INTERNATIONAL MULTISENSORY RESEARCH FORUM

7th Annual Meeting
June 18-21, 2006
Trinity College Dublin, Ireland

Meeting programme

International Multisensory Research Forum

IMRF 2006

Conference Committee

Fiona Newell (Chair)
Trinity College Dublin

David Alais
University of Sydney

Jason Chan
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Max Planck Institute for Biological Cybernetics

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University of California, Los Angeles

Stuart Smith
University College Dublin

Salvador Soto-Faraco
University of Barcelona, Spain

Charles Spence
University of Oxford, UK

Sponsors: Fáilte Ireland

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General Information

VENUE AND MEETING ROOMS
The conference will open with a wine reception on Saturday, 17th June in the Atrium in Trinity College. The meeting will be held in the Hamilton Building of Trinity College Dublin. Oral presentations will be held in the McNeill theatre on the ground floor and poster presentations will be held in the foyer of the lower ground floor.

HOSPITALITY
An opening reception will be held between 7.00pm and 9.00pm on Saturday, 17th June in the Atrium. A buffet lunch will be held on Sunday, 18th June in the Dining Hall on campus. The conference dinner will take place in the Royal Hospital Kilmainham on Tuesday, 20th June. Buses will leave from outside Trinity College at 7.15pm sharp. Exact details of departure will be announced during the meeting. Coffee/tea are provided and breaks are scheduled between the talk sessions (see programme for further details). For security and access to the meeting and hospitality, please wear your name badge.

REGISTRATION AND CONFERENCE MATERIALS PICK-UP
Delegates can register and pick up their conference materials at the opening reception on Saturday, 17th June. We will also have a registration desk located in the main entrance to the Hamilton Building on Sunday, 18th June from 8.00am until 6.00pm.

INSTRUCTIONS FOR TALK PRESENTERS
All talks (including Graduate symposium) will be 15 minutes with 5 minutes for questions. Talks for organized symposia will be 25 minutes long with 5 minutes for questions. The theatre is fully equipped with AV facilities, an overhead projector, radio mic and PC and Macintosh computers. We kindly ask that all presenters download and check their presentations before the beginning of their session. Presenters may use their own laptops but please have a copy of your talk on a CD or USB memory stick. We ask presenters wishing to use any other kind of equipment during their talk to contact the organizers as soon as possible.

INSTRUCTIONS FOR POSTER PRESENTERS
There will be two main posters sessions of 3 hours each. The poster space will be open at all times during the conference. Each poster session is divided into 2 separate time slots and poster presenters will be required to present during one of these times as follows:

<u>Poster session 1</u>

Sunday, 4.00pm-5.30pm:	Presentation of odd numbered posters ONLY
Monday, 10.00am -11.30am:	Presentation of even numbered posters ONLY

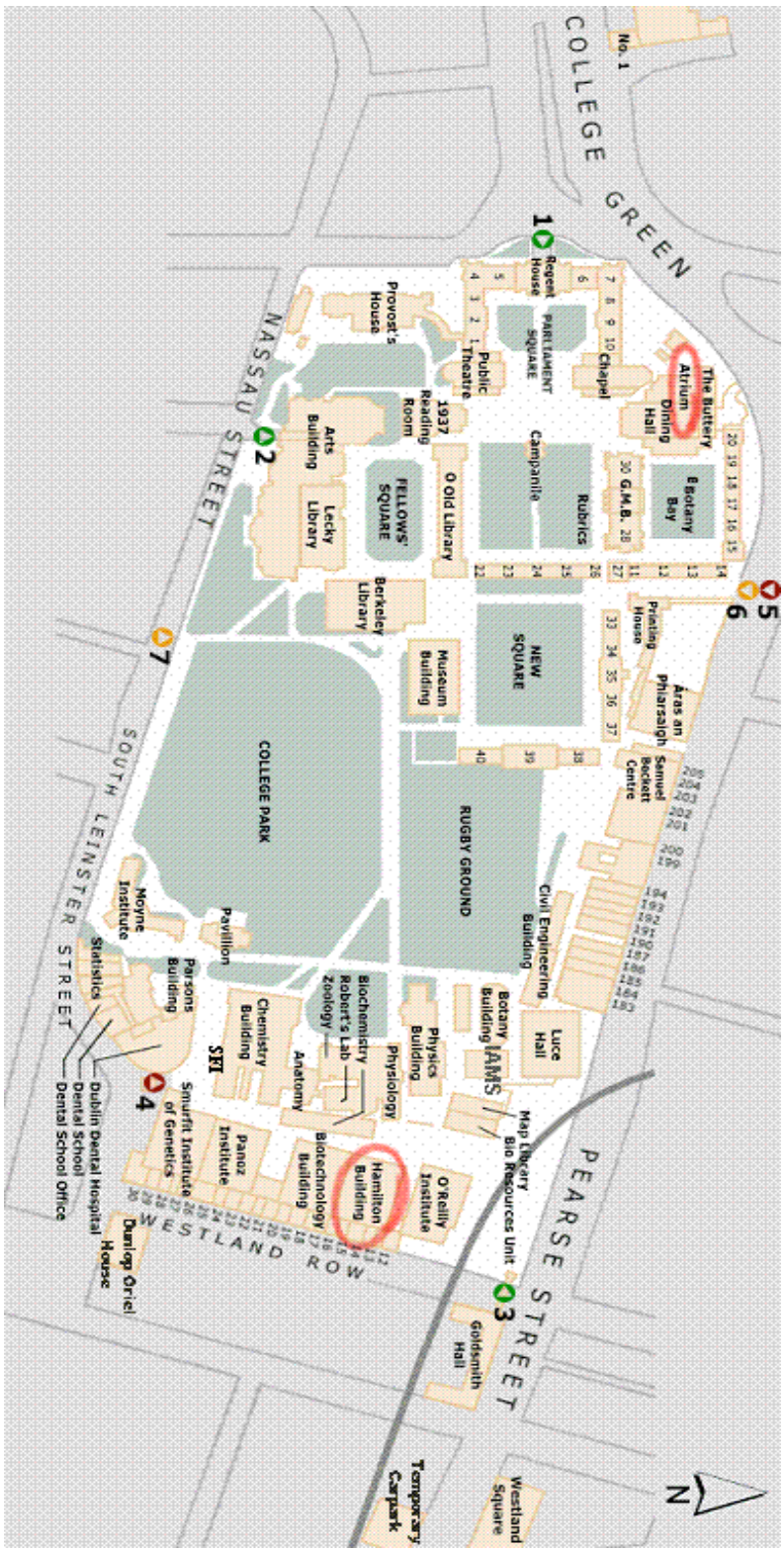
Please remove all posters in Session 1 before lunchtime, Monday 19th June.

<u>Poster session 2</u>
Please place all posters in Session ii by lunchtime, Monday 19th June.

Monday, 4.00pm-5.30pm:	Presentation of odd numbered posters ONLY
Tuesday, 10.00am-11.30am:	Presentation of even numbered posters ONLY

Please remove all posters in Session 2 by evening, Tuesday 20th June.

MAP OF TRINITY COLLEGE DUBLIN CAMPUS



Saturday, June 17, 2006

7.00 – 9.00pm	**Conference Reception**

Sunday, June 18, 2006

8.30-8.40	**Welcome**
8.40-10.00	**Paper Session I**
	8.40-9.00 *Adele Diederich* - Separating multisensory integration from unspecific warning effects in saccadic reaction time
	9.00-9.20 *Frederic Boy* - Perceptual awareness of one's own reaching movement is varied as a function of the accuracy of the visual feedback
	9.20-9.40 *Luc Tremblay* - On-line utilization of visual and proprioceptive information during manual aiming
	9.40-10.00 *Frank Durgin* - Locomotor capture and multisensory integration in the perception of linear self-motion
10.00-10.30	**Tea / Coffee**
10.30-11.30	**Paper Session II**
	10.30-10.50 *Marc O. Ernst* - Vision and touch are automatically integrated for the perception of sequences of events
	10.50-11.10 *David I. Shore* - Assessing the frames of references involved in the crossed hands temporal order judgements deficit
	11.10-1130 *Nienke Weder* - Crossmodal modulation of visual and tactile numerosity judgments
11.30-12.30	**Keynote address**
	WINNING THE DARPA GRAND CHALLENGE
	Sebastian Thrun, Stanford University
12.30-2.00	**Lunch in TCD Dining Hall** (provided)
2.00-4.00	**Symposium I**
	Multisensory processing in and near primary auditory cortex (*Organised by Charles Schroeder)*
	2.00-2.30 *Peter Lakatos* - Role of oscillations in multisensory enhancement of auditory processing
	2.30-3.00 *Michael Brosch* - Representation of non-auditory events in monkey auditory cortex
	3.00-3.30 *Troy Hackett* - Sources of somatic sensory input to auditory cortex in monkeys
	3.30-4.00 *Asif Ghazanfar* - Face/voice integration in monkey auditory cortex
4.00-5.40	**Tea/ Coffee and Poster Session 1** (odd numbers only)
5.40-7.00	**Paper Session III**
	5.40-6.00 *David Burr* - The ventriloquist effect in time is consistent with optimal combination across senses
	6.00-6.20 *David Hartnagel* - Egocentric and allocentric cues affect visual-auditory fusion in space
	6.20-6.40 *Petra A. Arndt* - BOLD Responses in Multisensory Spatial Cueing
	6.40-7.00 *Ulrike Zimmer* - Processing of visuo-tactile spatial congruency does not depend on available visuo-spatial and memory resources

Monday, June 19, 2006

8.40-10.00 **Paper Session IV**

8.40-9.00 *Salvador Soto-Faraco* - Multisensory integration of velocity information

9.00-9.20 *Virginie van Wassenhove* - Statistical learning of auditory-visual associations *(presented by Ladan Shams)*

9.20-9.40 *Martin Banks* - Auditory-visual temporal discrimination: Evidence for usage of a temporal cross-correlator

9.40-10.00 *Katsumi Watanabe* - Classification images reveal auditory influences on visual detection of temporal luminance deviation

10.00-11.30 **Tea/Coffee and Poster Session 1** (even numbers only)

11.30-12.30 **Keynote Tutorial**

ACTIVITY DEPENDENT AND ANATOMICAL CONNECTIVITY

Christian Büchel, University Medical Center, Hamburg-Eppendorf

12.30-2.00 **Lunch**

2.00-4.00 **Symposium II**

"Audio-visual integration subserving sensory-motor and cognitive function" (Organised by Douglas Munoz)

2.00-2.30 *Douglas Munoz* – Overt and covert orienting to combined audio-visual stimuli

2.30-3.00 *Lizabeth Romanski* - Integration of auditory and visual communication information in the primate prefrontal cortex.

3.00-3.30 *Martin Pare* - Statistics of gaze fixation distributions within dynamic faces during audiovisual speech perception

3.30-4.00 *Gary Paige* - Cross-sensory interaction and adaptation underlying spatial localization

4.00-5.30 **Tea/Coffee and Poster Session 2** (odd numbers only)

5.30-7.30 **Symposium III**

"Vestibular contribution to multisensory perception and movement control" (Organised by Alain Berthoz)

5.30-6.00 *Alain Berthoz* - The role of the vestibular system in multisensory integration during navigation

6.00-6.30 *Peter Their* - The integration of vestibular signals in parietal cortex contributing to observer-independent representations of the world

6.30-7.00 *Fabrizio Doricchi* - Crossmodal integration of vestibular cues, attentional orienting and space representation

7.00-7.30 *Stuart Smith* - Multisensory self-motion estimation, old ideas and new data

Tuesday, June 20, 2006

8.40-10.00 **Paper Session V**

8.40-9.00 *Gillian Sebestyen Forrester* - Multisensory Signal Integration in Great Ape Communication: (Gorilla)

9.00-9.20 *Christopher Moore* - Is MT a Multi-Modal Information Processing Region? 9.4T Monkey and 3T Human Studies

9.20-9.40 *Lynne E. Bernstein* - Audiovisual Phonetic Processing

9.40-10.00 *Thomas Thesen* - Spatio-temporal dynamics of multisensory speech processing: An investigation with fMRI, MEG and intra-cranial EEG

10.00-11.30 **Tea/Coffee and Poster Session 2** (even numbers only)

11.30-12.30 **Paper Session VI**

11.30-11.50 *Jennifer Bizley* - Physiological and anatomical evidence for multisensory interactions in auditory cortex

11.50-12.10 *Christoph Kayser* - Integration of sensory information in auditory cortex

12.10-12.30 *Terrence Stanford* - Superadditivity: Putting the Tail in Context

12.30-2.00 **Lunch**

2.00-4.00 **Symposium 4**

"Models of multisensory integration: synthetic vs. naturalistic situations?" (Organised by Beatrice de Gelder)

2.00-2.30 *Beatrice de Gelder* - Models of multisensory integration: synthetic vs. naturalistic situations?

2.30-3.00 *Alexandre Pouget* - Neural basis of Bayes-optimal multisensory integration: theory and experiments

3.00-3.30 *Andrew King* - Investigating multisensory convergence in the auditory cortex

3.30-4.00 *Maria Concetta Morrone* - Predicting the spatial and temporal distortions caused by saccades

4.00-4.30 **Tea/ Coffee**

4.30-6.10 **Paper Session VII**

4.30-4.50 *Krish Sathian* - Fine-grained tactile perception recruits early visual cortex in normally sighted humans

4.50-5.10 *Amir Amedi* - Highly transient activation of primary visual cortex (V1) for tactile object recognition in sighted following 5 days of blindfolding

5.10-5.30 *Sebastian Werner* - Audio-visual integration during multisensory object categorization.

5.30-5.50 *Till R. Schneider* - Effects of Visual Stimuli on Auditory Object Identification in a Crossmodal Priming Paradigm

5.50-6.10 *Marcus J. Naumer* - Visuo-tactile integration of 3D objects in fusiform gyrus

7.30 - **Conference Banquet – Royal Hospital Kilmainham** (included)

Wednesday, June 21, 2006

8.30-10.30 Graduate Symposium

8.30-8.50 *Argiro Vatakis* - Factors modulating the temporal perception of audiovisual speech stimuli

8.50-9.10 *Daniel Kislyuk* - visual speech affects discrimination of syllables in the auditory cortex: an MMN study

9.10-9.30 *Robyn Kim* - Sound facilitates visual perceptual learning

9.30-9.50 *Jyoti Mishra* - Different ERP Correlates of the Sound Induced Illusory Visual Flash and the Real Visual Flash

9.50-10.10 *Paul MacNeilage* - A Bayesian model for estimating body orientation from vestibular and visual information

10.10-10.30 Manuel Gomez-Ramirez - Bridging the Senses: An EEG and fMRI co-registration study of auditory, somatosensory and visual multisensory processes

10.30-11.00 Tea/Coffee

11.00-12.00 Keynote address

WHERE IT ALL BEGINS: MULTISENSORY CONVERGENCE

Alex Meredith, Virginia Commonwealth University

12.00-1.00 Business Meeting and Conference close

1.00-2.30 IMRF Committee lunch

Poster Session 1

Presenters on Sunday, 4:00 PM - 5:30 PM in Hamilton Building, Foyer

1. Nadia Bolognini - **A somatosensory and premotor network for the cortical mapping of actions: a 1Hz rTMS investigation**
3. John Butler - **Visual Vestibular Interactions for Self Motion Estimation**
5. Michael Barnett-Cowan **Visual and vestibular cues for self-orientation influence oculomotor and perceptual assessments of the internal representation of gravity and body orientation**
7. Yuka Igarashi - **The effect of posture of own hand on visuotactile spatial compatibility**
9. Nicola Bruno - **Exploring by eye and hand: bimodal interactions in the perception-action cycle**
11. Bernhard E. Riecke - **Visually induced linear vection is enhanced by small physical accelerations**
13. Salvador Soto-Faraco - **Ordering cross-modal events in time: When illusory and veridical perceptions coexist**
15. Vanessa Harrar - **Assessing multisensory temporal cues for motion perception**
17. Lynnette Leone - **Auditory capture of visual motion**
19. HONGOH - **Auditory cue effect on visual temporal order judgment: the spatial proximity of audio and visual stimuli**
21. Brozzoli Claudio - **Seeing Digits Modulates Finger Tactile Perception**
23. Mirjam Keetels - **Principles of Auditory and Auditory-Visual Grouping**
25. Elena Gherri - **ERP effects of movement preparation on visual processing: attention shifts to the hand, not the goal.**
27. Roberto Martuzzi - **Auditory areas are activated during a visuo-motor task**
29. Neil Harrison - **The effects of motor responses on the additive AV-(A+V) model: an ERP study**
31. Edmund Lalor - **Investigating Multisensory Integration using Spread Spectrum Stimulation.**
33. Aleksander Väljamäe - **Multisensory enhancement for cost-effective motion simulators**
35. Stephen Meredith **Advancing DTI Tractography Algorithms based on Qualitative and Quantitative Comparison of Algorithmic Performance**
37. Ludivine Sarlat - **Assessment of visuo-auditory cognition by immersion in virtual reality**
39. Matthias Bischoff - **EEG-theta associated with audio-visual binding**
41. Tobias Andersen - **Early Maximum Likelihood Integration of rapid flashes and beeps revisited**
43. Maria Concetta Morrone - **Bayesian fusion of visual and auditory stimuli during saccades: an inverted ventriloquist effect**
45. Monica N O' Connell - **Inverse effectiveness and the superadditivity of multisensory interactions in auditory association areas of the awake macaque monkey.**
47. Alexandre LEHMANN - **Multisensory landmarks improve route memory performance in humans : a virtual reality study**
49. Laurence Harris - **Visual and auditory cues for localization combine in a statistically optimal way.**
51. Jason Chan - **The effect of non-informative sound on haptic scene perception**
53. Tobias Schicke - **A common external reference frame for tactile localization**
55. Neil Roach - **Deciding when not to integrate: an investigation of the spatiotemporal limits of auditory-visual integration**
57. Jeannette R. Mahoney - **Look OVER Hear; Spatial Congruity and the Ventriloquist Illusion**
59. Naomi Bass Pitskel - **The functional effects of neuroplastic changes in visually-deprived sighted subjects.**
61. Davide Bottari - **Change Blindness in non-signers deaf individuals and cochlear implant patients**

