and the motor cortex in healthy human subjects.

In the first study, we used a paired pulse design to test whether single stimuli over sites anterior to motor cortex could affect its excitability as measured by the EMG response to a standard test stimulus. Two small figure of eight coils were used so that the stimuli could be given as close as 3cm apart, and the intensity of the anterior, conditioning stimulus was set to be lower than the active motor threshold for the motor cortex. Two points (A and B) were found to produce suppression of the response to the test shock, with a time course that reached a peak at an interstimulus interval of 6ms. Point A was 4-6 cm anterior to the hand area of motor cortex; point B was in the midline and 6cm anterior to the vertex. Since stimuli at these sites had no effect on the size of H-reflexes in arm muscles, nor on the EMG responses evoked by transcranial electrical stimulation of the motor cortex, we presume that the interaction we observed was due to activity in cortico-cortical connections between A or B and the motor cortex.

In the second and third studies we used repetitive TMS given at 1Hz for up to 25min to manipulate the excitability of the connection for a short period outlasting the end of the rTMS. Stimuli that were subthreshold for stimulating motor cortex in active subjects were used, and motor cortex excitability was again tested before and after the train by measuring the EMG response to a standard test shock. Stimuli given over a point 3cm anterior to the hand area could reduce motor cortical excitability in the resting state for up to 30min after the end of the train. There was no effect from stimulation over motor cortex itself. We conclude that it is possible to produce effects at distant sites by repetitive stimulation of one area of cortex. Finally, we examined the nature of this effect in more detail by testing how a subthreshold rTMS of premotor cortex affected paired pulse testing of motor cortex excitability. The train reduced the amount of cortico-cortical inhibition in motor cortex for up to 30min after the train, but only at a small range of

interstimulus intervals (6, 7ms). This implies that the train over premotor areas affected the excitability of intrinsic circuits in the motor cortex. Thus conditioning one part of the cortex with TMS can affect the way another cortical area processes incoming data.

Tracking developmental change in the human motor system with TMS.

Janet Eyre

University of Newcastle Medical School

Abstract not yet available

Visual awareness studied by transcranial magnetic stimulation in blindsight and in retinal blindness

Alan Cowey

University of Oxford

Subject G.Y. is a much studied hemianope whose left striate cortex is almost totally destroyed. He has blindsight (good visual detection and discrimination without visual awareness) for many visual stimuli presented within his blind-hemifield but sometimes reports faint conscious visual percepts especially for swiftly moving stimuli of high luminance contrast. To determine whether the latter reflect residual visual processing in extra-striate visual area MT/V5 we used repetitive transcranial magnetic stimulation (rTMS) over MT/V5 in his normal and his damaged hemisphere. On the normal side, "silvery swirling" visual phosphenes could be elicited by rTMS applied at an area over the position of MT/V5 as previously shown in this subject by fMRI.; but not by stimulating MT/V5 in the damaged hemisphere even following dense sampling of the adjacent regions. However, phosphenes were occasionally produced in the hemianopic field by TMS close to the midline which probably stimulated V3 of the damaged hemisphere. The size and position of the phosphenes was determined by asking the subject to fixate the centre of radial graph paper while rTMS was delivered and to mark the centre and edges of any phosphene on the paper. In contrast, phosphenes could be elicited in a peripherally blinded subject by stimulating MT/V5 in either hemisphere by rTMS. The phosphenes were achromatic and within 20 degree of the visual axis, the latter estimated by asking the blind subject to "fixate" the forefinger of one hand held at the centre of the graph paper while he used the other hand to mark any phosphene. We also studied the effects of rTMS in the blind subject when delivered over the sagittal midline. "Bright", often coloured, but stationary phosphenes were readily elicited with increasing eccentricity in the lower visual field the more rostral the rTMS. We conclude that even years after the eyes have been severed from the brain, striate cortex and visual area MT/V5 remain excitable and can generate visual percepts. But in the absence of V1, magnetic stimulation of area V5 on that side no longer yields conscious visual percepts, at least with the stimulation conditions we used.

Unravelling movement and action with TMS

Patrick Haggard

Institute of Cognitive Neuroscience, University College London

The information-processing underlying human action is characterised by a hierarchy, extending from very high-level intentions (e.g., "I want a drink") to the lowest level of motorneuronal firing and muscle contraction. The psychology of action has greatly

suffered from an inability to control the input to, and to selectively interfere with, the higher and lower levels of control. TMS over the motor cortex can produce involuntary movements, which correspond in some ways to normal operation of the lower (movement) part of the hierarchy, without operation of the higher (action) part. As such, they provide an important method for psychologists wishing to individuate the two kinds of processing.

I shall report a number of behavioural and psychophysical studies which have taken this approach. First, I shall report data showing that the conscious awareness of (TMS-induced) movement and the conscious awareness of intentional action differ fundamentally. Second, I shall report data on attempts to use TMS in a completely different way, in which, rather than evoking movements at the lower level of the hierarchy, it is used to try to intervene on the higher processes in the hierarchy directly.

Using TMS to study attention

Matthew Rushworth
University of Oxford

Transcranial magnetic stimulation (TMS) can be used to transiently disrupt the normal patterns of neuronal activity in association cortex. While TMS is being applied, a brain area will be unable to function normally. TMS, like the investigation of permanent brain lesions, can provide evidence about whether a brain area is critical for a cognitive process. In addition TMS, because it only induces a very brief disruption, can be used to investigate when a brain area is playing its most critical role. In a recent experiment we used fMRI to identify areas of blood oxygen level dependent (BOLD) signal increase in the dorsomedial frontal cortex during two set switching tasks. One task required subjects to switch between two different attentional sets involving the allocation of attention to different stimulus features. In the second task subjects switched between two different intentional or response sets. Although there were BOLD signal increases in the dorsomedial frontal cortex in both experiments, TMS only disrupted performance in the second case of intentional set switching. Further experiments demonstrated that medial frontal TMS only disrupted task performance when it was delivered at the time of actual set-switching, not when it was delivered at the time that subjects selected individual task responses. Comparing the effects of medial frontal and dorsal premotor TMS revealed a temporal double dissociation of function.

The time course of false recognition memory

Evan Heit, Noellie Brockdorff and Koen Lamberts
University of Warwick

In the Deese/Roediger-McDermott false memory paradigm (e.g., Roediger & McDermott, 1995), after subjects study a list of inter-related words, they falsely recognise semantically similar lures nearly to the extent that they correctly recognise studied items. This result seems to persist even when subjects are forewarned about the nature of the illusion. In two experiments we examined the time course of false recognition judgments. Using an old-new recognition task, we elicited responses at different time lags from presentation of stimulus through a response-signal procedure. We investigated the effects of study list length and forewarning on the time course of false recognition

judgments and examined the results in terms of changes in accuracy and changes in response bias over time. We report changes in the false recognition of lure items over time as well as changes in the effect of forewarning over time.

Roediger, H.L. III & McDermott, K.B. (1995) Creating false memories: Remembering words not presented in lists, *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21, 803-814.

Increased vulnerability to false positive memory errors in older adults: Notable exceptions and the conceptual detractor account

Wilma Koutstaal

University of Reading

Several recent studies have shown that healthy older adults more often make false positive errors in episodic memory tests than do younger individuals. We briefly report findings from two studies using novel perceptual shapes wherein this age-related elevation in false positive errors was greatly attenuated. We then report two experiments designed to test the viability of a "conceptual detractor account" of the age-related increase in susceptibility to false recognition. Do older individuals show especially elevated false positives in situations where the stimuli have preexisting semantic or conceptual representations, such that the presence of conceptual information detracts from the encoding and/or retrieval of item-specific information? In the first experiment, ambiguous visual shapes were presented either accompanied by disambiguating conceptual labels or without such labels (labelling condition manipulated between subjects). Relative to younger adults, older adults showed elevated false recognition if conceptual labels were present (at both study and test) but not if labels were never presented (significant age x condition interaction for raw, but not baseline-corrected responses; trend toward an interaction in baseline-corrected highly confident false recognition responses). In the second experiment, pictures of common versus abstract objects were presented in a within subjects design. Despite the change in materials and design a very similar pattern was found: relative to younger adults (n=18), older adults (n=13) showed higher overall false recognition for concrete but not abstract objects (significant age x condition interaction for raw false recognition, and for both raw and corrected high confidence measures; trend for the overall corrected measure). The adequacy and implications of the conceptual detractor account are assessed.

Levels of processing effects on implicit and explicit memory tasks: using question position to investigate the truncated processing hypothesis.

Ben R Newell and Sally Andrews

University of New South Wales, Australia.

Two experiments investigated the validity of the truncated processing hypothesis (Challis & Brodbeck, 1992) as an explanation of the weak levels of processing effects found on tests of implicit memory. The encoding question was positioned either before or after the target stimulus in standard deep and shallow encoding tasks. Contrary to the prediction of the hypothesis, both experiments found that performance on tests of implicit memory (word fragment and stem completion) was impaired in question-after-target-trials relative to question-before-target-trials. In contrast, a significant improvement on a test of explicit

memory (recognition) was found for shallowly encoded words in the question-after-target trials relative to those in the question-before-target trials. The results suggest that the temporal relationship between the question and the stimulus has important consequences for the form of memory code – perceptual or conceptual – established, and subsequent memory performance.

Challis, B.H., & Brodbeck, D.R. (1992). Levels of processing affects priming in word fragment completion. *Journal of Experimental Psychology: Learning, Memory & Cognition*, 18, 595 – 607.

Age-of-Acquisition effects on reading and picture naming in Spanish and English.

Brendan Weekes¹, Anna Saenz de Miera² and Jose Manual Igoa²

1. University of Sussex

2. Univesidad Autonoma de Madrid

The aim of this study was to compare the effects of the age of acquisition (AoA) of a word on oral reading and picture naming in Spanish and English. In the first experiment forty bilingual Spanish-English speakers were asked to read aloud Spanish (L1) words and to name line drawings in Spanish. Results showed significant effects of the rated AoA of a word in Spanish on both oral reading and picture naming performance in L1. Effects of AoA were found for both high and low frequency words on oral reading and picture naming performance. A multiple regression analysis found independent effects of rated AoA, written word frequency and word length on oral reading and picture naming in L1. In the second experiment, twenty bilingual Spanish-English speakers were asked to read aloud English (L2) words and to name line drawings in English. Results showed significant effects of the AoA of a word in English on oral reading and picture naming performance in L2. The results will be discussed with reference to recent accounts of AoA effects on oral reading (Ellis and Lambon-Ralph, 2000; Monaghan and Ellis, in press). We will argue that the present results are a challenge to the claim that AoA effects on reading are reduced for orthographies with consistent mappings between orthography and phonology such as Spanish.

Ellis, A.W. & Lambon-Ralph, M.A. (2000). Age of acquisition effects in adult lexical processing reflects loss of plasticity in maturing systems: Insights from connectionist networks. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 26, 1103-1123. Monaghan, J. & Ellis, A.W. (in press). What exactly interacts with spelling to sound consistency in word naming? *Journal of Experimental Psychology: Learning, Memory and Cognition*.

Comprehension of spatial and non-spatial language in Williams syndrome

Chris Jarrold, Caroline E Phillips, Alan D Baddeley, Julia Grant and Annette Karmiloff-Smith

University of Bristol

Individuals with Williams syndrome show an unusual cognitive profile, with relatively strong language abilities and impoverished visuo-spatial skills. Two studies are reported which examined the interaction of these strengths and weaknesses. In a first study, the Test for Reception of Grammar was given to 32 individuals with Williams syndrome and controls matched individually for total number of errors on the task. Individuals with

Williams syndrome had particular problems when asked to comprehend sentences with a spatial component, making significantly more errors on these items than both control groups. A second study examined comprehension of spatial and non-spatial sentences in more detail, comparing the performance of 15 individuals with Williams syndrome and control groups matched for vocabulary ability. Individuals with Williams syndrome again showed impaired comprehension of spatial items. In contrast, they were unimpaired on non-spatial items, with the exception of sentences testing comprehension of non-spatial comparatives (lighter and darker). These results indicate that the spatial difficulties experienced by individuals with Williams syndrome constrain aspects of their language comprehension. They also suggest that comprehension of comparative adjectives involves the construction of an internal spatial representation, even when these adjectives are not spatial in nature.

The effect of a verbal labelling strategy on rapid auditory processing: Evidence from normal and dyslexic readers

C M Marshall, M J Snowling and P J Bailey
University of York

The phonological difficulties of children with dyslexia have been attributed to underlying rapid auditory processing deficits, as measured by the Auditory Repetition Task (ART; Tallal, 1980; Tallal, Miller, Jenkins & Merzenich, 1997). This paradigm requires children to reproduce sequences of non-verbal tones presented at various rates. The present paper describes two experiments which investigated the effects of using a verbal labelling strategy on the ART, in both normal and dyslexic readers. Explicit encouragement to assign verbal labels to the stimuli facilitated the performance of normal children (with a mean age of 7 years, 0 months). In contrast, the ART scores of dyslexic children did not improve with a verbal strategy. The results suggest that children's propensity to label stimuli in a 'non-verbal' task influences performance. The extent to which performance is facilitated by such a verbal strategy may be determined by underlying language ability.

Tallal, P. (1980). Auditory temporal perception, phonics, and reading disabilities in children. *Brain and Language*, 9, 182-198. Tallal, P., Miller, S.L., Jenkins, W.M., & Merzenich, M.M. (1997). The role of temporal processing in developmental language-based learning disorders: research and clinical implications. In B. A. Blachman (Ed.), *Foundations of Reading Acquisition and Dyslexia: Implications for Early Intervention* (pp. 49-66). Hillsdale, NJ: Lawrence Erlbaum Associates.--

Regular and irregular verb inflection in Spanish child language

Harald Clahsen, Fraibet Aveledo, Iggy Roca
University of Essex

We present morphological analyses of verb inflections produced by 15 Spanish-speaking children (age range: 1;7 to 4;7) taken from longitudinal and cross-sectional samples of spontaneous speech and narratives. Our main observation is the existence of a dissociation between regular and irregular processes in the distribution of errors: regular suffixes and unmarked (non-alternating) stems are over-extended to irregulars in children's inflection errors, but not vice versa. With respect to the developmental pattern

of overregularizations we found that overregularization errors at all ages are only a small minority of the children's irregular verbs, and that the period of overregularization is preceded by a stage without errors. Furthermore, we found that the onset of overregularizations does not depend on changes in the children's verb vocabulary, but that it is connected to the emergence of obligatory finiteness markings. Our findings from Spanish supplement those on English and German child language and provide new cross-linguistic evidence for the dual-mechanism model

Alternative-route model? Children's acquisition of English verb morphology

Asma Siddiki, Kim Plunkett and Paul Harris

University of Oxford

Connectionist accounts of inflectional morphology claim that all verb inflections are stored in memory, whereas traditional symbolic accounts have long proposed separate processing routes for regular and irregular inflections: a rule-route and a memory route. Pinker's (1999) recent words-and-rules theory proposes a revision to the symbolic dual-route account, allowing that some regular verbs - allegedly those very high in frequency, with double inflections (e.g. dive/dove or dive/dived), or phonologically analogous to irregular verbs -- are inflected by the memory route as are irregular verbs. In the present study, to evaluate the predictions of the different accounts, we investigated the sensitivity of children's correct responses to verb frequency, rhyming verbs inflecting in the same manner (friends) and rhyming verbs inflecting in a different manner (enemies). 120 children aged 3:5 to 9:0 participated in an elicitation task of inflecting verb stimuli for past tense. Verbs were visually presented and verb stems were provided in sentences. The results show that children's performance patterns for regular and irregular verbs differ as predicted by the symbolic theory. However, their responses for regular verbs contradict the predictions of symbolic and words-and-rules theories, and comply with the predictions of connectionist account of inflectional morphology. The possibility of alternative explanations for the different patterns of results for regular and irregular verb inflections is considered.