Presenters on Monday, 10:00 AM - 11:30 AM in Hamilton Building, Foyer

2. Kerstin Koenigs - **Different Types of Eye-Movements alter Localization of Auditory Stimuli**
4. Ilja Frissen - **Aftereffects of prolonged locomotion on a circular treadmill**
6. Philip Jaekl, - **Drifts of the remembered location of visual, auditory and bimodal targets.**
8. Ross Deas - **Distortions of Visual and Auditory Space Following Motion Adaptation**
10. Stuart Jackson - **Action understanding: An investigation into the simultaneous perception and performance of human movement**
12. Wataru Teramoto - **The change of auditory motion detection depending on the direction of visually induced self-motion**
14. Stefan Rach **Visual-Tactile Integration: Does Stimulus Duration Influence the Relative Amount of Response Enhancement?**
16. Akira Suetsugu - **The effect of delaying the onset of a visual target on time course of the apparent displacement of the oculogyral illusion**
18. Kristie Dukewich - **Failure to Eliminate the Crossed-Hands Deficit in a Tactile Temporal Order Judgment**
20. Camille Koppen - **Prior Entry and the Colavita Effect**
22. Takuro Kayahara - **Feature-defined auditory saliency captures visual timing**
24. Kielan Yarrow - **Vibrotaction enhances perceived auditory volume at a post-perceptual level**
26. Matthias Gondan - **Temporal dynamics of auditory-visual interactions as revealed by event-related potentials to bimodal stimuli with different onset asynchrony**
28. Daniel Bergmann - **Neural correlates of synchrony perception using audiovisual speech stimuli**
30. Simon Kelly - **Effects of Alpha Oscillatory Power during Presentation of Naturalistic Multisensory Events**
32. Rosalyn Moran - **Fitting Intracranial multimodal ERPs to an exploratory, hierarchically arranged neural mass model.**
34. Barry Greene - **Integrating Information from Multiple Signals for the Robust Detection of Neonatal Seizures**
36. Rob L.J. van Eijk - **The influence of psychophysical procedure and stimulus type on estimates of human performance in detecting audio-visual asynchrony**
38. Hamish Innes-Brown - **Sound-induced illusory flashes: issues for a psychophysiological investigation.**
40. Johannes Burge - **Modeling the dynamics of visuo-motor adaptation behavior with a Kalman Filter**
42. Carmel A. Levitan - **When are three cues better than two? Statistical robustness in combining information from vision, touch, and sound.**
44. Daniel Senkowski - **More than just the sum of its parts: High-density electrical mapping of the inverse effectiveness principle in humans**
46. Benjamin Rowland - **Timing: A Critical Factor in Multisensory Integration**
48. Hannah Helbig - **There can be only one! Integrating vision and touch at different egocentric locations**
50. Fabrizio Leo - **Multisensory-mediated auditory localization**
52. Achille Pasqualotto - **Effects of the visual experience on spatial updating of haptic scenes**
54. Kohske Takahashi - **Illusory spatial perception induced by the temporal discrepancy between modalities in dynamic vision-haptics integration**
56. Brigitte Roeder - **Spatial reference frames used for tactile attention depend on developmental vision: Evidence from event-related potentials**
58. Kinga Igloi - **Parallel acquisition of map-based (allocentric) and action-based (egocentric) strategies in human navigation**
60. Pascal Barone - **High visuo-auditory integration performances in deaf subjects with cochlear implants**
62. Jung-Kyong Kim - **Visual-to-auditory substitution learning: Behavioral findings and neural correlates**

Poster Session 2

Presenters on Monday, 4:00 PM - 5:30 PM in Hamilton Building, Foyer

1. Marieke van der Hoeven - **Varying T1 difficulty influences a cross-modal attentional blink**
3. Ellen Poliakoff, **Individual differences in attending to touch versus vision under threatening and non-threatening conditions: implications for medically unexplained symptoms**
5. Malika Auvray - **Crossmodal change blindness between vision and touch**
7. Valerio Santangelo - **The Suppression of Reflexive Visual and Auditory Orienting when Voluntary Attention is Engaged**
9. Erik van der Burg - **The absence of an auditory-visual attentional blink using pure tones**
11. Theresa Cooke - **Effects of supervised and unsupervised categorization on visual and haptic object representations**
13. Kazunori Terada - **Combining Vision and Touch in Object Length Perception**
15. Conor O'Malley - **Cross-Modal Measurement of Auditory Mental Imagery Ability using the FAM (Foley Artist Method) approach**
17. Alberto Gallace - **Modulation of haptic length representation by means of a visual illusion and optokinetic stimulation**
19. Oliver Doehrmann - **Building novel audio-visual objects from abstract auditory and visual stimuli**
21. Sascha Tyll - **Crossmodal object binding increase perceived contrast**
23. Sophie Molholm - **Multisensory object based attention**
25. Xiang Zhou - **Temporal visual cues aid speech recognition**
27. Michelle Jarick - **Effects of Seeing and Hearing Speech on Speech Production**
29. Sabine van Linden - **Recalibration in Speech Perception: Lipread vs. Lexical Information**
31. Vera Blau - **Visual influences on speech sound discrimination: A parametric fMRI study**
33. Riikka Möttönen - **Audiovisual integration of speech and non-speech objects: an ERP study**
35. Dries Froyen - **Cross-modal enhancement of the MMN to phonemes indicates automatic processing of grapheme-phoneme correspondences.**
37. Agnès Alsius - **The Role of Attention in Audiovisual Speech Integration: Evidence from ERPs**
39. Shahin Zangenehpour - **Cross-modal recruitment of auditory and visual cortices following brief exposure to bimodal stimuli**
41. Brian Allman - **MULTISENSORY PROCESSING IN 'UNIMODAL' NEURONS: EVIDENCE FOR SUBTHRESHOLD EXCITATORY CROSS-MODAL EFFECTS IN CAT VISUAL CORTEX**
43. Yasuyuki Inoue - **Recognition of Human Body Movements: View-dependency, Inverse effect and biomechanical constraints.**
45. Massimiliano Zampini - **Auditory-somatosensory multisensory interactions: Effects of space and posture**
47. Nicholas Holmes - **The neural and multisensory bases of hand self-recognition: Preliminary investigations**
49. Ben Schouten - **The audiovisual perception of biological motion**
51. Hanneke Meeren - **INTEGRATION OF FACIAL EXPRESSIONS AND EMOTIONAL VOCALIZATIONS TAKES PLACE IN UNIMODAL VISUAL AREAS**
53. Noriaki Kanayama - **Depersonalized experience and multimodal processing**
55. Emma Siddall - **Multisensory insect warning displays and avian predator psychology**
57. Jan B.F. van Erp - **Cross-modal Associative Networks: are we all synesthetes?**
59. Sherlyn Yeap - **Sensory Processing Deficits Across Modalities in Schizophrenia**
61. M. Luisa Demattè - **Colour cues influence odour discrimination more than do shape cues**

Presenters on Tuesday, 10:00 AM - 11:30 AM in Hamilton Building, Foyer

2. Marco Vitello - **Tactile suppression and visual attention: Effects on tactile discrimination performance**
4. Elena Azañón - **Modulating tactile crossed-hands deficit by way of auditory and visual capture.**
6. Polly Dalton - **A visual working memory task interferes with tactile selective attention.**
8. Thomas Koelewijn - **Priming in a Visual and Auditory Attentional Blink Task**
10. Jennifer Montesi - **The effect of spatial selective attention on auditory-somatosensory interactions. A high-density ERP study.**
12. Simon Lacey - **Object representation in visual/haptic crossmodal memory**
14. Kumiko Enokizono - **Self-attribution of a viewing object modulates tactile discrimination performance**
16. Keiko Omori - **The effect of haptic information on visual illusion –active touch vs. passive touch-**
18. Raphaël Meylan - **Auditory-visual interactions affect subsequent visual responsiveness: An electrical neuroimaging study using rudimentary stimuli**
20. Grit Hein - **Integration of semantically unrelated and semantically contingent object features reveals cortical hierarchy in human audio-visual object recognition**
22. Lorina Naci, **Dynamic modulation of object processing stream during cross-modal integration**
24. Hans Colonius - **Audio-visual integration of letters and speech: From unimodal to bimodal subjective representation**
26. Julien Besle - **Influence of voicing, background noise and nature of the visual input on the RT facilitation to discriminate speech syllables**
28. Gary Bargary - **Synaesthesia and the McGurk effect**
30. Kaisa Tiippana - **Does sound location influence audiovisual speech perception?**
32. Nienke van Atteveldt - **Top-down task effects overrule automatic multisensory responses to letter-sound pairs in auditory association cortex**
34. Jeroen Stekelenburg, - **Electrophysiological correlates of multisensory integration of ecologically valid audiovisual events**
36. Julie Vidal - **EVENT-RELATED POTENTIAL STUDY OF AUDITORY-VISUAL INTERACTIONS IN CHILDREN**
38. Andrea Serino - **Visual enhancement of touch and Primary Somatosensory cortex**
40. Holle Kirchner - **EARLY RESPONSES IN THE LATERAL FRONTAL LOBE OF THE HUMAN BRAIN ARE SENSORY**
42. Jan Van den Stock - **Crossmodal bias effects in perception of human body language**
44. Donna Lloyd - **Strength of the rubber hand illusion varies as a function of distance between seen and felt hand**
46. Sarah Casey – Is **beauty In the eyes and ears of the beholder?**
48. Ana Tajadura - **Affecting emotional experience with auditory-vibrotactile heartbeat false feedback**
50. Francesco Pavani - **Fake hand illusion: The role of hand-size and hand-dimensionality**
52. Maurice Magnee - **Crossmodal integration of emotional faces and voices in Pervasive Developmental Disorder: an ERP study**
54. Massimiliano Zampini - **Auditory-somatosensory multisensory interactions: Effects of space and posture**
56. Céline Cappe - **Multisensory and motor integration in stimulus detection in monkeys**
58. Kylie J. Barnett - **Synaesthesia: Cross-modal mechanisms and the role of visual imagery**
60. Serena Mastroberardino - **Does Audio-Visual Interactions affect Working Memory Performance? Evidence using Non-Semantic Stimuli**
62. Anna Fusari - **Olfactory perceptual priming is resistant to aging and long-lasting**

Abstracts of oral presentations

(in order of presentation)

Abstract #1

SEPARATING MULTISENSORY INTEGRATION FROM UNSPECIFIC WARNING EFFECTS IN SACCADIC REACTION TIME

Adele Diederich, School of Humanities and Social Sciences, International University Bremen; Hans Colonius, Department of Psychology, Oldenburg University

Saccadic reaction time (SRT) to a visual target tends to be faster when auditory or tactile non-targets occur in close temporal or spatial proximity even when subjects are instructed to ignore the non-targets. When the non-target appears before the target, it may act as a general alerting or warning cue rather than as a stimulus causing crossmodal integration. The time-window-of-integration (TWIN) model for SRT (Colonius & Diederich, 2004, J Cog Neurosci) distinguishes an early, afferent stage of peripheral parallel processing followed by a compound stage of converging subprocesses. The model is extended here to permit the separation of a - spatially unspecific - warning effect from true multisensory integration. TWIN was tested in a focused attention task with visual target stimuli (LED) and auditory (white noise burst) and tactile (vibration applied to palm) stimuli as non-targets presented ipsi- or contralateral to the target at 23 different stimulus-onset-asynchronies (SOA) over a range of 700 ms. A quantitative fit of the model supports the notion that only a combination of multisensory integration and unspecific warning effects can account for the entire time course of the crossmodal mean SRT responses over SOA values in both ipsi-and contralateral configurations.

Abstract #2

PERCEPTUAL AWARENESS OF ONE'S OWN REACHING MOVEMENT IS VARIED AS A FUNCTION OF THE ACCURACY OF THE VISUAL FEEDBACK

Frederic Boy, Jean-Pierre Orliaguet, LPNC/CNRS UMR-5105; Yann Coello
URECA/Uni. of Lille, Richard Palluel-Germain, LPNC/CNRS UMR-5105

Using a video-controlled pointing task dissociating the motor and visual aspects of a movement, Boy et al. (2005) showed that visual information dominated when evaluating the spatial aspects of the movement and that kinesthetic/motoric information was neglected. Following recent advances in multisensory integration understanding (Ernst & Bülthoff, 2004), the goal of the present research is to show
that weakening the accuracy of visual signals modifies the way one is aware of the spatial aspects of his/her own movements. Participants had to monitor 20 pointings from the real-time images provided by a camera placed above the workspace and displayed on a video-screen. A low-pass spatial filtering of the images reduced their spatial resolution. Direct vision of the workspace was precluded and rotating the camera generated a directional discrepancy between actual and viewed movement. Differently to Boy et al. (2005), when movements' images are blurry, data showed that evaluations of the spatial aspects of action do not longer rely on the exclusive processing of visual information but rather integrates kinesthetic and/or motoric information. Thus, the integration of multisensory signals in building movement perceptual awareness is a flexible and adaptive process that depends of the accuracy of the information afforded by visual signals.

Abstract #3

ON-LINE UTILIZATION OF VISUAL AND PROPRIOCEPTIVE INFORMATION DURING MANUAL AIMING

Luc Tremblay, Elizabeth Corson, Darian Cheng, Marlene Luis, University of Toronto

Movement endpoint accuracy requires extensive use of sensory information during movement execution. Interestingly, studies on the on-line control of goal-directed movements focused primarily on visual information (see Elliott, et al., 2001; cf. Adams et al., 1977) and assumed that effects of visual feedback withdrawal on endpoint accuracy merely reflect its importance (e.g., Proteau et al., 1987). In this study, the hypothesis that visual feedback withdrawal alters proprioceptive information utilization was tested. Sixteen participants completed 20 discrete aiming movements (25 cm) in each of the sixteen conditions: 2 Vision (Full, No) X 3 Tendon Vibration (Triceps, Biceps, None) X 3 Galvanic Vestibular Stimulation (Left, Right, Neutral). Conditions were presented in a random order and triggered at movement initiation. The dependent variables were Constant Error (CE) and Variable Error (VE) for movement extent and direction. As expected, vision availability significantly affected aiming accuracy. Interestingly, there were significant interactions between Vision and Tendon Vibration for CE and VE in movement direction. Finally, there was an interaction involving all factors for CE in movement direction. These results support the

hypothesis that proprioceptive information utilization is affected by visual feedback availability and that such interaction is also present between sources of proprioceptive information.

Abstract #4
LOCOMOTOR CAPTURE AND MULTISENSORY INTEGRATION IN THE PERCEPTION OF LINEAR SELF-MOTION
Frank Durgin, Psychology, Swarthmore College

Normal walking begins with a strong vestibular signal during initial acceleration that is absent on a treadmill. During walking without visual feedback, automatic spatial updating of self-position along a linear trajectory is quite accurate. On a treadmill, such updating seems not to be automatic, but when tested using optic flow, locomotor speed can be shown to be overestimated. Conversely, supplying normal (for walking) acceleration profiles to a passive passenger on a cart produces a gross overestimation of the peak speed of self-motion. That is, locomotor signals and inertal signals presented in isolation both provide overestimates of the rate of self-motion, though they are well-calibrated when they co-occur. Because these signals normally do co-occur, it is likely that they share a joint coding space that intercalibrates the signals based on sensory and motor prediction. Here we report on some consequences of providing mismatched vestibular and motor signals using a treadmill on a cart with synchronized acceleration phases. Under these conditions, vivid locomotor capture (like visual capture of vestibular signals – Lishman & Lee, 1973) can occur, so that perceived speed of travel is determined primarily by perceived treadmill speed. Aftereffects will also be described.