Past tense morphology: Evidence for separable neural systems

L K Tyler¹, C Longworth¹, B Randall¹ and W D Marslen-Wilson²

1. University of Cambridge

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Dissociations between the regular and irregular past tense inflectional morphology have been important in testing claims about the cognitive and neural status of linguistic rules. These dissociations have been interpreted as evidence for (a) two computational systems, where the regulars are processed by rule and the irregulars are stored in memory and (b) in a single distributed system. Combining behavioural data from patients with detailed neuropathology can, in principle, provide strong constraints on accounts of the past tense. We report data showing that these dissociations are linked to damage to different neural regions, with deficits in processing the regulars associated with damage to L inferior frontal gyrus and impairments on the irregulars with damage to inferior temporal cortex. Further studies suggest that regular past tense deficits are due to impairments in morpho-phonological processing. These patterns of behavioural data and

neuropathology argue for dissociable processing routes to lexical representations, with a temporal lobe route for access to stored whole forms (such as the English irregular past tense), and a second route involving frontal phonological process in systems for the regular past tense, where access involves processes of phonological segmentation that parse the complex form into stem and affix.

Deficits in phonology and regular past-tense morphology

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Neuropsychological dissociations between regular and irregular past-tense verb processing have been explained in two ways: (a) separate mechanisms comprising a lexical-associative process for irregular and a rule-governed process for regular verbs; (b) a single system drawing on semantic and phonological knowledge. The latter account invokes phonological impairment as the basis of poorer performance for regular than irregular past-tense forms, due to greater phonological complexity of the regular past. In eight non-fluent aphasic patients with irregular > regular on a screening test, the advantage for irregular disappeared in sentence completion and repetition when phonological complexity was controlled. In reading, an advantage for irregular past forms was maintained only for the two patients with the most severely disrupted orthographic → phonological conversion, but many of the irregular past forms they read correctly were homonyms of concrete words. In a same-different judgement task on spoken words, all patients were impaired at judging regular present- and past-tense verbs like "press" and "pressed" to be different, but equally poor at the phonologically matched non-morphological discrimination between "cress" and "crest". These results provide strong evidence for a central phonological deficit that is not limited to speech output nor to morphological processing, but which is especially vulnerable to distinctions lacking phonological salience as typified by regular past-tense English verbs.

Impaired processing in quasi-regular domains of language: the case of English past-tense verbs

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Patients with semantic dementia, a neurodegenerative condition resulting in relatively selective deterioration of semantic knowledge, were tested on generation and two-alternative forced-choice (2AFC) recognition of the past tense of high- and low-frequency regular and irregular verbs in meaningful sentence frames, and on comprehension (in a 2AFC synonym judgement task) of the present tense of the same

verbs. We predicted and confirmed that the patients would have essentially normal ability to generate and recognise regular (and novel) past tense forms, but a dramatic and frequency-modulated deficit on irregular verbs. The patients' errors in generating irregular past tenses were predominantly straight regularisations (e.g., speak - "speaked") but included a substantial 23% of errors suggesting degradation of a system that combines information about regular and irregular forms in the same knowledge base (e.g., tear - "tored"; slit - "slat"). Across the set of 11 patients, the degree of impairment on both generation and recognition of irregular past tense was significantly correlated with the degree of comprehension impairment as measured by 2AFC verb synonym judgement. We conclude that a selective deficit on irregular past-tense verb forms does not require a hypothesis of two separate mechanisms but rather can arise from disruption to the semantic component of a single system containing knowledge about the entire past-tense vocabulary.

Semantic and phonological contributions to past tense morphology in children with poor language comprehension

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Any account of English past tense verb morphology needs to explain how children learn to process regular (play-played; jump-jumped) and irregular (sleep-slept; weep-wept) forms. Broadly speaking, we can distinguish between two theoretical accounts, those claiming that two separate mechanisms are needed (a rule-based system that underlies the processing of regular forms and a lexical association mechanism that deals with irregulars) and connectionist accounts that model both processes within a single system. A number of studies have highlighted the difficulties that children with specific language impairment or dyslexia have with past tense production, especially with regular verbs and with generalising to novel forms. In our study, children with specific weaknesses in language comprehension also showed impaired performance on tests of past tense elicitation. Unlike many children with SLI however, their difficulties were more pronounced on irregular rather than regular verbs. These findings are considered against competing theoretical models and we conclude that an important determiner of performance on past tense tasks is the efficiency of an individual's underlying language skills in both the phonological and semantic domains.

Double dissociations: do they implicate separate modules or Differential sensitivity to damage of contributing components?

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Double dissociations play a leading role in the interpretation of neuropsychological data. This presentation will focus on two different interpretations of the double dissociation observed, in both word reading and inflectional morphology, between novel words and familiar 'exceptional' or irregular words. One interpretation assumes that items of the two different types (novel words vs familiar exceptions) are processed by two separate mechanisms. The other assumes that all words are processed by the same integrated

multi-component system, but that various characteristics of the word types make them differentially vulnerable to damage to different components of the system. Both approaches can explain the double dissociation. I will outline reasons for preferring the integrated multi-component approach, which is embodied in the distributed developmental model of Seidenberg and McClelland and its successors, and consider whether the approaches can be distinguished empirically, drawing on recent accounts of inflectional morphology and word reading.

Basic processes in reading: Results requiring change in Coltheart and colleagues computational dual route cascaded model

Derek Besner

University of Waterloo, Canada

Abstract not yet available

Visual masking and/or release from masking can be feature specific

Angus Gellatly and Geoff Cole

Keele University

Enns & Di Lollo (2000) have recently described two new forms of visual masking in which a briefly presented target object that is clearly visible when presented alone becomes invisible when followed or accompanied by a second visual stimulus. In masking by object substitution, the target is followed by small objects that surround but do not touch it. In common onset masking, the target is surrounded by an object that onsets together with the target but remains on display after it has been turned off. Both these forms of masking are reported to be crucially dependent upon a broad distribution of attention. If attention is focussed on the target location masking is markedly reduced, or even eliminated. A similar reduction in masking occurs if the target differs from the masking object(s) and other potential target objects by a single pre-attentively detectable feature, which could summon spatial attention to the target location. [The latter finding is similar to an observation reported for metacontrast masking of an attended target by Werner (1935)]. Our experiments employed a combination of common onset and object substitution techniques to investigate whether masking of visual objects is all-or-none or feature specific. Target objects differed from all other display items along either the dimension of colour or orientation, and observers reported either the orientation or colour of the target. A distinctive feature of either kind improved reporting of either feature; however, there was greater release from masking when a distinctive feature matched the dimension to be reported than when it did not. Double distinctive features produced some degree of additivity.

Enns, J.T. & Di Lollo, V. (2000) What's new in visual masking? *Trends in Cognitive Science*, 4(9), 345- 352. Werner, H. (1935) Studies in contour. *American Journal of Psychology*, 47, 40-64.

Developing a new test of tactile selective attention: dihaptic tactile monitoring (DTM)

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Previous work on tactile selective attention has involved choice reaction times and response competition has been, therefore, a potentially confounding factor. In the DTM task, a tactile analogue of the dichotic listening task, response competition was reduced because a single response was used. Target (200 Hz) and Standard (40 Hz) vibrotactile stimuli were used and subjects were required to respond only to targets delivered to the attended hand. In each of three conditions, a sequence of 20% targets and 80% standards was presented to the attended hand. In a *unimanual* condition, stimuli were presented only to the attended hand and reaction times were faster and d' (sensitivity to targets) was larger than when stimuli were presented simultaneously to the unattended hand. RTs were faster and d' was larger in a *bimanual standard* condition, in which the unattended stimulus was always a standard, compared to a *bimanual distraction* condition, in which 20% of the unattended stimuli were targets. The effect did not differ significantly between the left and the right hands, nor between uncrossed and crossed arm postures.

Crossmodal integration of dynamic information

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In humans and other primates, the perception of an event in one sensory modality can be altered by conflicting sensory information presented in a different modality. For example, in the ventriloquist illusion, people typically mislocalize a sound toward a light when they are presented simultaneously from different locations, demonstrating crossmodal integration of perceived spatial location. Here, we show that auditory apparent motion, elicited by presenting sounds sequentially to different spatial locations, is automatically captured by concurrent visual apparent motion, demonstrating strong crossmodal integration of perceived dynamic information. Participants often reported hearing the sounds as moving in the same direction as the irrelevant lights even if lights and sounds moved in conflicting directions. In a series of experiments, we show that: (a) this motion capture phenomenon is tied to the dynamic attributes of objects rather than simply their spatial location or their coincidence in time; (b) it extrapolates to some but not all combinations of auditory, visual and tactile stimuli, thus describing a hierarchy of sensory dominance; and (c) it generalizes to real motion. Moreover, data obtained from a split-brain patient suggest that cortical areas are critical for this crossmodal integration of dynamic information.

Age, task-switching, and adaptation to novelty.

Jeff Nelson

The University of Western Australia

It is well known that advanced old age is accompanied by a reduction in executive abilities (eg. planning, inhibition, adaptation) The More/Odd Task, which involves speeded task-switching, was recently used to support the claim that age-related executive decline is a direct consequence of reduced information-processing speed. In the present experiment, the performance of two elderly samples (65-80 years; 80 to 95

years) on this task was compared. The initial analyses replicated Salthouse et al. in showing that the older group were slower and more error-prone than their younger counterparts. However, a closer inspection of the data revealed that the reaction-time disparity disappeared over the duration of the task and that there were qualitative differences in how the task was performed. A significant fatigue effect was detected in both samples. These results will be discussed in terms of adaptation to novelty, strategy application, information-processing speed, and fatigue. The conclusion brings the speed of processing explanation of senescent executive decline into question.

Time course of cortical attentional shifting and allocation of attentional resources in multi-element stimulus arrays.

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The steady-state visual evoked potential (SSVEP) - a nearly sinusoidal brain response elicited by a repetitive visual stimulus - can be used as a powerful tool to analyze temporal mechanisms of visual spatial attentional shifting on the cortical level. In addition, neural mechanisms, like facilitation and inhibition of spatial orienting can be investigated in multi-element stimulus arrays. In one of our studies, we have shown that shifting of attention to a peripheral stimulus cued by an endogenous attention direction cue is a rather slow cortical process which lasts up to 600 ms. In addition, we found no sign of an inhibition of the SSVEP to the unattended stimuli. Furthermore, we investigated the time course of attentional shifting to an exogenous cue, which is hypothesized to trigger a much faster shifting of attention. We found no difference in the shifting time between an endogenous and exogenous cue. In a last experiment we studied whether or not the beam of the attentional spotlight can have an annular shape, ignoring information presented in the center of the beam. Clear evidence was found that information in the center of the beam is processed differentially when ignored, suggesting that the beam must have been shaped like a donut.

ERP correlates of executive control in language-switching

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Efficient selection of a particular response when switching between tasks appears to involve the suppression of alternative modes of response, particularly when those alternatives are more habitual. Such suppression appears to be highly dependent upon the integrity of the prefrontal cortex, yet other cortical areas are probably also necessary to implement response switching. For example, functional brain imaging studies have demonstrated parietal cortex activation during repeated language switching during translation. We recorded dense-sensor EEG whilst bilingual subjects named digits in either their first or second language. The appropriate task (language) was signalled by the digits' colour. A single language was used consistently throughout 'pure' blocks; language switches occurred on every second trial within 'mixed' blocks. Stimulus duration was 1000msec on 50% of trials and 250msec on the remaining 50%. Responses were required at stimulus offset; thus, long stimulus duration trials allowed measurement of ERPs during stimulus and response processing to be free of movement

artefact. ERP components were found over frontal and parietal areas consistent with activation of the less habitual task, whether in pure or mixed blocks. Switch-specific effects were evident over both parietal and frontal cortices and importantly showed asymmetry across (first or second) languages. Correspondence with a frontal ERP component found when suppressing manual responding in a go/no-go reaction time task may imply similar inhibitory mechanisms are involved for both task- and response-suppression.

Visual extinction following bilateral stimulation: The importance of interhemispheric timing.

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Visual extinction is classically displayed when stimuli are applied to both visual fields at the same time. The question arises as to what temporal relation of stimuli in the two fields will lead to the greatest level of extinction. Different theories of extinction would make different predictions. For example, token individuation theories (e.g., Baylis et al, 1993) would predict greatest extinction at exact simultaneity; in contrast, disengagement theories (e.g., Posner et al, 1984) predict that greatest extinction would be seen when contralesional items are presented before ipsilesional. Typically we find that extinction is maximal when stimuli are exactly simultaneous. We show that close temporal proximity is also important in an extinction-like phenomenon in normal subjects. However, the requirement for simultaneity in the two hemifields may depend on the stimuli being equally likely to occur first in either hemisphere. As a result, maximal extinction may not always be found at exact simultaneity if stimuli are more likely to occur earlier in one hemifield. These results suggest that visual extinction must occur at a relatively late stage in processing.

Baylis GC, Driver J, Rafal R. (1993) Visual extinction and stimulus repetition. *Journal of Cognitive Neuroscience*, 5:453-466. Posner MI, Walker JA, Friedrich FJ, Rafal R. (1984) Effects of parietal injury on covert orienting of visual attention. *Journal of Neuroscience*, 4:1863-1874.

Mental representations in representational neglect

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In most investigations of representational neglect, patients are asked to report information derived from long-term visual knowledge. In contrast, studies of perceptual neglect involve reporting the contents of relatively novel scenes in the immediate environment. The present study aimed to establish how representational neglect might affect immediate recall of (a) recently perceived, novel visual layouts, (b) novel layouts presented only as auditory verbal descriptions, and (c) recently perceived novel layouts from the opposite imagined perspective. These conditions were contrasted with reports from visual perception and a test of immediate oral recall of verbal material. Data were

obtained from 11 hemi-neglect patients (9 with representational neglect), 6 right hemisphere lesion control patients with no evidence of neglect, and 15 healthy controls. Patients with representational neglect showed lateralised errors in recall from a recently perceived scene and from a verbally described scene. When recalling from the imagined opposite perspective, items on the imagined left (presented on the right) were recalled poorly, and at a level that would have been obtained if the items had actually been presented on the left. Verbal memory ability did not differ between patients and controls. Overall, the results indicate that representational neglect does not depend on the presence of perceptual neglect, that visual perception and visual mental representations are less closely linked than has been thought hitherto, and that visuo-spatial mental representations in both the healthy and the damaged brain have similar functional characteristics whether they are derived from perception or from auditory linguistic descriptive inputs.