Abstract #5
VISION AND TOUCH ARE AUTOMATICALLY INTEGRATED FOR THE PERCEPTION OF SEQUENCES OF EVENTS
Marc O. Ernst, Jean-Pierre Bresciani, Franziska Dammeier, Max Planck Institute for Biological Cybernetics, Germany

The purpose of the present experiment was to investigate the integration of sequences of visual and tactile events. Participants were presented with sequences of visual flashes and tactile taps simultaneously and instructed to count either the flashes (session 1) or the taps (session 2). The number of flashes could differ from the number of taps by ±1. For both sessions, the perceived number of events was significantly influenced by the number of events presented in the task-irrelevant modality. Touch had a stronger influence on vision than vision on touch. Interestingly, touch was the more reliable of the two modalities – less variable estimates when presented alone. For both sessions, the perceptual estimates were less variable when stimuli were presented in both modalities than when the task-relevant modality was presented alone. These results indicate that even when one signal is explicitly task-irrelevant, sensory information tends to be automatically integrated across modalities. They also suggest that the relative weight of each sensory channel in the integration process depends on its relative reliability. The results are described using a Bayesian probabilistic model for multimodal integration that accounts for the coupling between the sensory estimates.

Abstract #6
ASSESSING THE FRAMES OF REFERENCES INVOLVED IN THE CROSSED HANDS TEMPORAL ORDER JUDGMENTS DEFICIT: THE ROLE OF RESPONSE DEMANDS.
David I. Shore, Neuroscience & Behaviour, McMaster University; Alberto Gallace, Department of Experimental Psychology, University of Oxford; Keely Mimnagh, Neuroscience & Behaviour, McMaster University; Charles Spence, Department of Experimental Psychology, University of Oxford

Judging the order of two tactile stimuli delivered to the index finger of each hand produces Just Noticeable Differences (JNDs) in the nominal range of 20-40 ms. Placing the hands in a crossed posture drastically degrades performance (JNDs = 100-200 ms). Previous researchers have typically only required a spatial response in environmental coordinates (i.e., a 'left first' or 'right first' response). Here we examine the impact varying the response demands. When asked to respond to the limb (i.e., hand) stimulated rather than the location of that limb (i.e., on the right side of space), the deficit was significantly reduced, but not eliminated entirely. When asked to use an up-down response that was orthogonal to the left-right direction of hand crossing, the deficit was again reduced significantly. Finally, when making an entirely non-spatial stimulus-intensity discrimination response, no deficit was observed. These results are discussed in terms of processing stages involved in remapping the tactile stimulation from a somatotopic representation (on the body surface) into a more environmental (or body-centred) one.

Abstract #7
CROSSMODAL MODULATION OF VISUAL AND TACTILE NUMEROSITY JUDGMENTS.
Nienke Weder, Jan van Erp, Alexander Toet, TNO Human Factors; Peter Werkhoven, Department of Information and Computing Sciences, Utrecht University

All day long we experience simultaneous multisensory signals. These usually originate from the same source. When concurrent series of brief signals in two different modalities do not match, the brain has a tendency to make the perceived number congruent. For instance, the perceived number of visual flashes can be altered by simultaneous presentation of an incongruent number of auditory beeps (Shams, 2000) or tactile taps (Violentyev, 2005). We investigated whether these effects also occur in the visual-to-tactile direction and tested whether the illusions reflect a robust perceptual effect or can be attributed to interference of the taps with the ability to perceive flashes. In two experiments participants counted either flashes or taps that were presented concurrently with task irrelevant signals in the other modality and rated their confidence in each response. We found significant illusion effects in the 'count flashes' experiment, but not in the 'count taps' experiment. We will discuss these results in the light of current models of modality appropriateness, information reliability and directed attention. The visual illusions also occurred in trials with a high confidence rating, which implies that participants are not aware of the illusion. Our findings confirm the robust perceptual nature of these crossmodal effects.

Abstract #8
WINNING THE DARPA GRAND CHALLENGE
Sebastian Thrun, Stanford University

The DARPA Grand Challenge was the most significant event in the field of robotics in more than a decade. A mobile ground robot had to traverse 132 miles of punishing desert terrain in less than ten hours. In 2004, the best robot only made 7.3 miles. A year later, Stanford won this historical challenge and cashed the $2M prize. This talk, delivered by the leader of the Stanford Racing Team, will provide insights into the software architecture of Stanford's winning robot "Stanley." The robot heavily relied on advanced sensor technology, and advanced artificial intelligence to make sense out of the massive amounts of sensor data acquired by the vehicle. The talk will introduce you into the fascinating world of autonomous robotics, share with you many of the race insights, and discuss with you some of the implications for the future of self-driving cars.

Abstract #9
PROCESSING IN AND NEAR PRIMARY AUDITORY CORTEX. Organizer: Charles E. Schroeder, Nathan Kline Institute and Dept. Psychiatry, Columbia College of Physicians and Surgeons.

Converging evidence from studies in both human and nonhuman primates demonstrate multisensory convergence and interaction at the earliest stages of cortical auditory processing. These findings define what is arguably the most radical and controversial form of multisensory processing, and they call into question some of our most basic assumptions about the mechanisms and functions of low level cortical processing itself. The proposed symposium consists of four talks on this topic. Michael Brosch (Inst.Neurobiol. Magdeburg, Germany) will describe findings relating to the visual responsiveness of auditory neurons, uncovered by his recent studies in awake-behaving monkeys. Asif Ghazanfar (Dept. Psychology, Princeton Univ., New Jersey, USA) will describe findings from LFP and multiunit studies of audiovisual integration in vocalization processing in awake monkeys. Peter Lakatos (Hungarian Academy of Sciences, Budapest Hungary and Nathan Kline Institute, New York – USA) will discuss audiovisual and somato-auditory interactions as defined by LFP, CSD and multiunit studies in awake monkeys. Troy Hackett (Vanderbilt University, Nashville, TN) will discuss the cortical and subcortical input pathways that support multisensory interactions in auditory cortex.

Abstract #10
ROLE OF OSCILLATIONS IN MULTISENSORY ENHANCEMENT OF AUDITORY PROCESSING
Peter Lakatos, Monica N. O'Connell, Aimee Mills, Cognitive Neuroscience & Schizophrenia Program, Nathan Kline Institute; George Karmos
Inst. Psychology, Hungarian Acad. Sci., Budapest, Hungary; Charles Schroeder
Cognitive Neuroscience & Schizophrenia Program, Nathan Kline Institute.

EEG oscillations reflect cyclical variation in the excitability of neuronal ensembles. Cortical response amplitudes thus depend on the oscillatory phase under which inputs arrive. Critically, oscillations in delta, theta and gamma bands are coupled hierarchically, and overall phase can be re-set by sensory input. We tested the possibility that oscillatory phase re-setting contributes to multisensory enhancement of auditory processing in A1, by recording laminar profiles of synaptic activity and action potentials in awake monkeys. Somatosensory stimulation alone caused no 'classical' evoked response, but triggered oscillatory phase concentration (re-setting) weighted towards the supragranular layers, and beginning earlier than the local auditory response. Bimodal stimulation enhanced the auditory responses. Manipulation of SOA (between a sound and a preceding somatosensory stimulus) revealed a complex pattern of enhancement peaking within 1/2

gamma cycle (~15 ms SOA), with additional peaks near -30, -180 and -800 ms SOA (full gamma, theta and delta cycles). Collectively, these findings strongly support phase re-setting of ambient neuronal rhythms as a key process in multisensory integration. The fact that heteromodal inputs can use this mechanism to promote multisensory enhancement in primary cortical regions may explain many of the effects reported in both human and nonhuman species.

Abstract #11
REPRESENTATION OF NON-AUDITORY EVENTS IN MONKEY AUDITORY CORTEX
Michael Brosch, Institute of Neurobiology, Magdeburg

Early auditory cortex is generally considered to be unimodal. Here we describe extensive cross-modal activation in the auditory cortex of two monkeys while they performed an auditory categorization task: monkeys were required to grasp a touch bar and hold it after a cue-light was turned on. This triggered a sequence of tones of variable frequencies. Monkeys had to indicate the occurrence of a falling frequency step in the sequence by releasing the touch bar. In primary auditory cortex and posterior belt areas we found neurons whose firing was transiently synchronized to the cue-light or to the touch or release of the bar. Such firing not seen or was modified when the monkeys did not initiate a trial after the cue-light was lit or when they performed a visual task. We speculate that the responses to non-auditory events were formed by the tight association between the auditory task and visual stimuli, hand movements, and tactile feedback about the proper placement of the hand on a touch bar during the long training period (> 100,000 trials) of the monkeys. The representation of non-auditory sensory modalities and movements in auditory cortex could accelerate and improve performance of subjects in highly demanding auditory tasks.

Abstract #12
SOURCES OF SOMATIC SENSORY INPUT TO AUDITORY CORTEX IN MONKEYS
Troy Hackett, Dept. Psychology, Vanderbilt University; John Smiley, Cognitive Neuroscience & Schizophrenia Program, Nathan Kline Institute; George Karmos & Istvan Ulbert, Inst. Psychology, Hungarian Acad. Sci., Budapest, Hungary; Peter Lakatos & Charles Schroeder, Cognitive Neuroscience & Schizophrenia Program, Nathan Kline Inst.

Convergent auditory and somatic sensory activity in auditory cortex has been observed in several physiological studies of humans and nonhuman primates. These interactions have been found in association areas such as caudomedial (CM) belt area of auditory cortex adjacent to the core area, A1, as well as in the core or other belt areas. Since distinct sources of auditory input contribute to variations in the auditory properties of these areas, it is likely that regional differences in somatic sensory input underlie differences in multisensory activity, as well. To determine potential sources somatic input to A1, CM and adjoining areas, parallel studies of their cortical and thalamic connections were conducted in marmoset and macaque monkeys. In both species, the results suggest that the retroinsular area (Ri), located in the fundus of the lateral sulcus, is the principal source of somatosensory input to CM. Additional strong inputs from numerous multisensory nuclei in the posterior thalamus may also contribute to somatic activation in CM. In contrast, A1 lacks significant inputs from Ri, and has relatively fewer inputs from multisensory thalamic nuclei. These findings are consistent with current physiological findings, and support the hypothesis that regional differences characterize multisensory activity in auditory cortex.

Abstract #13
FACE/VOICE INTEGRATION IN MONKEY AUDITORY CORTEX
Asif Ghazanfar, Princeton University

Monkeys and humans recognize the correspondence between species-specific facial and vocal expressions, and these visual and auditory channels can be integrated into unified percepts to enhance detection and discrimination. What role sensory areas, such as the auditory cortex, play in such complex signal processing is poorly understood. To address this, we recorded neural activity in the auditory cortex of rhesus monkeys while they viewed vocalizing conspecifics. We found that the primate auditory cortex integrates facial and vocal signals through both enhancement and suppression of neuralactivity. This was true of both local field potential activity and spiking activity. The majority of multisensory responses were specific to face/voice integration, and the lateral belt region of auditory cortex showed a greater frequency of multisensory integration than the auditory core cortex. One possible source of face-specific visual information in the auditory cortex is the superior temporal sulcus (STS). To test this hypothesis, we recorded in both auditory cortex and the STS concurrently and have been exploring the nature of their interactions during unimodal versus bimodal vocal processing.

Abstract #14
THE VENTRILOQUIST EFFECT IN TIME IS CONSISTENT WITH OPTIMAL COMBINATION ACROSS SENSES
David Burr, Department of Psychology,

University of Florence; Martin Banks, Department of Optometry, University of California, Berkeley; Concetta Morrone
Facolta' di Psicologia, Universita' Vita-Salute "San Raffaele", Milan, Italy

The “ventriloquist effect” (mislocalization of sound toward a visual stimulus) is consistent with optimal integration of visual and auditory signals (Alais & Burr, Curr. Biol., 2004). Here we report that “temporal ventriloquism”, the tendency for a sequence of sounds to “capture” visual flashes in time (Shams & Shimojo, Nature, 2000), is also consistent with optimal integration. Subjects performed a temporal bisection task, reporting whether the second (probe) stimulus in a 3-stimulus (800 ms) sequence was closer in time to the first or third. In single-cue sessions, the three stimuli were all either visual flashes or auditory tones. In the double-cue sessions, all stimuli comprised both flash and tone, presented simultaneously for the probe stimulus, but at consistently different times for the first and third stimuli. The perceived point of bisection in the double-cue condition was determined more by tone than flash timing, but both cues influenced the bisection. The results were well predicted from optimal combination of the visual and auditory cues with relative weights derived from the single-cue conditions. Importantly, bisection thresholds in the bimodal condition were significantly better than in either single-cue condition, strong evidence for inter-modal combination. Further discrimination experiments suggested that combination was not mandatory (Hillis et al., Science, 2002), but that subjects retain access to single-cue information as well as the combined information, calling into question the concept of mandatory temporal binding.

Abstract #15
EGOCENTRIC AND ALLOCENTRIC CUES AFFECT VISUAL-AUDITORY FUSION IN SPACE
David Hartnagel, Alain Bichot & Corinne Roumes, IMASSA - Université Paris 8

Space perception implies egocentric and allocentric cues from multiple sensory modalities. In a luminous environment, the position of the eyes in head affects visual-auditory (VA) fusion in space, the reference frame of VA fusion space is neither head-centered nor eye-centered but is instead the result of an integration phenomenon (Hartnagel et al. 2004). This gaze shift effect appears in total darkness where no allocentric visual cues are available (Hartnagel et al. 2005). Experiments on Induced Roelofs Effect (Bridgeman et al. 1997) showed that visual localization depends on the surrounding visual frame. The present experiment investigates effects of visual allocentric cues on VA fusion space when the reference frames are aligned or dissociated. To ensure that reference frames are aligned or dissociated, the subject’s head was maintained by a bite-board and eye position was checked by an eye-tracker. Two types of allocentric visual cues were tested, the edges of the visual display and 2 broken lines (vertical/ horizontal). A broadband noise burst and a 1° spot of light, 500ms duration, were simultaneously presented with a random spatial disparity. Participants had to judge about their unity. Results showed that AV fusion is dependant of egocentric as allocentric sensory cues.

Abstract #16
BOLD RESPONSES IN MULTISENSORY SPATIAL CUEING
Petra A. Arndt, Department of Psychology, Carl-von-Ossietzky University; Simon Müller Institute of Physics, Carl-von-Ossietzky University; Mark W. Greenlee, Department of Psychology, Regensburg University, Germany

Recent studies showed that sensory-specific brain areas are involved in representing multimodal stimuli sharing semantic or other features. In this fMRI-study we investigate whether this holds for multisensory spatial cueing. In a forced-choice paradigm subjects indicated the position of a previously learned object (gabor stimulus with specific orientation) which is presented together with a distractor. A virtual-acoustics auditory cue given 200ms before visual stimulus onset is located at the target position in 80% and at the distractor position in 20% of the bimodal trials. Unimodal visual, unimodal auditory, bimodal trials and a baseline condition were presented in pseudorandom order. Using sparse imaging technique BOLD-signals were acquired in visual and auditory cortices, parts of the parietal and of the frontal lobe. A random effects analysis (12 participants) revealed activity in the visual cortex under auditory stimulation. This may mirror visual-auditory interaction or the fact that participants expect the target at a specific position. A strong, lateralized activation of the auditory cortex under unimodal visual stimulation suggests an involvement of sensory-specific areas in multisensory cueing. Moreover the contrasts of bimodal vs. visual stimulation and of valid vs. invalid cued trials show activation in the occipito-parietal region involved in multisensory and attentional processes.

Abstract #17
PROCESSING OF VISUO-TACTILE SPATIAL CONGRUENCY DOES NOT DEPEND ON AVAILABLE VISUO-SPATIAL AND MEMORY RESOURCES
Ulrike Zimmer, Emiliano Macaluso,

NeuroImaging Laboratory - Fondazione Santa Lucia

Tactile stimuli presented at the same location as a visual target can yield to increased activity in contralateral occipital cortex, compared with spatially-incongruent bimodal stimulation. Does this crossmodal congruency effect in visual cortex depend on available cognitive resources? Visual attention and visual working memory can modulate activation associated with visual distractor-stimuli in visual cortex, reducing brain responses during high attentional load or low memory load. Here, we asked if visual cognitive load also affects multisensory processing in visual cortex. In two separate fMRI studies we manipulated the load-level of a non-spatial working memory task, and of an endogenous visuo-spatial attention task. Concurrently with the primary task, we presented visual and tactile stimuli that were either spatially-congruent or spatially-incongruent. We assessed any enhancement of activity for congruent versus incongruent bimodal stimulation, as a function of visual load. In both experiments, we found crossmodal enhancements for spatially-congruent stimulation in contralateral occipital cortex. Critically, these crossmodal spatial effects were present irrespective of the level of load, both in the non-spatial working memory and in the visuo-spatial attention experiment. We conclude that processing of visuo-tactile spatial congruence in visual cortex does not depend on available visuo-spatial and memory resources.