How features determine concept categorisation: A computational model of semantic knowledge

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This paper presents a computational model of semantic memory, trained with behaviourally realistic vectors. The results are consistent with the *conceptual structure account* (Tyler, Moss, Durrant-Peatfield & Levy, 2000), which claims that concepts can be understood, and the effects of random damage predicted, based on (i) the number of correlations among features, and (ii) the distinctiveness of those correlated features; the former indicating category membership, the latter distinguishing between concepts. The model shows a changing direction of domain-specific deficits as damage accumulates (living concepts lost first, then objects upon severe lesioning). Also, the pattern of error differs between domains; living things tend to be confused with other members of the same category, whilst object errors disperse more widely across categories and domains. Recent neuropsychological evidence demonstrates a similar pattern for semantically impaired patients. For both patients and the model, this can be attributed to the timing of featural loss: distinctive features are lost earlier than shared features. The model demonstrates that the relative timing of feature loss differs between domains, resulting in the emergence of domain-specific effects.

Tyler, L.K., Moss, H.E., Durrant-Peatfield, M. & Levy, J.P. (2000). Conceptual structure and the structure of concepts. *Brain and Language*, 75.2, 195-231.

Effects of left frontal lesions on the selection of context appropriate meanings

Claudia Metzler (Introduced by Roland Baddeley)

University of Manchester

The present study examined the role of the left frontal cortex in strategic aspects of semantic processing. Participants were tested in a semantic priming task involving the meaning access of ambiguous and unambiguous words. Patients with left or bilateral

frontal lesions failed to develop semantic facilitation of context-appropriate homograph meanings relative to age-matched controls and patients with right frontal lesions who produced more facilitation than the controls. When the ambiguous words, however, were replaced by unambiguous words, the patients with left frontal lesions improved to normal levels of semantic priming. This pattern of results is difficult to explain in terms of a problem to access semantic *information per se* or in the use of contextual cues. The findings are, however, consistent with a deficit in selecting context-appropriate meanings in the presence of competing meanings.

Positive mood and executive function: evidence from fluency and Stroop tasks.

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Aberdeen University

Contrasting predictions have been made about the effects of positive mood states on the performance of 'frontal lobe tests' which tap executive functions such as inhibition, switching and strategy use. It has been argued that positive mood is likely to improve most cognitive processes, particularly those dependent on the frontal cortex and anterior cingulate of the brain (Ashby, Isen & Turken, 1999). However there is some experimental evidence that happy mood may impair executive functioning (e.g. Oaksford, Morris, Grainger & Williams, 1996). The current experiments investigated the effects of positive mood on fluency and Stroop tests, which are frequently used to assess executive function. Positive mood improved performance on letter fluency and the novel uses test of fluency while impairing performance on an alternating fluency task. On the Stroop task, positive mood impaired performance on colour-ink naming and alternating conditions. The effect of positive mood on an executive task may therefore depend on whether a task is impaired by diffuse semantic activation.

Ashby, F.G., Isen, A.M., & Turken, U. (1999). A neuropsychological theory of positive affect and its influence on cognition, *Psychological Review*, 106, 529-550. Oaksford, M., Morris, F., Grainger, B., & Williams, J. M. G. (1996). Mood, reasoning, and central executive processes. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 22, 477-493.

Understanding quantity information in messages about contraceptive effectiveness

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This paper looks at the understanding of quantity information in a natural setting – in conveying information about the reliability of contraceptive methods. A survey of 300 women attending a family planning clinic shows that women do not interpret percentage statements appropriately, omitting the time period over which the risk is taken from their calculations. Nevertheless, participants report with reasonable accuracy the reliability of several common methods of contraception. Furthermore the study suggests that reliability estimates for these methods are influenced not only by the quantity information from literature presented to women in clinics, but also by the amount of knowledge the women have about the particular method. It was hypothesised that percentage information may be integrated more effectively into some models of contraception than

others. While the study suggested at least two distinct models of how the combined pill works, there was no apparent effect of the particular model held on participants' beliefs about reliability. The paper concludes that estimates of risk are influenced by percentage messages and that this is integrated to some extent with our existing knowledge of the risk situation. However we have only a crude understanding of the quantity associated with the risk itself.

Using "change blindness" to investigate face familiarisation.

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A typical experiment from the change detection literature demonstrates that when an aspect of a visual image is altered, observers find the change difficult to detect. More recent studies report that "expert knowledge" about the object that is changed significantly reduced the time taken to detect a change made to that class of objects. The process of facial familiarisation might be analogous to accumulation of expert knowledge, and here we investigate this possibility by using a change detection paradigm to explore the features encoded in face familiarisation.

We present two experiments which show firstly that personal familiarity with a set of faces reduces relative blindness, and secondly that different facial feature "changes" produced different levels of relative blindness. We account for these results by arguing that depth of encoding and relative blindness are negatively related.

Four heads are better than one. Combining face composites yields improvements in face likeness.

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Participants attempted to construct faces of unfamiliar (Expts 1 and 2) and famous people (Expt 1), with reference images present (Expt 1), or from memory (Expts 1 and 2), using the electronic face composite system PRO-Fit. Four different composites were constructed for each target face. The "average" of all four composites, created by morphing (4-Morph) was rated as a better likeness than the individual likenesses on average. The 4-Morphs also appeared to be as good as the best individual likeness of each face. When participants attempted to identify which face from a six item line-up the composite represented, the 4-morphs again performed as well as the best individual face. In Experiment 2, when participants familiar with the four women targets attempted to identify them, there was a trend showing better recognition from multiple composites (whether combined or not) rather than individual ones. Overall rates of identification were low, however. These results have practical implications for the way in which evidence from different witnesses is used in police investigations.

The space-man cometh or Simple visual reaction time to lateralised sinusoidal gratings

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Studies of hemispheric asymmetry in visual detection reaction time (RT) paradigms using simple stimuli, have shown little or no asymmetry. This is consistent with the anatomical symmetry of visual input pathways (retino-striate projections), and the lack of attentional involvement in simple detection tasks. In most studies, however, only a limited range of stimuli were used. There is cause, therefore, to examine a much wider range of stimulus variables, to confirm the absence of functional asymmetry, and further to examine stimulus-RT relationships with respect to neuroanatomical and neurophysiological properties of the visual input pathways.

We varied the contrast, spatial frequency, luminance, eccentricity, and visual field, of sinusoidal grating stimuli presented to two subjects, and derived a linear coefficient relating contrast level and RT. This coefficient correlated with anatomical and physiological properties of visual input pathways in man and other animals, and offered distinct advantages over using raw RTs. Plotting the coefficient against eccentricity for different spatial frequencies and luminances produced a '*Space-Ship*' graph, which illuminated further pathway properties. Perceptual-motor hemispheric asymmetries, inter-stimulus, and inter-subject variability were found for raw RTs, but not for the linear coefficient. The derived measure better reflects early visual processing than raw RT data.

"..begins with a single step". Modular unification of timing tasks

J H Wearden

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Over the last decade, the use of procedures and theoretical models derived from scalar timing theory (SET) has revolutionized many aspects of time Psychology in humans, and has breathed new life into the venerable idea that the basis of at least some time judgements in humans is the output of an internal clock. Simple theoretical models derived from SET fit data from many timing tasks, including apparently complicated procedures like categorical timing (Wearden, 1995), where people make judgements of up to 36 different duration values. In contrast, theoretical models of the "classical trio" of timing tasks widely used in the non-SET-based timing literature, *verbal estimation, production, and reproduction*, are lacking. Some of the data from a study of the performance of 80+ subjects on 7 different timing tasks will be presented, and results suggest that different tasks are composed of different selections of "modules", of which there may be a dozen or more. To investigate this modular structure in a simpler way, data were obtained on verbal estimation, production, and reproduction of the same durations, and a theoretical model of temporal reproduction was developed. This model was consistent with SET-like representations of time and SET-like decision processes, so began the process of linking classical timing tasks to those based on SET. Reproduction data from a number of studies showed an effect similar to the classical Vierordt's Law (shorter durations are "overestimated" relative to longer ones) but the model showed that this behaviour could be consistent with SET-consistent veridical representations of time.