Abstract #18

MULTISENSORY INTEGRATION OF VELOCITY INFORMATION

Salvador Soto-Faraco, Joan Lopez-Moliner, University of Barcelona, Spain

Information about the motion of objects is extracted by multiple sensory modalities and integrated during perception. Several studies have demonstrated strong multisensory interactions in motion direction, but much less is known about other motion parameters such as speed. Here, we used a 2IFC psychophysical procedure to find the velocity at which a moving sound combined with a moving visual grating had to be presented in order to be subjectively equivalent to a standard sound moving at 30º/sec. Information about visual speed of motion is derived from the integration of Spatial and Temporal Frequency (SF and TF) characteristics, two features that are coded by separate populations of neurons up to V1 and MT/V5. In this study, we assessed the effects of Temporal and Spatial Frequency variations independently. We found a strong influence of visual speed on the perceived speed of sounds. Yet, none of the separable components of visual speed (Temporal or Spatial frequency) exerted a considerable effect individually. Therefore, it seems that the integration of auditory and visual information about motion occurs only after the unimodal visual integrative processes leading to speed perception have been completed.

Abstract #19

STATISTICAL LEARNING OF AUDITORY-VISUAL ASSOCIATIONS

Virginie van Wassenhove, Psychology, UCLA; Aaron Seitz, Psychology, Boston University; Ladan Shams, Psychology, UCLA

Statistical learning refers to the implicit learning of stimulus associations and has been independently reported for visual, auditory and tactile sensory modalities. Here, we tested whether such learning can be observed for synthetic auditory-visual pairings. Joint and conditional probabilities were tested on different groups of participants using a rapid-serial presentation (RSP) paradigm. During the experiment, participants were first exposed to (passively observed) the stimuli. In the second phase of the experiment, participants were presented with ‘singles’ (one auditory or visual stimulus), ‘doublets’ (two stimuli, unimodal or bimodal) or quartets (pairs of bimodal stimuli) in a two-interval forced choice paradigm. They were asked to determine the interval whose stimulus was most frequently occurring during the exposure period. We examined the effects of (i) stimulus duration in the RSP procedure, (ii) joint probability, and (iii) conditional probability on statistical learning. Our results suggest that audio-visual statistical learning occur naturally despite the absence of a task or of an explicit attentional engagement. Additionally, bimodal statistical learning is more efficient than unimodal learning across all stimulus durations.

Abstract #20

AUDITORY-VISUAL TEMPORAL DISCRIMINATION: EVIDENCE FOR USAGE OF A TEMPORAL CROSS-CORRELATOR

Martin Banks, Vision Science Program, University of California, Berkeley; David Burr, Department of Psychology, University of Florence; Concetta Morrone, Facolta' di Psicologia, Universita' Vita-Salute San Raffaele, Milan, Italy

The brain combines information from different senses in a way that approaches statistical optimality. The precision of the combined estimate is better than the precision from either sense alone (Ernst & Banks, 2002). For example, the nervous system combines appropriate auditory (speech train) and visual signals (lip movements) to achieve better word recognition (Grant et al., 1998). As part of

examining how auditory-visual correlations in time guide signal combination, we measured temporal discrimination with auditory-auditory, visual-visual, and auditory-visual stimuli. Two brief stimulus pairs were presented on each trial. One had a longer inter-stimulus interval than the other and the observer indicated which was longer. We measured interval-discrimination thresholds as a function of the base interval. Auditory-auditory and visual-visual thresholds decreased with increases in base interval from 0 to 40 ms. With yet larger intervals, threshold rose proportional to the base interval (Weber's law). The auditory-visual thresholds had the same dipper, but the lowest threshold occurred at much longer base intervals. We will show that the observed behavior is consistent with the use of a temporal cross-correlator with a longer sampling window in the cross-modal than in the within-modal case.

Abstract #21
CLASSIFICATION IMAGES REVEAL AUDITORY INFLUENCES ON VISUAL DETECTION OF TEMPORAL LUMINANCE DEVIATION
Katsumi Watanabe, Research Center for Advanced Science and Technology, University of Tokyo; Masayoshi Nagai, Institute of Human Science and Biomedical Engineering, National Institute of Advanced Industrial Science and Technology

Changes in visual appearance by auditory stimuli have been widely reported (e.g., Stein et al., 1996). However, mechanisms underlying auditory effects on vision are largely unknown. Here we use classification image technique (e.g., Ahumada, 1996) to show that a sound modifies the visual strategies used for detection of temporal luminance deviation. A pedestal luminance increment (signal) was embedded in a sequence of Gaussian contrast noise. The signal timing was fixed. In 50% of trials, no signal existed. A staircase procedure adjusted the signal level. A 20-ms beep was presented at a predetermined time, which varied among sessions, relative to the signal frame. Subjects reported whether the sequence contained the signal in 2AFC. Classification images were clearly peaked around the moment of the visual signal. More intriguingly, another conspicuous peak was present at about 20-ms before the sound, when the sound occurred within an about 400-ms window around the visual signal. The present study thus demonstrates that (1) classification images reveal the subject's strategies of audio-visual interactions, (2) the auditory enhancement of perceived visual intensity may operate at high temporal precision (~20 ms), and (3) the temporal window of this audio-visual interaction is relatively large (~400 ms).

Abstract #22
ACTIVITY DEPENDENT AND ANATOMICAL CONNECTIVITY
Christian Büchel, Dept. of Systems Neuroscience, University Medical Center, Hamburg-Eppendorf, Germany

In my talk I will introduce how MR can be used to infer connectivity in the human brain. In the first part I will introduce techniques like effective and functional connectivity that can be derived from fMRI data. In the second part I will introduce how diffusion weighted imaging can be used to infer anatomical connectivity in the living human. In addition to a tutorial overview of the techniques I will exemplify them with interesting data.

Abstract #23
AUDIO-VISUAL INTEGRATION SUBSERVING SENSORY-MOTOR AND COGNITIVE FUNCTION.
(Organised by Douglas Munoz, Centre for Neuroscience Studies, Queen's University)

A fundamental feature of advanced animals is the ability to sense, interact with, and navigate through a complex environment. Behavioural tasks such as speech perception and covert attentional orienting require neural systems that control a variety of motor actions under the guidance of different sensory systems. Here, we propose to examine and contrast the effects of visual and auditory cross-modal processing to guide different behaviours. Gary Paige will compare of eye position effects on the acquisition of visual or auditory spatial targets. Doug Munoz will discuss factors influencing covert orienting (i.e., attention capture and inhibition-of-return) that are differentially affected by visual versus auditory cueing. Martin Paré will describe how eye movements are used to help collect facial information during speech perception and the pattern of gaze fixations is dictated by strategies of subjects, not properties of the stimuli. Liz Romanski will discuss how single neurons integrate communication-relevant face and vocalization stimuli in the prefrontal cortex of non-human primates. These selective topics will generate a general discussion with the audience to identify commonalities and/or distinctions related to how information from auditory and visual systems combine to influence our perceptions of, and interactions with our environment.

OVERT AND COVERT ORIENTING TO COMBINED AUDIO-VISUAL STIMULI.
D. P. Munoz and A. H. Bell, Queen's University, Canada

Recent neurophysiological evidence shows a

clear role for the superior colliculus (SC) in reflexive covert orienting. In a standard visual cueing task, a cue is presented somewhere in the visual field in advance of the target. The cue can be located at the same location as the target or elsewhere, and it can sometimes reliably predict upcoming target location. In these tasks, modified sensory processing in the SC is correlated with both reflexive attention capture and subsequent inhibition of return: attention capture is correlated with an augmented sensory response to the target and inhibition of return is correlated with a reduction in magnitude of the sensory response. When the cue reliably predicts upcoming target location, top-down influences can modify SC activity in advance of target presentation to then influence sensory processing of the target. Previous reports have described conflicting results in auditory cueing tasks, with some studies producing reliable behavioural effects with auditory cues and others failing to produce effects. The Munoz lab has generated new neurophysiological evidence in the SC showing why cueing effects for auditory and visual stimuli produce such different influences on behavior.

Abstract #24
INTEGRATION OF AUDITORY AND VISUAL COMMUNICATION INFORMATION IN THE PRIMATE PREFRONTAL CORTEX.
Lizabeth Romanski, University of Rochester

Social communication relies on the integration of auditory and visual information. To understand how these two modalities are integrated during social communication we recorded from the primate ventrolateral prefrontal cortex (VLPFC) during the simultaneous and separate presentation of vocalizations and corresponding facial gestures. The stimuli consisted of short video clips of conspecific macaques vocalizing which were deconstructed into audio and visual components and presented separately and simultaneously. The single units we encountered responded robustly to auditory, visual and combined face-vocalization stimuli. The multimodal neurons represented one-third of the task responsive population and exhibited significantly enhanced or suppressed responses to bimodal stimuli. Combination of face or movie stimuli with incongruent vocalizations resulted in significant changes in neuronal firing compared to congruent stimuli. Moreover, alterations of the temporal onset of auditory-visual stimuli also resulted in a significant change when the onset of the auditory stimulus preceded the visual motion stimulus. Our results suggest that VLPFC neurons in the rhesus monkey integrate communication-relevant auditory and visual information. Analysis of multimodal processing in the VLPFC of non-human primates may help us to understand social communication in the human brain, in which the integration of multimodal sensory information is crucial.

Abstract #25
STATISTICS OF GAZE FIXATION DISTRIBUTIONS WITHIN DYNAMIC FACES DURING AUDIOVISUAL SPEECH PERCEPTION
Martin Pare, Depts of Physiology and Psychology, Queens University, Canada.

The human face is a multifaceted stimulus of particular significance for social communication, including audiovisual speech. To understand better the process of gathering facial information, we examined the spatial distribution of gaze fixations displayed by subjects performing audiovisual speech perception tasks while viewing dynamic talking faces. In a series of experiments, we found that gaze fixations are asymmetrically distributed, influenced by the nature of the task and the perceptual difficulty, but not necessarily correlated with perceptual accuracy. Although gaze tend to be directed more toward the lips of a talker during speech, high spatial frequency information afforded by direct oral foveation is not necessary for the successful processing of visual speech information. When speech intelligibility is decreased with acoustic noise, subjects minimize their gaze fixation distributions around the center of the talker's face, which constitutes an ideal vantage point to process a face as a whole. These findings show that the process of gathering facial information is structured mostly because of the observer's strategy rather than the stimulus itself and that it is not restricted to foveal image processing. This work emphasizes the importance of studying face processing with dynamic stimuli to simulate naturalistic communication conditions.

Abstract #26
CROSS-SENSORY INTERACTION AND ADAPTATION UNDERLYING SPATIAL LOCALIZATION
Gary Paige, Dept. of Neurobiology & Anatomy; Babak Razavi , Biomedical Engineering; William O'Neill, Dept. of Neurobiology & Anatomy, University of Rochester

The brain uses vision and audition to construct a spatial map of the external world. The integrity of this map requires that the two senses maintain spatial calibration. This poses two key challenges. 1) Vision and audition are encoded using different mechanisms and coordinate schemes; visual images are topographically mapped directly onto the retina, while auditory space must be constructed centrally based upon interaural and spectral

cues from the two ears. Spatial congruence requires adaptive mechanisms that co-calibrate the two sensory modalities over time, given sufficient cross-sensory interaction. 2) The visual and auditory frames of reference shift relative to one another during eye movements. The brain must account for this to maintain spatial register and constancy, presumably by exploiting an eye-in-head signal. We will discuss long-term adaptive as well as more immediate processes that ensure concordance between visual and auditory space. The latter focuses on how eye position systematically and dynamically shifts the localization of auditory, but not visual, targets across a broad spatial field. This may reflect dynamic errors in how eye position signals are used to align visual and auditory space, or that eccentric gaze gradually shifts (adapts) our sense of 'straight-ahead.'

Abstract #27
VESTIBULAR CONTRIBUTION TO MULTISENSORY PERCEPTION AND MOVEMENT CONTROL
(Organised by Alain Berthoz, College de France, Paris)

Our symposium will present 4 different aspects of multisensory information involving the vestibular system F. Dorrichi will present data whowing that vestibular information can induce an attentional bias in visual perception in human subjects and patients with neglect. A. Berthoz will present data on visual/kinesthetic and vestibular integration during conflict solving between kinesthetic plus vestibular information and visual information during navigation using virtual reality P. Thier will deal with neuronal basis of visual /vestibualr integration in the parietal cortex of the monkey and also in humans. S. Smith will talk about visual-vesibular integration in humans.

THE ROLE OF THE VESTIBULAR SYSTEM IN MULTISENSORY INTEGRATION DURING NAVIGATION
Alain Berthoz, College de France, Paris

The vestibular system provide the brain with information concerning head angular and linear acceleration. It also constitutes a fundamental reference frames for spatial orientation . I shall describe experiments which show that the vestibular system not only contributes to the perception and memory of travelled paths but is in interaction with vision and kinesthetic cues for the cognitive mechanisms which underly spatial memory for navigation. The neural basis of these mechanisms will be described both from experiments using brain imaging (fMRI), neuropsychological studies in patients and neurophysiological studies. I shall show that at all levels of these mechanisms a multisensory processing is present. In addtition I will show how visual vestibular conflicts are solved in the brain not only by weighing mechanisms but by decision making and sensory selection.

Abstract #28
THE INTEGRATION OF VESTIBULAR SIGNALS IN PARIETAL CORTEX CONTRIBUTING TO OBSERVER-INDEPENDENT REPRESENTATIONS OF THE WORLD
Peter Their, Uwe Ilg, & Peter W. Dicke, Department of Cognitive Neurology, Hertie Institute for Clinical Brain Research, University of Tuebingen

Parietooccipital cortex contains severals areas with distinct roles in the generation of smooth-pursuit eye movements. Area MT contributes to smooth-pursuit by extracting retinal slip of the target image, one of the key inputs driving smooth-pursuit. On the other hand, the lateral part of neighboring area MST (=MSTl) seems to contain the explicit representation of object motion in world-centered coordinates. This is suggested by the existence of MSTl visual tracking (VT-) neurons which are multimodal neurons sensitive to retinal image slip, to eye movements as well as to head movements with identical preferred directions. The notion that these three inputs are used to reconstruct the movement of an object in world-coordinates is supported by the observation that their discharge persists, when movement of the object is compensated by eye and/or head movements, stabilizing the object image on the retina. This word-centered representation of object motion may be advantageous for a number of functions beyond the programming of pursuit. However, its role in smooth-pursuit is clearly demonstrated by the fact that lesions of MSTl cause an ipsiversive smooth-pursuit deficit that can be replicated by "lesioning" a VT-neuron-like layer in a model generating smooth combined eye and head pursuit movements.

Abstract #29
CROSSMODAL INTEGRATION OF VESTIBULAR CUES, ATTENTIONAL ORIENTING AND SPACE REPRESENTATION
Fabrizio Doricchi, Universita' degli Studi "La Sapienza" and Fondazione Santa Lucia, Rome Italy

Vestibular organs feed the central nervous system with inputs that can be crucial for effective spatial perception and orientation. We review experimental evidence clarifying how vestibular stimulation drives attentional orienting in different sensory modalities during movements of the head and the body. This evidence allows correct interpretation of improvement of spatial neglect following caloric

vestibular stimulation and provides new cues on the interpretation of sensory-motor spatial compatibility effects. Finally, we provide suggestions on the relationships between crossmodal integration and representation of space.

Abstract #30
MULTISENSORY SELF-MOTION ESTIMATION, OLD IDEAS AND NEW DATA
Stuart Smith, School of Psychology, University College Dublin

Moving through one's environment is a naturally multisensory task involving a coordinated set of sensorimotor processes that encode and compare information from visual, vestibular, proprioceptive, motor-corollary, and cognitive inputs. Interaction between visual and vestibular information in the perception of self-motion has been reported in the literature for over 50 years [e.g. Battersby et at, 1956]. The importance of visual inputs for estimation of self-motion direction (heading) was first recognised by Gibson (1950) who postulated that heading could be recovered by locating the focus of expansion (FOE) of the radially expanding optic flow field coincident with forward translation. We have recently shown [Stone, Smith and Bush, 2004] that humans with intact vestibular function can estimate their direction of linear translation using vestibular cues alone with as much certainty as they do using visual cues. Here we report the results of an ongoing study of self-motion estimation that investigates whether visual and vestibular information can be combined in a statistically optimal fashion. We discuss our results from the perspective that successful execution of self-motion behaviour requires the computation of one's own spatial orientation relative to the environment. Nearly 20 years ago Larry Young and colleagues [Borah, Young & Curry, 1988] showed that an internal model based on the Kalman filter could provide a qualitative account of multisensory contributions to human spatial orientation.