Wearden, J.H. (1995). Categorical scaling of stimulus duration by humans. *Journal of*

Twenty-ninth Bartlett Lecture

Semantic memory: A parallel distributed processing approach

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How do people acquire, represent, and process the information that allows them to perform semantic tasks? I argue that the semantic system exploits graded, distributed representations that emerge as a simple learning mechanism assimilates the structure of the environment from experience. On this view, learned similarities among object representations constrain how knowledge generalizes, how easily it is acquired, how quickly it can be accessed, and how it degrades in dementia. These points are illustrated in a simple feed-forward model that learns relationships between items and the properties they exhibit in different contexts. Computer simulations with the model show that it can account for a broad range of disparate phenomena, including progressive differentiation of conceptual knowledge in development, progressive de-differentiation in semantic dementia, basic-level primacy, over-extension of frequent concepts, expertise effects, and findings that have been used to advance the notion that conceptual knowledge takes the form of domain-specific theories.

Localist and distributed models: A developmental perspective

Kim Plunkett

Oxford University

Both localist connectionist and parallel distributed processing systems have an important role to play in the modelling of cognitive processes. The advantage of localist representations is that they provide a straightforward mechanism for capturing the possibility that a system may be able to entertain multiple propositions, each with different strength, and that the process of resolving uncertainty may be thought of as a constraint satisfaction problem, in which many different pieces of information interact. Localist representations are also useful when the modeller has prior knowledge about the system and wishes to design the model to reflect that knowledge in a straightforward way. The Interactive Activation model of word recognition and the TRACE model of speech perception are examples of models which use localist representations. In many cases, however, the modeller may have only limited prior knowledge about the system and the target of the modelling endeavour is to understand how certain types of knowledge can emerge from a limited set of prior assumptions. This is particularly true in the application of connectionism to developmental issues where emergentism is a prevalent phenomenon. In these cases, distributed connectionist models have proved an invaluable tool for studying linguistic and cognitive development, while localist models have remained quite silent.

Modelling attention in a quasi-modular, interactive system: The SAIM model

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The control of visual attention in the brain is likely based on a network of interacting neural areas, with lesions to different regions of the network generating different forms of attentional disorder. We have modelled this in SAIM (Selective Attention and Identification Model), which uses quasi-modular but interactive processing modules to achieve selective, translation invariant object recognition. We show how this approach can simulate contrasting problems within the syndrome of unilateral neglect. We suggest that the tractable architecture of the model enables us to understand the pattern of breakdown within neglect as reflecting deficits of particular forms of computation. Possible limitations in scaling-up and in learning representations are discussed.

What we learn from connectionist modelling in psychology: The case of visual word recognition.

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The application of connectionist modelling to the study of visual word recognition is examined with reference to two of the most influential papers on the topic over the last 25 years (McClelland & Rumelhart, 1981; Seidenberg & McClelland, 1989). This allows a seemingly straightforward comparison of the use of localist versus distributed representations in connectionist modelling, although the comparison is complicated by subtle differences in the domains of application of these two models. Preference for one or the other approach appears to be partly determined by whether it is learning or performance that is at stake. I suggest some reasons for preferring a localist approach when human performance is to be explained, and illustrate these with simulation studies run on recent variants of a localist interactive-activation model.

Sparse distributed representations in perceptual and memory systems in the brain.

Edmund Rolls

University of Oxford

Much of the information in the responses of single neurons in the primate temporal visual cortex about which visual stimulus has been seen is contained in the firing rate of the neurons, and is available in periods of the firing as short as 50 or even 20 ms (Rolls & Treves, 1998). The information theoretic approach has been extended for application to the activity of the responses of many neurons to a set of stimuli, and it has been shown that the information (for example about which object has been shown) rises approximately linearly with the number of neurons in the population. This means that the encoding is distributed, that the information provided by different neurons is almost independent (with a large stimulus set), and that the number of stimuli that can be encoded increases exponentially with the number of neurons in the population. This property is seen even with neurally plausible, dot product, decoding. The implication is that the code can be read off from this part of the visual system (and from the hippocampus where the information is about spatial view; and from the orbitofrontal cortex where the information is about odour) just by measuring the firing rates of small populations of neurons. Little information is added by knowing the relative time of firing

of the different neurons in a population of inferior temporal cortex neurons, that is, synchronization of firing is not an important factor in conveying information in these neurons. These experiments provide evidence that there is an object-based representation of objects, as well as faces, in the primate temporal cortical visual areas. This may be a representation of 3D objects based on learning about the 2D views of each object (Rolls & Deco, 2002).

Rolls, E.T. and Treves, A. (1998) *Neural Networks and Brain Function*. Oxford University Press. Rolls, E.T. and Deco, G. (2002) *Computational Neuroscience of Vision*. Oxford University Press.

Discovering representations

David C Plaut

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Computational modeling, including connectionist/neural network modeling, can serve a number of useful roles in the development of theories of cognitive processes. For many of these roles, including verifying the internal coherence of theoretical claims and generating precise, quantitative predictions, the specific choice of formalism is relatively unimportant and is driven largely by ease of implementation and clarity of communication. Models employing "localist" representations, in which processing units correspond to meaningful entities, have been highly effective in this regard. In other contexts, however, the choice of formalism plays a critical role in theory development. A case in point concerns investigations of the nature of cortical representations themselves---how cortical areas learn to represent and process relevant information in carrying out complex cognitive tasks. Here, rather than stipulate a specific form of internal representation in advance, it is more informative to stipulate the tasks that such representations must support, and allow these task demands, in concert with general computational principles, to give rise to appropriate representations. The structure of the tasks will then determine whether the representations become localist-like or more distributed in character. The effectiveness of this approach is illustrated in the context of a system that develops a graded degree of modality-specific functional specialization within semantic/conceptual representations.

What counts as a model?

Mike Burton

University of Glasgow

Disputes about the formal properties of distributed and local connectionist models are generally accompanied by arguments about the utility of these classes of models in psychological theorising. However, there is no conventional way to evaluate models in psychology. Often one relies on authors' descriptions of a model's behaviour, along with intuitions about whether the claims seem reasonable. This contrasts strongly with the established mechanisms for evaluating empirical research, which demand conventional styles of reporting, and enough information to replicate experimental procedures. In this paper I will review some arguments, ancient and modern, about what constitutes a model. I will argue that localist and distributed systems (as psychological models) differ

not only in convenience of representation, but also in their potential to be accountable.

Two forms of representation in spatial short-term memory: Evidence from location change detection

Kevin Dent and Mary M Smyth
Lancaster University

This study explores the possibility that there exist different types of representation in spatial short-term memory. It was hypothesised that memory for small numbers of locations, three or less, makes use of a limited set of pointers which refer to perceptually defined locations, while memory for larger sets of locations depends on a relational description of the whole set. Participants viewed an array of three or six locations presented within a surrounding frame, after a brief interval they decided whether a target dot occupied an old or a new location. The frame surrounding the array was either present or absent during the interval, non-target context locations were either present or absent at recall and presentation time was either 750 ms or 1500 ms. The results showed that the absence of the surrounding frame in the interval impaired performance with three but not six items. Importantly however the frame effect was modulated by the presence of non-target context at recall. The presence of context eliminates the effect of frame but only given a longer presentation time or six items. These results are consistent with the hypothesis of two forms of representation in spatial short-term memory: i) a pointer system which dominates memory for small sets of locations and is disrupted by the removal of the pointer referent during maintenance, ii) a relational representation which dominates memory for larger sets of locations and is disrupted by the removal of non-target context at recall.