Abstract #31
MULTISENSORY SIGNAL INTEGRATION IN GREAT APE COMMUNICATION: (GORILLA GORILLA GORILLA)
Gillian Sebestyen Forrester, University of Sussex; Neil Forrester, Birkbeck College, University of London

Communication is a dynamic and cognitively distributed process that enlists all of our available senses. Like Humans, animals integrate sensory signals to enhance or change the significance of a single signal. However, to date, studies of animal communication have generally focused on a single sensory channel within a limited linear framework. This is partly because neither the technology nor the framework existed to undergo the task of capturing, coding and analyzing multisensory signals. This research introduces a new theoretical method for managing multimodal signals during primate communication. This work endeavours to objectively assess visual, auditory and tactile signals without preconceived notions of meaning, emotion or intention. This is achieved through a data capture and coding system that limits the subjectivity of the human observer. Furthermore, this technique acknowledges the distributed nature of communication by considering the attentional state and spatial proximities of all social participants, rather than a single individual, as well as the social context within which communication takes place. Finally, this model seeks to create a common language for scientists with which to identify significant patterns in signal frequency, sequence and interaction.

Abstract #32
IS MT A MULTI-MODAL INFORMATION PROCESSING REGION? 9.4T MONKEY AND 3T HUMAN STUDIES
Christopher Moore, MIT; Aimee Nelson University of Toronto

Recent reports describe activation of MT+ correlated with moving tactile stimulation in sighted humans. These findings suggest that the formerly 'unimodal' area MT is multi-modal, and that its information-processing role supercedes its visual designation. Several alternative explanations exist for these results. These studies used only moving stimuli in awake humans: As such, 'cognitive' factors may be central to MT+ activation, and MT+ may not be selective for motion. Further, MT+ in the human is an amalgam of areas, likely including established multi-modal areas. In humans scanned at 3T during vibrotactile stimulation (100Hz for 1s), we observed consistent MT+ activation (N=5/7 Ss). Using identical stimuli in anesthetized monkeys scanned at high field (9.4T) and high resolution (.6x.6x1mm voxels), we observed MT+ activation, replicated within and across animals. Preliminary visual fMRI, anatomical MR and histological studies suggest that MT proper was activated by this tactile input. These studies demonstrate that tactile input to MT+ is robust: It is not dependent on motion content or conscious awareness, and is not species specific. Further, they suggest that MT+ activation is localized to area MT proper. In total, they support the hypothesis that MT is multisensory, and plays a significantly broader information-processing role than previously appreciated.

Abstract #33
AUDIOVISUAL PHONETIC PROCESSING
Lynne E. Bernstein & Jintao Jiang, Communication Neuroscience Department, House Ear Institute, Los Angeles, California, USA

Audiovisual speech stimuli are well-known to produce multisensory interactions. These stimuli, which are typically natural recordings, afford multiple and complex attributes. Not all of the observed multisensory interactions are necessarily due to linguistically relevant (phonetic) stimulus attributes. Understanding multisensory phonetic processing requires isolating effects of the physical stimulus attributes that are due to the production of speech segments (consonants and vowels) and supra-segmental prosodic features. We suggest that quantitative measures of AV phonetic stimulus attributes can be used to isolate cortical-level AV phonetic processing interactions. We examined the hypothesis that during perception of incongruent auditory and visual speech stimuli, as in the McGurk effect, bottom-up stimulus information mismatches with stored representations, leading to distinct neural responses. Those responses were predicted to vary as a function of AV stimulus congruity, which was estimated using distance metrics between optical and acoustic signals. Subjects susceptible to the McGurk effect were enrolled in an fMRI study and were imaged at 3T. AV nonsense stimuli were selected to have three quantified levels of congruity: high (HC—matched), medium (MC—mismatched), and low congruity (LC—mismatched). To screen for areas sensitive to AV speech interactions in the fMRI data, overall activity was tested with the contrast [(HC – REST) ∩ (MC – REST) ∩ (LC – REST)]. Then, contrasts were formed to find those areas that specifically were sensitive to differences in AV stimulus congruity [i.e., within the conjunction [(HC – REST) ∩ (MC – REST) ∩ (LC – REST)], the contrasts (LC – HC), (MC – HC), and (LC – MC) were formed]. Many areas were active in the contrast between the LC (highly mismatched) versus HC (matched), but those areas that were also active in the contrast between the medium mismatch and the matched, (MC – HC), were in left STS and right occipitotemporal sulcus. The contrast between low and medium congruity mismatch resulted in activation in right inferior frontal gyrus. Thus, our results showed sensitivity to AV phonetic congruity levels that had been estimated quantitatively. The demonstration of this type of second-order isomorphism, that is, between stimulus congruity relationships and differential cortical activity, opens up an avenue to more sensitive studies of AV phonetic processing. The differential levels of activity across congruity levels support the hypothesis that AV phonetic perception involves registering the correspondence between modality specific phonetic representations.

Abstract #34
SPATIO-TEMPORAL DYNAMICS OF MULTISENSORY SPEECH PROCESSING: AN INVESTIGATION WITH FMRI, MEG AND INTRA-CRANIAL EEG
Thomas Thesen, Department of Neurology, New York University; Peter Hansen, University of Oxford; Rick Reale, University of Wisconsin; Ian Holliday, University of Aston; John Brugge, University of Wisconsin; Ruth Campbell, University College London; Robert Osterbauer, University of Oxford; Krish Singh, University of Aston; Matthew Howard, University of Iowa; Hiroto Kawasaki, University of Iowa; Hiroyuki Oya
University of Iowa; Gemma Calvert, University of Bath

A standing debate in the field of multisensory speech perception is the level of processing at which the auditory and visual sensory streams converge. We investigated the spatio-temporal dynamics of natural audio-visual (AV) speech perception using a paradigm combining multiple neuroimaging techniques, namely functional MRI (fMRI), magnetoencephalography (MEG) and intra-cranial electroencephalography (iEEG). The high spatial specificity and resolution of fMRI was used to localize cortical areas involved in AV speech perception and integration. The fMRI results were then used in constraining the inverse solution of the MEG source model to yield millisecond timing information about activity in these areas during multisensory integration. After identifying multisensory integration sites and their time-course in the posterior superior temporal lobe, we focused on this area using the high temporal and spatial resolution of intracranial EEG. Consistent results from all imaging modalities support an involvement of primary and secondary auditory cortex in the integration of AV speech. Moreover, evoked fields/potentials and frequency analysis of the MEG and iEEG data suggest that visual speech influences auditory cortex at both the earliest and later stages of cortical processing of natural AV speech signals. A novel spatio-temporal model of AV speech perception is introduced.

Abstract #35
PHYSIOLOGICAL AND ANATOMICAL EVIDENCE FOR MULTISENSORY INTERACTIONS IN AUDITORY CORTEX
Jennifer Bizley, Fernando Nodal, Victoria Bajo, Department of Physiology, Anatomy and Genetics, Oxford; Israel Nelken, Department of Neurobiology, Hebrew University; Andrew King, Department of Physiology, Anatomy and Genetics, University of Oxford

Recent studies, conducted almost exclusively in primates, have shown that several cortical areas usually associated with modality-specific sensory processing are subject to influences from other senses. Here we demonstrate using single-unit recordings that visually-responsive units are widespread in the auditory cortex of anesthetized ferrets. In many cases, these units were also acoustically responsive and frequently transmitted more information in their spike discharge patterns in response to paired visual-auditory stimulation than when either modality was presented by itself. Visually-responsive units were present throughout the depth of the cortex. They were particularly common in non-tonotopic areas on the anterior ectosylvian gyrus, but were also found in tonotopic areas, including the edges of the primary auditory fields on the middle ectosylvian gyrus. Within each auditory cortical field, the pure tone response properties of neurons sensitive to visual stimuli did not differ in any systematic way from those of visually-unresponsive neurons. Neural tracer injections revealed direct inputs from different areas of visual cortex to both primary and non-primary auditory fields, indicating a potential source of origin of the visual responses in auditory cortex. These data suggest that multisensory convergence and integration are features common to all auditory cortical areas.

Abstract #36
INTEGRATION OF SENSORY INFORMATION IN AUDITORY CORTEX
Christoph Kayser, Max Planck Institut for Biological Cybernetics, Germany

Traditionally it is assumed that information from different senses is integrated only in higher association cortices. Contrasting this belief, we demonstrate multisensory integration in areas proximal to primary sensory areas - in the so called auditory belt. Using a combination of high-resolution functional magnetic resonance imaging (fMRI) in electrophysiological recordings in macaque monkeys, we quantify the integration of audio-visual and audio-tactile stimulation. Integration of auditory noise with tactile stimulation of the hand is reliably found in anaesthetized animals at the posterior end and along the lateral side of the auditory belt. This integration occurs only for temporally coincident stimuli and obeys the principle of inverse effectiveness: integration is stronger for less effective stimuli. Locations with significant integration responded to auditory alone stimulation but only few to tactile alone. Combining visual and auditory stimulation, robust multisensory integration in auditory cortex was found in alert animals, but only weaker in anaesthetized animals. Similar to audio-tactile integration, the audio-visual interaction was found in areas of the belt. Together our results suggest that touch and vision related activity in auditory cortex arise from a different set of projections. Touch related information arrives as feed-forward input, vision related input arrives in a top-down fashion. Our findings demonstrate that multisensory integration can occur early in the processing hierarchy - one processing stage above primary auditory cortex. Further, this multisensory integration occurs pre-attentive, as demonstrated in anaesthetized animals. Such early integration might be necessary for quick and consistent interpretation of our world and might explain multisensory illusions where a stimulus perceived by one modality is altered by a stimulus in another modality.

Abstract #37
SUPERADDITIVITY: PUTTING THE TAIL IN CONTEXT
Terrence Stanford & Barry Stein
Neurobiology & Anatomy, Wake Forest University, School of Medicine, USA

The behavioral benefits of integrating stimuli from multiple senses (such as decreased reaction time and increased stimulus detection) likely derive from the physiological phenomenon of multisensory enhancement. Whether measured with functional imaging, evoked potentials, or single-neuron recordings, enhancement refers to a relative increase in the level of neural activity for multisensory versus unisensory stimuli. Historically, much emphasis has been placed on “superadditive” enhancements, apparently supralinear interactions wherein the multisensory response exceeds the sum of the responses obtained for the modality-specific component stimuli. Superadditivity is manifest in all recording methods (single neurons, MRI, ERP), has been reported for many neural structures and species, and has had a strong conceptual impact in the multisensory literature. Yet this literature is equivocal, rendering conclusions about the relative incidence of superadditivity ranging from “quite common” to “nonexistent”. This circumstance begs a careful re-examination of how and when superadditivity occurs. Here we show that “superadditivity” cannot be adequately classified as common or rare or anything in between but is only properly considered as context-dependent. Specifically, the mode of integration depends on the efficacy of the modality-specific stimulus components, and when viewed through this prism, even widely disparate findings are unified. (NS36916 and NS22543)

Abstract #38
MODELS OF MULTISENSORY INTEGRATION: SYNTHETIC VS. NATURALISTIC SITUATIONS

(Organised by Beatrice de Gelder, Tilburg Universitity, Netherlands)

Natural images are increasingly used at many levels of visual processing. The usefulness of such stimuli is now a matter of active debate. One side is motivated by the way evolutionary pressures shape the perceptual system and argues that simple, synthetic stimuli (such as bars, dots and gratings) are doomed to fail experiments intended to capture fundamental properties of visual neurons. The counterargument holds that natural images are too poorly understood to be useful for testing theories. To goal of this symposium is to start a similar debate in multisensory research in an attempt to arrive at a better understanding of these complex issues. In audiovisual research a large number of studies also use simple synthetic stimuli and the tacit assumption is that models (mathematical, functional) derived from experiments with simple stimuli can applied equally well to naturalistic stimulus combinations. Major questions are: 1. What is the importance of using naturalistic stimuli for new models of multisensory integration and can we define a theoretical basis for a classification of types of multisensory situations. 2. What are the factors and computations involved in binding the signals from different modalities and are these different depending on whether synthetic or naturalistic stimuli are used? 3. Are naturalistic and synthetic stimuli integrated at different representational stage corresponding to different moments in time?

Abstract #39
NEURAL BASIS OF BAYES-OPTIMAL MULTISENSORY INTEGRATION: THEORY AND EXPERIMENTS
Alexandre Pouget, Brain and Cognitive Sciences, University of Rochester

Humans can combine multisensory inputs near optimally. This is quite remarkable considering that sensory inputs often come in very different formats, such as the voice of a speaker and the image of the lips movements. Moreover, sensory modalities are not equally reliable, and their degree of reliability can change from one instant to the next. I will present a neural model based on the notions of basis functions and probabilistic population codes, that can solve both of these problems optimally. The model makes two major predictions: 1- multisensory neurons should be mostly additive, and 2- their receptive fields are not necessarily in spatial correspondence. Both of these predictions are at odd with the current dogma in the multisensory integration literature, which claims that many neurons are superadditive, and that the receptive fields of most multisensory neurons are in spatial alignment. I will show that, in fact, experimental data support our predictions.

Abstract #40
INVESTIGATING MULTISENSORY CONVERGENCE IN THE AUDITORY CORTEX
Andrew King, Department of Physiology, Anatomy and Genetics, University of Oxford

Multisensory convergence is now known to be extremely widespread within the brain, extending well beyond areas such as the superior colliculus and association areas of the cortex. Indeed, the prevalence of crossmodal interactions reported in recent studies in humans and other species suggests that most of the cerebral cortex is multisensory in nature. Particular attention has focussed on the auditory cortex where inputs from other sensory modalities have been found in both primary and non-primary fields. Multisensory integration has so far been defined only in terms of enhancement and suppression of neural responses. This is surprising given the importance of temporal coding and we have found that measures which take into account the full spike discharge pattern provide a more sensitive index of multisensory convergence than those based on spike rate alone. Although the integration of facial and vocal signals in primate auditory cortex is clearly important for communication, the functional significance of the multisensory responses described in most studies, which typically use much simpler stimuli, is poorly understood. Valuable insights into those functions and of the role of different auditory cortical fields can be obtained, however, by studying not only the receptive field properties of the neurons but also the sources of their non-auditory inputs.

Abstract #41
PREDICTING THE SPATIAL AND TEMPORAL DISTORTIONS CAUSED BY SACCADES.
Maria Concetta Morrone, Universita' Vita-Salute S Raffaele, Milan Italy

Saccades cause major consequences to human vision. As well as suppressing sensitivity, they cause transient but dramatic compressive distortions in both space and in time. However, neither the apparent location nor the apparent duration of acoustic targets is affected by saccades. When visuo-acoustic stimuli are displayed briefly during saccades, their apparent position is determined largely by sound, a form of "inversed ventriloquist effect". This can be well explained by optimal Bayesian fusion between the two signals, assuming that the intention to move the eyes causes the visual signal to become more noisy peri-saccadically. I will then go on to present a model based on neuronal mechanisms that

simultaneously encode space and time. The model simulates both the spatial and temporal compression of visual stimuli during saccades as a consequence of the rapid updating receptive field organization.

Abstract #42
FINE-GRAINED TACTILE PERCEPTION RECRUITS EARLY VISUAL CORTEX IN NORMALLY SIGHTED HUMANS
Krish Sathian, Randall Stilla & Erica Mariola
Department of Neurology, Emory University School of Medicine, Atlanta, GA, USA

It is now accepted that extrastriate visual cortex is involved in touch in sighted humans. However, cross-modal activity in striate cortex (V1) is thought to occur only in the blind. In two separate fMRI studies, we have found cross-modal activity in or near V1 of normally sighted subjects. The first study contrasted shape and texture, perceived both haptically and visually. Bisensory texture-selectivity was found in medial occipital cortex near the calcarine fissure. In the second study, subjects were trained to tactually discriminate the direction of spatial offset of a central dot in a linear 3-dot array. Training progressively decreased the discrimination threshold, expressed in terms of the magnitude of offset required for 75% accuracy, well into the hyperacuity range (<1mm). Subjects underwent fMRI scanning before and after training on this experimental task; the scans included the experimental (spatial) task and a control (temporal) task. The task-by-session interaction revealed training-specific effects in medial occipital cortex, determined by retinotopic mapping in some subjects to be within V1 or V2. Thus, much of visual cortex, including V1, appears to have multisensory functions. Recruitment of cortex in or near V1 may occur in tactile tasks demanding particularly high spatial resolution.

Abstract #43
HIGHLY TRANSIENT ACTIVATION OF PRIMARY VISUAL CORTEX (V1) FOR TACTILE OBJECT RECOGNITION IN SIGHTED FOLLOWING 5 DAYS OF BLINDFOLDING
Amir Amedi, Joan Camprodon, Lotfi Merabet
Felix Bermpohl, Erin Haligan, Naomi Bass-Pitskel, Itamar Ronen, Dae-Shik Kim & Alvaro Pascual-Leone
Center for Non-invasive Brain Stimulation, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, USA

The occipital cortex undergoes dramatic cross-modal plasticity in the blind. This could reflect connectivity and processing, which exist also in sighted (but is inhibited to some extent by visual input), or massive reorganization and growth of new connections due to prolonged blindness. One approach to answer this question is to induce complete visual deprivation in sighted subjects. Here we studied the effects of 5 days of blindfolding on tactile object recognition task (TOR) and verbal memory task. At baseline and on Day 1, LOC / LOtv showed robust TOR activation. Retinotopic areas including V1, showed negligible activation to TOR. However, on Day 5 we found robust TOR activation in V1 with either the left or the right hand but not during low-level sensorimotor controls. This activation is dramatically reduced only hours following the removal of the blindfold, and was absent 2 days later. This clearly shows a dramatic change in the V1 pattern of activation following complete visual deprivation. The speed of these functional changes makes the establishment of new connections highly improbable. Instead, we hypothesize the existence of somatosensory inputs to V1, that become unmasked with visual deafferentation.

Abstract #44
AUDIO-VISUAL INTEGRATION DURING MULTISENSORY OBJECT CATEGORIZATION.
Sebastian Werner & Uta Noppeney, Max Planck Institute for Biological Cybernetics / Department of Cognitive and Computational Psychophysics, Germany

Tools or musical instruments are characterized by their form and sound. We investigated audio-visual integration during semantic categorization by presenting pictures and sounds of objects separately or together and manipulating the degree of information content. The 3 x 6 factorial design manipulated (1) auditory information (sound, noise, silence) and (2) visual information (6 levels of image degradation). The visual information was degraded by manipulating the amount of phase scrambling of the image (0%, 20%, 40%, 60%, 80%, 100%). Subjects categorized stimuli as musical instruments or tools. In terms of accuracy and reaction times (RT), we found significant main effects of (1) visual and (2) auditory information and (3) an interaction between the two factors. The interaction was primarily due to an increased facilitatory effect of sound for the 80% degradation level. Consistently across the first 5 levels of visual degradation, we observed RT improvements for the sound-visual relative to the noise- or silence-visual conditions. Corresponding RT distributions significantly violated the so-called race model inequality across the first 5 percentiles of their cumulative density functions (even when controlling for low-level audio-visual interactions). These results suggest that redundant structural and semantic information is not independently processed but integrated during semantic categorization.

Abstract #45
EFFECTS OF VISUAL STIMULI ON AUDITORY OBJECT IDENTIFICATION IN A CROSSMODAL PRIMING PARADIGM
Till R. Schneider, Department of Neurophysiology and Pathophysiology, University Medical Center Hamburg-Eppendorf; Stefan Debener, MRC Institute of Hearing Research Southampton, UK; Andreas K. Engel, Department of Neurophysiology and Pathophysiology, University Medical Center Hamburg-Eppendorf

Crossmodal integration processes were investigated by repeating semantically identical stimuli of objects in the auditory and visual modality in order to test whether priming induced memory effects are predominantly amodal or modality-specific. Twenty-six subjects participated in a S1-S2 priming experiment with auditory and visual stimuli of different objects while EEG was recorded. Congruent and incongruent visual-auditory stimulus pairs were presented with an inter-stimulus interval of 1000 ms. In a unimodal control condition congruent and incongruent auditory stimulus pairs were presented. Subjects had to estimate the size of the objects. Reaction times were decreased for congruent compared to incongruent stimulus pairs in the crossmodal as well as in the unimodal condition. Auditory evoked potentials showed a positive shift in the time range of 300 to 400 ms after congruent compared to incongruent stimulation in both the cross- and unimodal condition. These findings on auditory evoked potentials are consistent with earlier reports in the repetition priming literature. Moreover, an increase in the gamma-band response induced by the auditory S2 stimulus was observed for semantically congruent stimulus pairs in the crossmodal condition. The implications of these results for the modality specificity of memory representations are discussed.

Abstract #46
VISUO-TACTILE INTEGRATION OF 3D OBJECTS IN FUSIFORM GYRUS
Marcus J. Naumer, Leonie Ratz, Institute of Medical Psychology, Frankfurt Medical School, Frankfurt/Main; Notger G. Mueller, Brain Imaging Center (BIC), and Cognitive Neurology Unit, Frankfurt Medical School, Frankfurt/Main; Jochen Kaiser, Institute of Medical Psychology, Frankfurt Medical School, Frankfurt/Main; Grit Hein, Brain Imaging Center (BIC), and Cognitive Neurology Unit, Frankfurt Medical School, Frankfurt/Main, Germany

Functional imaging studies of visuo-tactile (VT) processing revealed LOtv and IPS as the prime candidate regions for object-related VT integration (Amedi et al., 2005; Sathian, 2005). However, most of these studies computed conjunctions of unimodal visual and tactile activations. To test more strictly for VT integration (Beauchamp, 2005; Laurienti et al., 2005), we searched for regions that were activated by each of the unimodal conditions (V; T), and additionally responded more strongly to bimodal VT stimulation than to each of the unimodal conditions. Using fMRI, we assessed VT integration of natural (animals) and artificial 3D objects ("fribbles"; www.cog.brown.edu/~tarr/), while controlling for potential motor, naming, and imagery confounds. During natural stimulation, animal photographs were either presented canonically or mirrored horizontally. We mainly revealed four cortical regions that showed VT integration effects for 3D objects: right and left fusiform gyrus (FG), left LOtv, and left IPS. Interestingly, right FG showed the most robust VT integration effect that neither depended on the particular stimulus material (animals or fribbles) nor on orientation congruency. While VT integration of natural material involved rather anterior portions of right FG, abstract 3D material was integrated in a more posterior part of FG.

Abstract #47
FACTORS MODULATING THE TEMPORAL PERCEPTION OF AUDIOVISUAL SPEECH STIMULI
Argiro Vatakis & Charles Spence
Experimental Psychology, University of Oxford

We report a series of 4 experiments designed to investigate the factors modulating people's sensitivity to asynchrony for audiovisual speech stimuli. Short speech video clips were presented randomly at a range of stimulus onset asynchronies (SOAs) using the method of constant stimuli. Participants made unspeeded temporal order judgments (TOJs) regarding which stream appeared to have been presented first. The first major finding to emerge from our experiments was that people's sensitivity to asynchrony in brief speech stimuli is much better than has been suggested on the basis of previous research (that has typically used continuous speech streams as stimuli). Furthermore, significant differences in temporal discrimination accuracy (as measured by the just noticeable difference; JND) were obtained as a function of the place of articulation, backness, height of lip-opening, and lip-rounding, while no such differences were found for any of the other articulatory features tested. Interestingly, our results also revealed that highly-salient visual-speech stimuli typically require smaller visual leads for the point of subjective simultaneity (PSS) to be achieved than do less-salient visual-speech stimuli. Finally, the 'assumption of unity' (Welch & Warren, 1980) was also found to modulate

TOJ performance for speech (but not for non-speech) stimuli.

Abstract #48
VISUAL SPEECH AFFECTS DISCRIMINATION OF SYLLABLES IN THE AUDITORY CORTEX: AN MMN STUDY
Daniel Kislyuk, Riikka Möttönen, Mikko Sams
Cognitive Technology Group, Laboratory of Computational Engineering, Helsinki University of Technology

Infrequent changes in the visual component of audiovisual speech stimuli, resulting in the "McGurk effect", elicit a mismatch response (MMN) in the auditory cortex even when the auditory stream remains constant (Sams et al., 1991; Möttönen et al., 2002; Colin et al., 2002). This result has been interpreted to suggest that visual information modifies processing of auditory information in the auditory cortex. However, this MMN may arise due to the change in the visual stimulus per se. In the present EEG experiment, we avoided this possibility by keeping the visual sequence constant. An odd-ball sequence of auditory stimuli consisting of frequent /va/ syllables (standards) and infrequent /ba/ syllables (deviants) was presented to nine subjects. Deviant stimuli in the unisensory acoustic stimulus sequence elicited a typical MMN, indicating stimulus discrimination. When the acoustic stimuli were dubbed onto a video of mouth constantly articulating /va/, the deviant acoustic /ba/ was perceived as /va/ due to the McGurk effect and was perceptually indistinguishable from the standards. Now acoustic deviants did not elicit any mismatch response, indicating that auditory cortex did not discriminate between the acoustic stimuli anymore. Our finding suggests that processing visual information can change neural representations underlying auditory discrimination similarly as occurs when the properties of the acoustic stimulus are changed.

Abstract #49
SOUND FACILITATES VISUAL PERCEPTUAL LEARNING
Robyn Kim, Psychology, UCLA; Aaron Seitz, Psychology, Boston University; Ladan Shams, Psychology, UCLA,

Although performance on low-level visual perceptual tasks can be improved with training, such learning requires intensive practice. To investigate whether the addition of sound can facilitate visual perceptual learning, we compared coherent motion detection performance of an audio-visual trained group with that of a unisensory(visual)-trained group over ten days. On trials containing only visual signals, both groups improved with training; furthermore, improvement was specific to the trained motion directions and therefore likely due to low-level perceptual-learning. However, the audio-visual trained group exhibited both significantly faster learning within a session and also better retention of improvements across sessions than the unisensory-trained group when compared in trials containing only visual signal. Control conditions ruled out alerting effect of sound as the underlying factor. These results indicate that sound can indeed facilitate visual perceptual-learning. In addition, while both groups demonstrated an increase in audio-visual interaction from pre- to post-test, the change in interaction of the audio-visual-trained group significantly exceeded that of the unisensory-trained group, suggesting that there are both fast learning (within session) and sustained training effects for audio-visual interactions. Altogether these findings suggest that multisensory training is more effective for learning, and unisensory training is suboptimal even for learning unisensory tasks.

Abstract #50
CORTICAL PROCESSES UNDERLYING THE SOUND INDUCED VISUAL ILLUSION
Jyoti Mishra, Dept. of Computational Neurobiology, UCSD; Antigona Martinez, Department of Neurosciences, UCSD; Wolfgang Teder-Sälejärvi, Dept. of Psychology, North Dakota State University; Terrence Sejnowski, Computational Neurobio. Lab, Salk Institute, La Jolla; Steven Hillyard, Dept. of Neurosciences, UCSD

When a single flash of light is presented interposed between two brief auditory stimuli separated by 70-100 msec, subjects typically report perceiving two flashes (Shams et al 2000, 2002). The neural mechanisms underlying this striking illusory flash phenomenon remain unknown. Preliminary electrophysiological and neuromagnetic evidence from Shams and colleagues (2001, 2005) suggested a visual cortex modulation produced by the paired sounds that qualitatively resembles activity elicited by a real visual stimulus. Using 64 channel ERP recordings, we found that neural activity associated with the illusory flash has significantly different spatio-temporal characteristics from activity evoked by a real visual stimulus. Difference ERPs calculated to reflect the auditory-visual interaction producing the illusory flash included an early positivite difference over bilateral occipital areas at 120 ms after the first sound (pd120), a centrally distributed positivity at 180 ms (pd180) and a centro-parietally distributed negativity at 270 ms (nd270). The difference ERP for the real visual flash on the other hand contained typical occipitally distributed P1 and N1 components over the contralateral hemisphere. Possible

mechanisms for the illusory flash effect will be discussed.

Abstract #51
A BAYESIAN MODEL FOR ESTIMATING BODY ORIENTATION FROM VESTIBULAR AND VISUAL INFORMATION
Paul MacNeilage & Martin Banks, UC Berkeley, Vision Science, USA

Otolith signals are ambiguous cues to body orientation because they are affected by inertial forces when the body is accelerated. The ambiguity can be resolved with added visual information indicating orientation and acceleration with respect to the earth. We have been investigating how noisy vestibular and visual signals are combined. Here we present a statistically optimal Bayesian model of this process. We represent the likelihoods associated with sensory measurements in a 2D body orientation / body acceleration space. The likelihood function associated with the otolith signal traces a curve because there is no unique solution for orientation and acceleration based on the otolith signal alone. The most likely estimates are those that satisfy the gravitoinertial force equation, F = G + I. Likelihood functions associated with other sensory signals can resolve this ambiguity. In addition, we propose two priors, one acting along each dimension in the orientation/acceleration space, the idiotropic prior and the no-acceleration prior. These priors are consistent with behavioral observations, specifically the Aubert effect and somatogravic illusion. Recent experiments confirm predictions of the model: 1) visual signals affect interpretation of the otolith signal 2) less reliable signals are weighted less 3) combined estimates are more precise than single-cue.

Abstract #52
BRIDGING THE SENSES: AN EEG AND FMRI CO-REGISTRATION STUDY OF AUDITORY, SOMATOSENSORY AND VISUAL MULTISENSORY PROCESSES
Manuel Gomez-Ramirez, Marina Shpaner, Cognitive Neuroscience Program of The City College of the City University of New York; Simon Kelly, Cogntive Neurophysiology Lab of the Nathan S. Kline Institute; Meredith Theeman, Environmental Psychology program of the City University of New York; Lars Ross, Aaron Krakowski & John Foxe, Cognitive Neuroscience Program of The City College of the City University of New York

The prevailing model of how multisensory integration effects occur is that different sensory inputs emanating from an entity are analyzed through their respective unisensory processing streams after which they are combined in higher-order 'multisensory' regions of the cortex. To date, most studies investigating multisensory integration processes have only been carried-out using stimuli coming from only two modalities. As a consequence, a direct comparison of the latency and neuronal sources of multisensory integration effects between all the different senses is not possible. Here, we investigated the latency and topographical differences of multisensory integration processes between the auditory, somatosensory and visual modalities. The ERP evidence reveals distinct multisensory integration sites for the different pairings of multisensory stimuli. Earlier integration effects were observed for the auditory and somatosensory multisensory stimuli. Topographical and source analyses techniques localize this integration effect to regions over auditory cortices. Similarly, the fMRI data localized this effect to areas posterior to primary auditory cortex. This result suggests that auditory and somatosensory inputs may have direct connections at relatively early stages of stimulus processing and provides strong evidence against the prevailing model of higher-order processing of multisensory stimuli.

Abstract #53
WHERE IT ALL BEGINS: MULTISENSORY CONVERGENCE
Alex Meredith, Virginia Commonwealth University

Multisensory processing has a profound influence on perception and behavior, yet little is known about the first, requisite step in this process: multisensory convergence. Investigations of multisensory processing traditionally select neurons for examination by identifying those which are independently activated by inputs from different sensory modalities. Under these conditions, strong correlations have been demonstrated between neuronal activity and multisensory detection and orientation behaviors. However, the recent explosion of multisensory studies has identified a wide variety of other effects, some of which do not seem to conform to this traditional model of convergence. This presentation will put forward non-traditional patterns of multisensory convergence and the neurophysiological products they generate, with the overall objective of expanding the context in which multisensory processing is investigated.

Poster Session 1
(abstracts in order of poster number)

Poster # 1
A SOMATOSENSORY AND PREMOTOR NETWORK FOR THE CORTICAL MAPPING OF ACTIONS: A 1HZ RTMS INVESTIGATION
Nadia Bolognini, Dipartimento di Psicologia, Università di Milano-Bicocca; Alessio Avenanti, Dipartimento di Psicologia, Università degli studi di Roma "La Sapienza"; Angelo Maravita, Dipartimento di Psicologia, Università di Milano-Bicocca; Salvatore M Aglioti, Dipartimento di Psicologia, Università degli studi di Roma "La Sapienza"

Transcranial Magnetic Stimulation studies indicate that observing another person's action can selectively facilitate the corticospinal motor representation of the muscles involved in the observed movement. This phenomenon is functionally akin to the "mirror" activation of premotor neurons in the monkey. Cortico-cortical projections from the inferior frontal gyrus (IFG) to the primary motor cortex (M1) seem to play a major role in enhancing cortico-spinal excitability during action observation. Nonetheless, there is evidence suggesting an involvement of somatosensory areas in mirror motor functions. Here we explore the effects of disruption of motor and somatosensory activity on motor mirror responses. MEPs to focal single-pulse TMS over M1 during the observation of bio-mechanically possible and impossible movements were recorded in a baseline condition and after repetitive TMS over S1, M1 and IFG. Both in the baseline and after M1 disruption, we found a significant MEP facilitation, specific for the muscle involved in the observed movement and comparable for possible and impossible movements. By contrast, interference with IFG and S1 selectively reduced MEPs for possible movements and impossible movements respectively. These results suggest that a complex somatosensory and premotor network is necessary for the cortical mapping of different aspects of observed actions.