The role of oculomotor control during the maintenance of location in spatial short-term memory

David G Pearson and Arash Sahraie
University of Aberdeen

The Corsi blocks procedure (De Renzi & Nichelli, 1975) has been widely adopted as a measure of spatial short-term memory in both experimental and applied settings, but the nature of the cognitive mechanisms employed by participants to encode and maintain spatial information during the task remain unclear. Early research on spatial short-term memory suggested that eye movements might play an important role during the maintenance of location (e.g., Baddeley, 1986), but more recently it has been argued that spatial rehearsal is based either on shifts in spatial attention (Smyth & Scholey, 1994), or else involves much more generalised attentional resources (Klauer & Stegmaier, 1997). A series of experiments will be reported which have examined the effect of a range of secondary tasks on Corsi span, including continuous and saccadic eye movements, attention shifts without eye movements, concurrent hand movements, saccadic eye movements without visual input, concurrent articulatory suppression, and dynamic visual noise. In all conditions participants eye movements were monitored using EOGs. On the basis of the results of these experiments it will be argued that current theories of rehearsal in spatial short-term memory may have underestimated the importance of cognitive systems related to oculomotor control.

Undefined variance in experimental data: Evidence against the Gaussian Hypothesis

Richard A Heath

University of Sunderland

The conventional methodology for analysing experimental data assumes that residuals derived from the general linear model are independent samples from a Gaussian distribution with finite mean and variance. This distribution cannot handle data, such as response time (RT), that exhibit both skew and outliers. Rather than search for data transformations, such as the logarithmic or reciprocal, that might satisfy a Gaussian assumption, an analysis using a stable stochastic process was computed. Such a process contains two additional estimable parameters the stability, α ($0 < \alpha \leq 2$), and skew, β ($-1 \leq \beta \leq +1$) in addition to location (mean) and scale (standard deviation) parameters. Stable distributions were fit to four-choice RT data, as well as inter-keypress time (IKT) in a typing task, using a maximum likelihood estimation procedure. The stable distributions generally fit the data quite accurately, even when outliers were retained. In almost every case the distributions were positively skewed and the stability parameter, α , was greater than one but less than two. This result implies that the theoretical distribution contains a finite mean but the variance is not defined, since the largest finite integer moment must not exceed α . The relationship between these parameter estimates and nonlinear dynamical models for RT is described.

Comparing contours across surfaces and across apertures.

Marco Bertamini and Camilla J Croucher

University of Liverpool

In a detection task the type of symmetry to be detected (reflection vs. translation) interacts with closure (within-object vs. between-objects). If the effect of closure on detection of reflectional symmetry can be explained as a general within-object advantage, the advantage for open contours found with translation is an exception, which has been described as a jigsaw or lock-and-key process. We report a series of experiments that tested a different type of symmetry: centric or rotational symmetry. The findings are: (a) the lack of a within-object advantage is common to both translation and rotation; (b) the within-object condition was slower than the between-object condition but slower also than a baseline condition with no closure; (c) what was described originally as a between-object advantage is instead better described as an aperture advantage (because the number of objects present is not important); (d) participants' awareness of using a lock-and-key strategy did not affect performance. We suggest that the most promising interpretation is that the effect is linked to an obligatory assignment of a representation based on polarity for closed contours.

Evidence for a primitive acoustic sense in humans

Neil P McAngus Todd

University of Manchester

The conventional view in auditory science is that whatever the role of the otolith organs in lower vertebrates, in mammals hearing is mediated entirely by the cochlea. Evidence accumulated over the last few decades, though, supports the case that the sacculus has

conserved an acoustic sensitivity throughout vertebrate phylogeny (Todd et al. 2000; Todd and Cody, 2000). The question remains, however, whether saccular acoustic sensitivity in humans has any perceptual or behavioural significance. One way in which this may be tackled is by looking for any evidence of a change in the pattern of frequency or intensity discrimination in the region of saccular sensitivity. However, in practise it would prove very difficult in humans to dissociate any specifically saccular contribution from cochlear input to discrimination, even in profoundly deaf subjects. An alternative approach is to look for a change in the quality of sensation above the saccular threshold (Todd, in press). The results of such an experiment are reported here.

10 human subjects were stimulated monaurally with 100 ms trains of 10 ms tone pulses with pulse repetition rate of 40 Hz, and were required to rate the pleasantness of the stimuli on a 9 point scale. The design included three within-subject factors: carrier frequency (two levels, 200 Hz and 4,000 Hz) intensity (13 levels from 55 - 115 dB(A) in 5 dB steps) and ear (left and right). For intensities above 90 dB myogenic vestibular evoked potentials (MVEP) were also obtained from the ipsilateral sternocleidomastoid muscle from which it was possible to obtain saccular acoustic thresholds by linear regression of MVEP amplitudes against intensity. A further between-subjects factor was added which assessed subjects' attitude to vestibular sensations. The results indicate that across subjects there is a general trend of decreasing pleasantness with increasing intensity, but for the 200 Hz condition there is a significant positive departure from monotonicity in pleasantness ($p < 0.05$) above the mean saccular threshold. However, when split by the between-subjects factor the positive departure was only evident for those subjects who have a positive attitude to vestibular sensations ($p < 0.01$). Implications of these results for human responses to loud sound and the possible evolutionary significance of saccular acoustic sensitivity are discussed.

Todd, N.P.McAngus and Cody, F. (2000) Vestibular responses to loud dance music: A physiological basis for the "rock and roll threshold"? *Journal of the Acoustical Society of America*. 107(1), 496-500.

Todd, N.P.McAngus, Cody, F. and Banks, J. (2000) A saccular origin of frequency tuning in myogenic vestibular evoked potentials?:

Implications for human responses to loud sounds. *Hearing Research*. 141, 180-188.

Todd, N.P.McAngus (in press) Evidence for a behavioural significance of saccular acoustic sensitivity in humans. *Journal of the Acoustical Society of America*.

The relationship between age, intelligence, and stimulus response compatibility in a sample of children and elderly adults

Mike Anderson¹, Ted Nettelbeck² and Patrick Rabbitt³

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2. Adelaide University

3. Age and Cognitive Performance Research Centre, University of Manchester

Two experiments were conducted with the aim of (1) extending recent work on the relationship between speed of information processing and intellectual development in children; and (2) comparing directly any developmental effects in children with developmental effects in a sample of elderly adults. The first experiment looked at the

effect of information load and S-R compatibility on the decision times (DTs) and movement times (MTs) of 33 seven-year-olds and 28 eleven-year-olds children in Western Australia. As predicted, younger children were more adversely affected than older children by lowering compatibility. The patterns of children's DT data were consistent with the hypothesis that age-related improvement in response selection, not processing speed, is responsible for faster decision times during childhood development. The second experiment looked at the same variables in 60 elderly participants (23 men and 37 women) who were recruited from the panel at the University of Manchester's Age and Cognitive Performance Research Centre. The patterns of results from the children in the first experiment and from the elderly adults in the second were quite different. The most obvious difference was the absence of any age-related effect on the DTs of the elderly - instead there was a large effect on MTs. It is likely that this different pattern of results reflects differences in strategies between children and the elderly. Implications for understanding the relationship between age and intelligence in children and elderly adults will be discussed.

Real-time suppression of background noise for television broadcasts: The impact on elderly viewers.