Poster #2
DIFFERENT TYPES OF EYE-MOVEMENTS ALTER LOCALIZATION OF AUDITORY STIMULI
Kerstin Koenigs & Frank Bremmer, Neurophysik, Philipps-Universität Marburg

Previous studies have shown that the perceived location of visual stimuli briefly flashed during smooth pursuit, saccades or optokinetic nystagmus (OKN) is not veridical. In our current study we investigated whether these mislocalizations generalize across senses, i.e. whether they can also be observed for brief auditory stimuli presented during OKN or pursuit. Experiments were carried out in a light-proof sound attenuated chamber. Normal human subjects performed eye movements elicited by visual stimuli. An auditory target (white noise) was presented for 5 ms. The subjects had to indicate the perceived target position relative to a ruler. Our data clearly indicate that spatial mislocalization occurs during reflexive eye movements and for auditory targets. OKN induces a shift in the direction of the slow eye movement. The effect is stronger for "Schau" as compared to "Stier"-Nystagmus. Preliminary results indicate that smooth pursuit causes a centrifugal shift of perceived auditory stimulus location with respect to the fovea. The observed pattern of these mislocalizations is different from that found for visual targets. This suggests that different neural mechanisms are at play to integrate oculomotor signals and information on the spatial location of visual as compared to auditory stimuli. Supported by DFG-Research Training Network 885 – NeuroAct

Poster #3
VISUAL VESTIBULAR INTERACTIONS FOR SELF MOTION ESTIMATION
John Butler, Max Planck Institute for Biological Cybernetics; Stuart Smith, UCD School of Psychology, Karl Beykirch, Heinrich H. Buelthoff, Max Planck Institute for Biological Cybernetics

Accurate perception of self-motion through cluttered environments involves a coordinated set of sensorimotor processes that encode and compare information from visual, vestibular, proprioceptive, motor-corollary, and cognitive inputs. Our goal was to investigate the interaction between visual and vestibular cues to the direction of linear self-motion (heading direction). In the vestibular experiment, blindfolded participants were given two distinct forward linear translations, using a Stewart Platform, with identical acceleration profiles. One motion was a standard heading direction, while the test heading was randomly varied using the method of constant stimuli. The participants judged in which interval they moved further towards the right. In the visual alone condition, participants were presented with two intervals of radial optic flow stimuli and judged which of the two intervals represented a pattern of optic flow consistent with more rightward self-motion. In the combined experiments, participants were presented with a translation stimulus that had both vestibular

and visual information. From participants' responses, we compute a psychometric function for both experiments, from which we can calculate the participant's uncertainty (standard deviation of the cumulative Gaussian fit). Using the uncertainty values from the vestibular alone and visual alone experiments, we will predict the outcome of this experiment using a maximum-likelihood-method.

Poster #4
AFTEREFFECTS OF PROLONGED LOCOMOTION ON A CIRCULAR TREADMILL
Ilja Frissen, Jan L. Souman, Marc O Ernst, Max planck Institute for Biological Cybernetics

Vestibular activity, motor command efference copies, and proprioception, among others, contribute to self-motion perception. According to Durgin et al. (2005) these sources are recalibrated when they are in conflict with the global self-motion percept. We tested this hypothesis by having participants walk blindfolded on a circular treadmill, under different conditions which varied in speed and direction of treadmill rotation independent of the participants' walking speed. Recalibration was assessed with two tasks. Participants either stood in place and judged when the treadmill had rotated 360º (passive task), or walked 360º on a stationary treadmill (active task). Durgin's, results indicate that participants should undershoot relative to pretest performance in the active task when the treadmill had rotated in the walking direction and that they should overshoot when it was moving against the walking direction. For the passive task the opposite pattern was predicted. However, we obtained an overshoot in both tasks increasing with the duration of adaptation. One possible source for the difference between Durgin's and our results might be the availability of visual information that his participants had at the start of pre/posttests about their location in space. In our study disorientation might have accumulated leading to an increasing overshoot.

Poster #5
VISUAL AND VESTIBULAR CUES FOR SELF-ORIENTATION INFLUENCE OCULOMOTOR AND PERCEPTUAL ASSESSMENTS OF THE INTERNAL REPRESENTATION OF GRAVITY AND BODY ORIENTATION
Michael Barnett-Cowan & Laurence, R. Harris, York University, Psychology, Centre for Vision Research

Visual and vestibular cues influence the internal representation of gravity and perceived body orientation as shown by tilting either the visual world or subjects themselves relative to gravity and aligning an unseen rod to the perceived direction of gravity. The direction of saccadic eye movements has also been used to assess the influence of vestibular, but not yet visual cues. We assessed the effects of visual and vestibular cues by independently varying body and visual orientation using the York Tumbling Room. Subjects indicated the vertical and horizontal axes of their heads (egocentric tasks), the direction of gravity and the horizon (allocentric tasks). The perceived orientation of gravity and the horizon were also measured using rod alignment. In the dark, body-tilt did not affect the egocentric tasks, but systematically shifted the orientations of perceived gravity and the horizon as indicated by saccades and rod settings. Combinations of body-tilt and visual-tilt led to systematic shifts in both perceived head-tilt and gravity with the perceived horizon not always orthogonal to gravity. Thus, allocentric, but not egocentric, tasks are affected by vestibular cues, while both tasks are affected by visual cues. Oculomotor and perceptual systems may use different representations of gravity and the horizon.

Poster #6
DRIFTS OF THE REMEMBERED LOCATION OF VISUAL, AUDITORY AND BIMODAL TARGETS.
Philip Jaekl & Laurence Harris, Psychology, York University, Canada

Over time, the remembered locations of auditory and visual stimuli may be subject to systematic drift. We have determined if such a drift occurs for bimodal auditory-visual stimuli and whether or not change in the remembered locations across time could be estimated from the combination of unimodal auditory and visual data. We recorded the remembered location of 15 and 30° auditory, visual and bimodal targets after delays of 0-12s using a staircase technique. There was a significant drift over time towards a centrally located fixation point for 30° targets and significant drift away from the fixation point for 15° targets, regardless of modality. For the 15° targets, simultaneous multiple regression analysis revealed the remembered location of a bimodal target could be reliably estimated from unimodal data. For the 30° targets, the perceived bimodal location could not be reliably estimated from a multiple regression, although the drift of bimodal targets was less than for unimodal targets. For both target eccentricities the variance in the estimates was lower for vision compared to audition. These data suggest that spatial memory for bimodal auditory-visual stimuli is systematically governed by optimal sensory integration where visual information has more influence than auditory information.

Poster #7
THE EFFECT OF POSTURE OF OWN HAND ON VISUOTACTILE SPATIAL COMPATIBILITY
Yuka Igarashi, Department of Psychology, Tokyo Metropolitan University; Japan Society for the Promotion of Science; Norimichi Kitagawa
NTT Communication Science Laboratories, NTT Corporation; Shigeru Ichihara, Department of Psychology, Tokyo Metropolitan University

In this study, we investigated whether visuotactile spatial compatibility is affected by posture of own hand. Participants made speeded discrimination responses to the location of vibrotactile targets presented to either the tip or base of their forefinger, while trying to ignore simultaneously-presented visual distractors presented to either side of central fixation on a front display. The participants rested their stimulated hand on a desk in either forward pointing or inward pointing posture. The array of the visual distractors was presented in four different angular rotations (0, 45, 90 and 135 degrees). We found that, when the participants' hand was placed in the forward pointing posture, the magnitude of the visuotactile interference effects decreased as the angular difference in orientation between the hand posture and the visual distractor array increased. On the other hand, when the participants rested their hand in the inward orientation, such complete dependence of the magnitude of the visuotactile interference effects on proprioception was not observed, suggesting that visuotactile spatial compatibility is determined depending on both egocentric orientation of own hand and allocentric vertical orientation of the visual distractor array. Possible interactions between vision, touch, proprioception, and the internal representation of the hand will also be discussed.

Poster #8
DISTORTIONS OF VISUAL AND AUDITORY SPACE FOLLOWING MOTION ADAPTATION
Ross Deas, Neil Roach & Paul V. McGraw
Visual Neuroscience Group, School of Psychology, University of Nottingham, UK

There is growing evidence that the neural mechanisms which encode visual and auditory motion are more similar than previously thought. In this study, we examine the effects of motion adaptation on the perceived location of subsequently presented stationary stimuli. Following adaptation to unidirectional visual motion, the perceived position of a stationary stimulus appears offset in the direction opposite to the adapting motion, showing a direct interaction between the mechanisms which encode motion and spatial position. This motion induced shift is velocity dependent and peaks at ~10 deg/s. Using individual head related transfer functions (HRTF) we created auditory motion stimuli in the horizontal plane which could vary in angular velocity, spatial extent and duration. Subjects adapted to unidirectional auditory motion and then made a spatial localization judgment of a stationary auditory stimulus relative to the midline. Consistent with visual findings, all subjects showed a marked direction dependant shift in perceived auditory position, relative to a 'no adaptation' baseline measure. The velocity tuning functions for this effect showed a striking similarity to their visual counterparts suggesting a common processing scheme for these effects. Subsequent experiments investigated the cross-modal effects of motion adaptation on position coding. (this project was supported by the wellcome trust)

Poster #9
EXPLORING BY EYE AND HAND: BIMODAL INTERACTIONS IN THE PERCEPTION-ACTION CYCLE
Nicola Bruno, Dipartimento di Psicologia, Università di Trieste; Marco Bertamini & Georg Meyer, School of Psychology, University of Liverpool

Perceiving the three-dimensional structure of an object often involves merging vision and haptics over extended periods of exploration. As exploration progresses, new information may require changing how the two sensory signals are treated. We asked whether (i) bimodal interactions during extended observation can adjust to changes in the quality of unimodal sensory signals; and (ii) there are specific temporal constraints on these adjustments. When viewing a three-dimensional Necker cube with one eye, participants experience illusory reversals even while they feel the cube with their hands. This property makes the visual-haptic Necker cube an excellent model to investigate bimodal processes when previously consistent bimodal signals change in quality over time or begin to conflict. Our participants reported reversals while we varied their exploratory behavior. We varied fixation by asking participants to move fixation from the front to the back of the cube, and we varied haptic information by asking them to hold the cube with only the fingers or to explore the cube with the hands. We recorded fixations as well as hand movements. Both kinds of exploration had a clear effect on the probability of experiencing alternative percepts as well as on the time course of reversals. In addition, when both were performed the effect of visual exploration was modulated by that of haptic exploration. Overall, these results suggest that (i) bimodal processes can adjust to changes in the quality of unimodal signals

during exploration, and (ii) the adjustments caused by these changes are characterized by specific temporal dynamics.

Poster #10
ACTION UNDERSTANDING: AN INVESTIGATION INTO THE SIMULTANEOUS PERCEPTION AND PERFORMANCE OF HUMAN MOVEMENT
Stuart Jackson, School of Computer Science and Informatics, UCD; Nuala Brady, School of Psychology, UCD; Fred Cummins, School of Computer Science and Informatics, UCD; Kenneth Monaghan, School of Physiotherapy and Performance Science, UCD

In a series of behavioural studies, we are examining the interaction between the observation of human movement and the simultaneous control by the observer of his/her own movement. We are particularly interested in answering the question of whether the presence of an actual person is crucial to inducing interaction between observed and performed actions. Do certain features of observed human movement (direction, velocity, effector, etc.) have a greater impact on movement control than others? Can these features be isolated and investigated using point-light displays, a widely used test material in action perception research? The study tasks require participants to perform gross arm movements in either horizontal or vertical directions while simultaneously observing either another person or a point-light figure perform the same or different movements. Movement variability is measured as the angular displacement of a point on the hand relative to the shoulder/torso, and is recorded using 3-D motion tracking equipment. Initial data suggest movement control may be differentially affected across conditions. The results are particularly relevant to work on autism spectrum disorder (ASD), in which biological movement perception is found to be impaired, and are also relevant to research on shared perception-action systems, or 'mirror neuron' systems, more generally.

Poster #11
VISUALLY INDUCED LINEAR VECTION IS ENHANCED BY SMALL PHYSICAL ACCELERATIONS
Bernhard E. Riecke, Franck Caniard, Jörg Schulte-Pelkum, Max Planck Institute for Biological Cybernetics, Tübingen, Germany

Wong & Frost (1981) showed that the onset latency of visually induced self-rotation illusions (circular vection) can be reduced by concomitant small physical motions (jerks). Here, we tested whether (a) such facilitation also applies for translations, and (b) whether the strength of the jerk (degree of visuo-vestibular cue conflict) matters. 14 naïve observers rated onset, intensity, and convincingness of forward linear vection induced by photorealistic visual stimuli of a street of houses presented on a projection screen (FOV: 75°×58°). For 2/3 of the trials, brief physical forward accelerations (jerks applied using a Stewart motion platform) accompanied the visual motion onset. Adding jerks enhanced vection significantly; Onset latency was reduced by 50%, convincingness and intensity ratings increased by more than 60%. Effect size was independent of visual acceleration (1.2 and 12m/s^2) and jerk size (about 0.8 and 1.6m/s^2 at participants' head for 1 and 3cm displacement, respectively), and showed no interactions. Thus, quantitative matching between the visual and physical acceleration profiles might not be as critical as often believed as long as they match qualitatively and are temporally synchronized. These findings could be employed for improving the convincingness and effectiveness of low-cost simulators without the need for expensive, large motion platforms.

Poster #12
THE CHANGE OF AUDITORY MOTION DETECTION DEPENDING ON THE DIRECTION OF VISUALLY INDUCED SELF-MOTION
Wataru Teramoto, Hiroshi Watanabe, Hiroyuki Umemura, National Institute of Advanced Industrial Science and Technology, Japan

We investigated the influence of large-field visual motion on the detection performance of auditory motion. Several studies have demonstrated that local visual motion (i.e. object-motion) captures the perceived direction of auditory motion. However, little is known about the influence of global visual motion such that self-motion perception is induced on auditory motion perception. In the present study we used Gaussian white-noise filtered with head-related transfer functions as auditory stimuli. They were virtually presented in observers' back space, moving leftward or rightward from just behind their heads at various constant speeds, while large-field visual motion was continuously presented and compelled observers to perceive self-motion (either yaw-axis or pitch-axis circular vection). Observers were requested to judge the moving direction of the auditory stimuli as quickly and accurately as possible. As a result, auditory stimuli moving leftward were detected more quickly and accurately than those moving rightward when rightward visual motion was presented while inducing leftward self-motion, and vice versa. There was no difference between upward and downward visual motion conditions. The implications of these results are discussed in light of the contribution of self-

motion mechanism to auditory spatiotemporal processing.

Poster #13
ORDERING CROSS-MODAL EVENTS IN TIME: WHEN ILLUSORY AND VERIDICAL PERCEPTIONS COEXIST
Salvador Soto-Faraco, ICREA & Parc Cientific de Barcelona, Universitat de Barcelona; Agnes Alsius, Dept. Psicologia Basica & Parc Cientific de Barcelona, Universitat de Barcelona

A prevalent view in multi-sensory integration literature is that cross-modal binding results in a coherent and unitary perceptual experience. This is used to explain the dramatic illusions that are often experienced as a consequence of exposure to inter-sensory conflict such as the McGurk illusion. Looking at lip movements that mismatch an acoustically presented syllable (i.e., the lip movements of [ga] with the sound /ba/) leads to an alteration of what is heard (often /da/, in the example). However, in stark contrast with the assumption of unity, here we report that observers can access veridical information regarding the true temporal order of unisensory component signals of an audiovisual syllable, while at the same time they experience an acoustic illusion that results in a reversal of the time order of the information specified in each sensory modality. This result raises the possibility that our brain can gain access to some unimodal component information as well as to the result of the integrated percept, suggesting the separability between the processing level at which sensory judgments can be made and the processing level at which multisensory binding occurs.

Poster #14
VISUAL-TACTILE INTEGRATION: DOES STIMULUS DURATION INFLUENCE THE RELATIVE AMOUNT OF RESPONSE ENHANCEMENT?

Stefan Rach, Department of Psychology, Oldenburg University, Germany; Adele Diederich
School of Humanities and Social Sciences, International University Bremen, Germany
Neurophysiological studies on higher mammals suggest that the benefits of multisensory integration are larger for less intense stimuli, that is, inverse effectiveness: the relative amount of multisensory response enhancement (MRE) is inversely related to stimulus intensity (Stein & Meredith, 1993, MIT Press). This finding is supported by behavioral studies on humans that showed an inverse relation between the magnitude of intersensory facilitation and stimulus intensity. Two experiments were conducted to investigate whether inverse effectiveness might apply also to stimulus duration. Participants were required to perform saccades to visual targets positioned left or right from fixation, while, on some trials, ignoring tactile non-targets that were presented either spatially aligned or contralateral to the visual target (focused attention paradigm). Stimulus duration of both target and non-target varied. Saccadic reaction times were recorded. Both experiments revealed that the largest relative amount of intersensory facilitation (in terms of MRE) was elicited by the shortest stimuli and that MRE decreased with increasing stimulus duration, thus, inverse effectiveness of stimulus duration.