Alex R Carmichael

Age and Cognitive Performance Research Centre, University of Manchester

This paper presents data from an applied project, set up with the aim of enhancing primary dialogue, narration etc. in relation to background 'noise' at the reception end of the digital television broadcast chain. A variety of 'audio engineering' and 'digital processing' approaches to this problem have been developed and their effectiveness tested with a sample of elderly volunteers. A group of volunteers aged between 64 and 83 years each underwent test sessions with 'processed' material, and a 'baseline'. Each version was tested with both objective and subjective measures. The objective measure was the Revised SPIN (SPeech In Noise) Test (Bilger, 1984) incorporating a 'twelve speaker babble' as background 'noise' (+6Db S/N). Other measures taken were the HHIE (Hearing Handicap Inventory for the Elderly; Ventry & Weinstein, 1982), and simple subjective ratings regarding the 'clarity' and 'pleasantness' of the different material. The volunteer group has also provided pure tone audiograms and (as part of a longitudinal study on cognitive ageing currently running in our centre) various measures of cognitive ability such as vocabulary and 'IQ' score. The results are discussed in terms of the complex interrelationships which emerge between these disparate measures and in relation to the apparent limitations of 'digital signal processing' approaches for real-time suppression of background 'noise'.

Investigation of candidate genes for cognitive decline in older adults

Neil Pendleton

Department of Geriatric Medicine, University of Manchester

Although, a genetic component to cognitive decline and dementia in older adults had extensive literature support, the candidates for the genes responsible are still unknown. In later onset dementia, the apolipoprotein E gene has been implicated in a number of publications for development of this disorder. In addition to this there have been

publications in a number of studies implicating the apolipoprotein E4 genotype with an increased risk of cognitive decline in healthy older adults. We have examined the relationship between apolipoprotein genotype and intelligence test performance in the Age and Cognitive Performance Research Centre volunteer group. The relationship apolipoprotein genotype and intelligence test scores are examined both in cross-sectional and longitudinal analyses using models developed by this group. In addition, the same process is applied to the genetics of a lysosomal proteinase that processes amyloid and other proteins. The results are explained in the context of the biological plausibility of these genes having an effect on the rate of decline in intelligence test scores with time.

Detection and analysis of "abnormal" memory in a "normal" aged population

Christine Lowe and Patrick Rabbitt

Age and Cognitive Performance Research Centre, University of Manchester

Data from a 17 year longitudinal study of cognitive ageing were analysed using random effects modelling to identify 65 "memory impaired" (MI) individuals whose scores on memory tests had declined markedly more rapidly than their IQ scores. The 65 MI individuals and 65 age and sex matched controls completed a further battery of 13 memory, and 3 "processing speed" tests and the self-reported health, Cornell Medical Index (CMI). The MIs and control group differed significantly on all 'expected' memory measures but not on measures of speed or health. Thus neither markers of global cognitive change nor "disease burden" can mediate these abnormally rapid changes in memory. Between-measure correlations will also be presented along with a possible theoretical conclusion.

Global and modular models of cognitive ageing.

Patrick Rabbitt

Age and Cognitive Performance Research Centre, University of Manchester

In a sample of 6400 older community residents studied for 18 years the most informative changes were not age-related declines in average cognitive abilities but rather in variability of performance within and between individuals and tasks. These are only exposed when ways are found to identify and allow for effects of drop-out, and of improvement due to repeated testing. Smaller studies of longitudinal changes in performance on neuropsychological tests on groups of 100 to 300 individuals also indicate increasing variability, with age, between individuals in their profiles of performance across different cognitive abilities, notably those held to require frontal and temporal lobe integrity. Analysis of drop-out effects suggests a model for the increasing incidence of these changes in an ageing population.

Local Information

Accommodation

Accommodation (single rooms, ensuite or shared facilities) has been reserved in Ashburne Hall, Old Hall Lane, Fallowfield, Manchester, M14 6HP. Alternative accommodation is shown below, and should be booked directly with the hotel or guest

house. Reservations for Ashburne Hall can be made on the enclosed booking form, which should be returned to Pip Brown, Age and Cognitive Performance Research Unit, Zochonis Building, University of Manchester, Oxford Road, Manchester. M13 9PL (Tel: 0161 275 7348) before Monday 25 June, 2001.

Hotels & Guest Houses:

Willow Bank Hotel, 340-342 Wilmslow Road, Fallowfield, Manchester, Tel: 0161 224 0461. Email: willowbankhotel@feathers.uk.com . Ensuite room £59.95 including VAT. NB Please state when booking that this is the quoted special rate for a University of Manchester event.

For other accommodation try website - <http://www.visitmanchester.org.uk/>

For general information about the Manchester area, see the website - www.manchester.com.

Messages

Messages for those attending the meeting can be sent via – Ashburne Hall, Old Hall Lane, Fallowfield, Manchester, M14 6HP. Tel: 0161 224 2835

Email: Ashburne.Hall@man.ac.uk .

Access

From M60 motorway (East)

Leave M60 at Junction 7 signposted Manchester/Altrincham/Sale. Follow A56 Chester Road towards Manchester centre $\frac{3}{4}$ mile. Then turn right at traffic lights into A6010 Wilbraham Road, signposted Chorlton. Carry on for $2\frac{1}{2}$ miles to Wilmslow Road. Signs for Fallowfield Campus then show directions to Ashburne Hall.

From M56 motorway

At Junction 3 of the M56, continue towards Manchester along A5103 Princess Parkway/Princess Road for 3 miles, turn right at traffic lights into Wilbraham Road A6010 signed (MCFC/Sheffield/Ashton-under-Lyne). Fallowfield Campus signs show the directions to Ashburne Hall.

From M67 motorway

Follow M67 west from Mottram, onto A57 signposted Manchester. After about 2 miles turn left at traffic lights into Mount Road, then second right into Stanley Grove. After $\frac{3}{4}$ mile cross over A6 into Dickenson Road A6010. Then after $\frac{1}{2}$ mile left into Birchfields Road A34, then after $\frac{1}{2}$ mile turn right into Old Hall Lane and pick up the Fallowfield Campus signs with directions to Ashburne Hall.

Rail and Bus

British Rail main line services to Piccadilly Station, Victoria Station and Mauldeth Road Station. Bus routes from the City Centre and main stations, all the 40's (except 47), W2 and 143 then alight at Owens Park, Fallowfield. Taxis, available outside all Stations and from the City Centre, cost approximately £2.50-£5.

Airport

Manchester is an international airport. Taxi costs approximately £12-£15. Alternatively a

number 44 bus, then alight at Owens Park, Fallowfield.

Parking

There is parking for around 12 cars at Ashburne Hall. On arrival press intercom at barrier and you will be told if space is available. There is additional on-road parking in Old Hall Lane (see map for details) or left out of Ashburne Hall onto Wilmslow Road and first left into Mosely Road, left into Chancellor's Way to the Armitage Centre car park (free parking).

Eating and drinking

Lunch

Turn left out of the main entrance of Ashburne Hall and there are a number of cafes and pubs in Wilmslow Road

Pubs and bars with lunchtime and evening food

Karma, 310 Wilmslow Road

Something Blu, 317 Wilmslow Road

The Queen of Hearts, 256 Wilmslow Road

Orange Grove, 304 Wilmslow Road

The Friendship Inn, 353 Wilmslow Road

Other Restaurants

Turning right out of Ashburne Hall takes you to the 'Curry Mile' – numerous Indian restaurants. A few to choose from below.

Shere Khan, 52 Wilmslow Road

Tandoori Kitchen, 131-133 Wilmslow Road

Hanan, 54 Wilmslow Road

OR

Kosmos Taverna, 248 Wilmslow Road (Greek, recommended)

From the main entrance of Ashburne Hall, a 10 minute trip by most northbound buses in Wilmslow Road will take you to the City Centre – for restaurants see website www.manchester.com

Most southbound buses in Wilmslow Road will take you to Didsbury Village (10 minutes) for a selection of nice pubs and restaurants.

Conference Dinner

This will be a Chinese Banquet, held at the Yang Sing, 34 Princess Street, Manchester. Please book, and indicate any dietary requirements, on the enclosed form which should be returned to Pip Brown, Age and Cognitive Performance Research Unit, Zochonis Building, University of Manchester, Oxford Road, Manchester. M13 9PL (Tel: 0161 275 7348) before Monday, 25 June, 2001.