Poster #15
ASSESSING MULTISENSORY TEMPORAL CUES FOR MOTION PERCEPTION
Vanessa Harrar & Laurence R. Harris
York Univerisity, Centre for vision research. Canada

Perceiving motion requires integration of spatial and temporal information in some cases across modalities. To investigate this integration we used three types of stimuli in a classic Ternus configuration: lights, mechanical touches and combined lights and touches. The three stimuli (ABC) were arranged in a row across three finger tips. A and B were presented and extinguished and, after a delay (varied using constant stimuli), B and C were illuminated and extinguished. Subjects were asked whether they perceived AB moving to BC or A moving to C. For all three stimulus types, at short delays A to C dominated, while at longer delays AB to BC dominated. The critical delay, where the perception changed, was significantly different for each stimulus type. The multimodal transition was predictable from the unimodal transitions in a statistically optimal integration. These results support a multimodal motion system. Special thanks to Tom Troscianko and NSERC.

Poster #16
THE EFFECT OF DELAYING THE ONSET OF A VISUAL TARGET ON TIME COURSE OF THE APPARENT DISPLACEMENT OF THE OCULOGYRAL ILLUSION
Akira Suetsugu, Graduate School of Business Administration, Kobe University; Taku Konishi
Depertment of Psychology, Kobe University

We examined the effect of delaying the onset of a visual target after vestibular stimulation on the apparent displacement of the oculogyral illusion (OGI) that is a visual illusion caused by vestibular stimulation. In the dark room, participants performed a pointing task to a visual target for 100 s after vestibular stimulation provided by the cessation of constant rotation (72 deg/s, 8 revolutions) around the Z axis. The onset of the visual target was just after the rotations was stopped

(no-delayed condition), or 20 s after that (delayed condition). We also measured baseline without vestibular stimulation. In the no-delayed condition, the visual target was localized near baseline at the onset of the task and the apparent displacement increased for about 20-24 s. The same characteristics were observed in the delayed condition although vestibular signal to cause the apparent displacement had changed during the delay period. These results suggest that time course of the apparent displacement of the OGI is not only a function of time after vestibular stimulation and the timing of the onset of the first visual input after vestibular stimulation have an effect on the visual-vestibular integration process of visual target localization.

Poster #17
AUDITORY CAPTURE OF VISUAL MOTION
Lynnette Leone, Mark McCourt
Center for Visual Neuroscience, North Dakota State University, USA

We asked: 1) if the perceived direction of visual motion is influenced by auditory motion; 2) if contrast discrimination thresholds for visual motion are altered by concurrent auditory motion; and if 3) reflexive tracking eye movements to ambiguous visual motion stimuli are influenced by concurrent auditory motion. The visual stimulus was a compound Gabor patch (375 ms) whose motion energy was varied by adjusting the contrast of its rightward- and leftward-drifting components. Visual motion was paired with sounds whose motion in 3D auditory space could be manipulated (rightward, leftward, static, no sound). Observers judged the direction of visual motion. Discrimination thresholds for detecting rightward (or leftward) visual motion were obtained under similar auditory conditions. Finally, observers judged the direction of motion of an ambiguous (left-right balanced) visual stimulus during eyetracking. Results show that the perceived direction of visual motion is strongly influenced by concurrent auditory motion, such that auditory motion "captured" ambiguous visual motion. Visual motion discrimination thresholds were elevated for congruent auditory motion (and reduced for non-congruent auditory motion). Finally, auditory motion affected the gain of reflexive tracking eye movements elicited by an ambiguous visual stimulus, suggesting audiovisual interaction at very short latencies in an early processing site.

Poster #18
FAILURE TO ELIMINATE THE CROSSED-HANDS DEFICIT IN A TACTILE TEMPORAL ORDER JUDGMENT
Kristie Dukewich, Dalhousie University, Department of Psychology; David Shore McMaster University, Department of Psychology

Being able to identify and interact with tactile stimuli is fundamentally dependent on first being able to localize such stimuli, but it remains to be determined whether remapping of somatotopic locations into allocentric space is a necessary step for that interaction to occur. In a tactile temporal order judgment (TOJ) task participants are asked to temporally order two successive tactile stimulations to different hands. Results from experiments using tactile TOJ have suggested that the spatial remapping of body coordinates into allocentric space is critical for completing this task. The current study sought to determine whether this spatial remapping is necessary by attempting to eliminate the crossed-hands deficit. The results demonstrate that the crossed-hands deficit cannot be eliminate with speed stress, practice, or correct feedback, suggesting that observers remap somatotopic coordinates into external space automatically. The deficit appears to be linked to tactile tasks in which spatial resolution is necessary; however, more experiments need to be done in order to confirm that spatial resolution is both necessary and sufficient to produce the effect.

Poster #19
AUDITORY CUE EFFECT ON VISUAL TEMPORAL ORDER JUDGMENT: THE SPATIAL PROXIMITY OF AUDIO AND VISUAL STIMULI
Yuki HONGOH, Shinichi KITA
Department of Psychology, Kobe University; Yoshiharu SOETA, Institute for Human Science and Biomedical Engineering, National Institute of Advanced Industrial Science and Technology

We examined the effect of auditory cue on visual temporal-order judgment (TOJ). A pair of small speakers and light-emitting diodes (LEDs) were used in order to make proximate the locations of auditory and visual stimuli. Two visual stimuli were presented successively at a short interval after an auditory cue, which was presented on either the right or left side. Results showed biased judgment that the visual target at the auditory-cued side was presented first. This effect remained even when the auditory and visual stimuli were 600ms apart. Compared with results of our preceding study (Hongoh & Kita, 2005), in which a headset and a CRT display were used, the auditory cue effect in the present study was smaller. In other words, the auditory cue effect on visual TOJ was less substantial when the distance of auditory and visual stimuli was reduced. This difference suggests that the unambiguity of the auditory cue sound localization plays an important role in the

auditory cue effect on visual TOJ. This effect might not be due to the often-cited hypothesis that multisensory stimuli are from a same event or a sequence of related events.

Poster #20
PRIOR ENTRY AND THE COLAVITA EFFECT
Camille Koppen & Charles Spence, Experimental Psychology, Oxford University

The Colavita effect describes the phenomenon whereby in a speeded discrimination task in which participants are presented with unimodal auditory, unimodal visual, or bimodal audiovisual stimuli, they often fail to respond to the auditory component of the bimodal targets. In the present study, we presented participants with unimodal auditory, unimodal visual, and bimodal stimuli, and varied the stimulus onset asynchrony (SOA) between the auditory and visual components of the bimodal targets. Participants responded to the auditory, visual and bimodal targets by pressing an auditory response key, a visual response key, or both keys. On bimodal trials, participants failed to respond to the sound significantly more often than they failed to respond to the light, thus demonstrating the prototypical Colavita effect. Importantly, the magnitude of the Colavita effect was found to decrease when the visual stimulus was presented after the sound. The magnitude of the Colavita effect at each SOA was also found to correlate significantly ($r = +0.825$) with the likelihood that participants would judge the visual stimulus as coming before the auditory stimulus when they performed an unspeeded temporal order judgment task in a separate block, thus supporting a prior entry interpretation of the Colavita effect.

Poster #21
SEEING DIGITS MODULATES FINGER TACTILE PERCEPTION
Brozzoli Claudio, INSERM U534 Espace et Action

Perceiving numbers involves a spatial component. Neuropsychological and TMS studies provided evidence that subjects use spatial representations, akin to a 'mental number line', in basic numerical processing tasks. Merely looking at numbers may modulate visual perception. We asked whether visual number perception may modulate tactile detection, according to number magnitude. Moreover, from the observation that western subjects' way of counting (1 to 5) is associated on their fingers, we tested whether tactile perception would be affected according to an anatomy/magnitude-based association, or an out-of-the-body spatial representation of number magnitude. Normal participants were asked to detect touches delivered to the little finger of the (unseen) right hand after a brief central presentation of one of four digits (1, 2, 4, 5), with the hand either in a palm-down, or palm-up posture. When the little finger was stimulated in the right hemispace (palm-down), tactile detection performance was better following visual presentation of the largest (5) than smallest number (1); a better performance after the smallest than the largest digit presentation was found in the opposite posture (palm-up). Implications for multisensory body-space number mapping are discussed.

Poster #22
FEATURE-DEFINED AUDITORY SALIENCY CAPTURES VISUAL TIMING
Takuro Kayahara, Department of Spatial Design and Information Systems, Miyagi University

It is not easy to decide which information in one modality should be integrated with which one in the other modality to perceive coherent world, because the world consists of too many objects and events. The cues and the mechanisms for correct integration of information from different modality remain unclear. In this study, the phenomenon in which the salient tone element defined by frequency difference in a tonal sequence captures perceived timing of visual flash was reported. In the experiment, visual flash of a disk on a CRT display was presented at the same time of 2nd or 3rd element tone in an auditory sequence which consisted of 4 sine waves of 100-ms duration. Subjects were required to respond which element of 2nd or 3rd in the auditory sequence was heard when the disk was presented. In results, subjects could judge correctly which auditory element was heard at the same time of the disk when the frequency of all auditory elements was the same, although when the frequency of 2nd or 3rd element was different from other elements of the sequence, 2nd or 3rd element captures the 'timing' of the disk, and judgment of subjects was biased significantly. These results suggest that the integration of the information from different modality might not be achieved by static cues or mechanisms such as mere timing between modalities, but be achieved with some dynamic manners depending on the structure of information in one modality.

Poster #23
PRINCIPLES OF AUDITORY AND AUDITORY-VISUAL GROUPING
Mirjam Keetels & Jean Vroomen
Psychology, Tilburg University

The authors explored principles of auditory and auditory-visual grouping. Participants made visual temporal order judgments (TOJ) about which of two centrally presented lights appeared first while they heard task-irrelevant

critical sounds before the first and after the second light. Temporally misaligned sounds captured the onsets of the lights (i.e., temporal ventriloquism). This temporal ventriloquist effect was greatly attenuated when the critical sounds themselves were flanked by similar sounds, but not when the flanking sounds had different frequency, or rhythm. The results demonstrate that principles of auditory grouping take priority over intersensory ones.

Poster #24
VIBROTACTION ENHANCES PERCEIVED AUDITORY VOLUME AT A POST-PERCEPTUAL LEVEL
Kielan Yarrow, Sobell Dept., Institute of Neurology, and Institute of Cognitive Neuroscience, UCL

Vibrotactile stimuli can elicit a compelling impression of having actually heard a tone, even when very little sound energy is being generated. It has previously been shown that subjects judge auditory tones embedded in white noise to be louder when they are accompanied by a vibrotactile stimulus of the same frequency. A first experiment replicated this result at four different levels of auditory stimulation (no tone, threshold tone, 10 dB above threshold and 20 dB above threshold). The presence of a vibrotactile stimulus induced an increase in the perceived volume of auditory tones across this range. In a second experiment, a two-interval forced choice procedure was used to assess the nature of this crossmodal interaction. Subjects were biased when vibrotaction was applied in one interval, but performance was identical when vibrotaction was applied in both intervals compared to when no vibrotactile stimuli were applied. This result demonstrates that vibrotaction can be ignored when judging the presence of an auditory tone. This implies that the interaction between vibrotaction and audition does not occur at an early perceptual level.

Poster #25
ERP EFFECTS OF MOVEMENT PREPARATION ON VISUAL PROCESSING: ATTENTION SHIFTS TO THE HAND, NOT THE GOAL.
Elena Gherri, Dipartimento di Scienze Sociali, Cognitive e Quantitative, Universita' di Modena e Reggio Emilia; José Van Velzen, Martin Eimer
Department of Psychology, Birkbeck College, University of London, UK

We investigated whether lateralised ERP components during reaching movement preparation are triggered by effector or target selection, and whether movement preparation induces spatially selective modulations of visual processing. Participants executed one of four possible movements (left/right hand toward left/right target). In experiment 1, a cue indicated the effector to use or the movement direction, and the imperative stimulus contained the lacking information (direction or effector, respectively). In experiment 2, the cue conveyed full information (effector and direction). Task-irrelevant visual probe stimuli were presented randomly near the hand or the target location during response preparation. In both experiments anterior and posterior lateralised ERP components (ADAN, LDAP) were elicited contralateral to the selected effector and to the selected movement direction. The LDAP was more pronounced during effector selection. During preparation based on partial information, enhanced early visual components were observed in ERPs elicited by probes near the cued hand, but not near the target location. During preparation based on full information, visual processing was enhanced near the target location only when effector and target were located in the same hemifield. These results suggest that during covert reaching movement preparation, visuospatial attention shifts toward the starting location of the cued hand, not to the goal location.

Poster #26
TEMPORAL DYNAMICS OF AUDITORY-VISUAL INTERACTIONS AS REVEALED BY EVENT-RELATED POTENTIALS TO BIMODAL STIMULI WITH DIFFERENT ONSET ASYNCHRONY
Matthias Gondan, Matthias Dinnbier & Mark W. Greenlee, Experimental Psychology, University of Regensburg, Germany

In a very basic paradigm of multisensory research, event-related potentials (ERPs) are measured while participants observe a series of e.g. auditory, visual, and bimodal auditory-visual stimuli. In this approach, the ERP to auditory-visual stimuli (AV) is compared to the sum of the ERPs to auditory (A) and visual (V) stimuli: AV–(A+V). If the result differs from zero, it is concluded that audition and vision interact at some processing stage. Using this method, several studies have demonstrated very early multisensory interactions at processing stages which were previously considered as unisensory. The nature of these interactions was interpreted as a modulation of activity in one sensory channel due to the concurrent presentation of a stimulus in the other sensory channel. We tested this hypothesis using bimodal auditory-visual stimuli with different onset asynchronies (0, 30, 60, 90, 120 ms), either with a leading auditory or a leading visual stimulus. Results indicate that the ERP responses to synchronous and asynchronous stimuli are different. More

refined analyses revealed a specific ERP component, related to the synchronous auditory-visual presentation. It can be concluded that auditory-visual interactions occur within a very limited time window, reflecting short-lived activity in supramodal neural generators.

Poster #27
AUDITORY AREAS ARE ACTIVATED DURING A VISUO-MOTOR TASK
Roberto Martuzzi, Department of Radiology, University Hospital, Lausanne,; Micah Murray, Division of Neuropsychology, University Hospital, Lausanne,; Philippe Maeder, Eleonora Fornari
Department of Radiology, University Hospital, Lausanne; Jean-Philippe Thiran, Signal Processing Institute, Ecole Polytechnique Fédérale de Lausanne, Lausanne,; Stephanie Clarke, Division of Neuropsychology, University Hospital, Lausanne; Christoph Michel, Department of Neuroscience, University of Geneva, Geneva; Reto Meuli, Department of Radiology, University Hospital, Lausanne, Switzerland

Evidence is accumulating that brain regions traditionally considered as unisensory contribute to multisensory interactions. In this study, we investigated the BOLD response within auditory areas during a visuo-motor task. Ten subjects performed a simple reaction-time task in response to a lateralized visual stimulus at 1.5T. Stimuli were randomly presented at the right or at the left visual field (lateralization 9.5°), and subjects were asked to respond upon simple detection with the right hand in the first session and with the left one during the second session. Stimuli were presented for 125ms with and inter-trial interval varying from 14.125 to 17.875s in steps of 125ms. In addition to activations within visual- and motor-related areas, we identified frank bilateral activations within auditory areas, with a clear predominance (both in size and in intensity) on the side contralateral to the responding hand. This dominance suggests that the signal intensity is primarily modulated by the responding hand and/or by the somatosensory stimulation generated during the motor response. The visual field of stimulation did not directly impact response size or intensity. The collective findings raise the possibility that activations in auditory cortices during visuo-motor tasks are more related to auditory-somatosensory interactions than to auditory-visual interactions.

Poster #28
NEURAL CORRELATES OF SYNCHRONY PERCEPTION USING AUDIOVISUAL SPEECH STIMULI
Daniel Bergmann, Department of Neurology II, Otto von Guericke University, Magdeburg, Germany; Charles Spence, Department of Experimental Psychology, University of Oxford; Hans-Jochen Heinze, Department of Neurology II, Otto von Guericke University, Magdeburg; Toemme Noesselt. Department of Neurology II, Otto von Guericke University, Magdeburg, Germany

We explored the neural bases of the perception of synchrony for complex audiovisual speech stimuli using short video-clips. Subjects' (n=12) individual delay-thresholds were determined and then used in a subsequent fMRI-experiment. Auditory, visual, and polysensory brain-areas were identified in preliminary localizer runs before the main experimental session in which three conditions (sound preceding vision, synchronous, vision preceding sound) were presented while subjects indicated whether they perceived the video-clips as being synchronous or not. Analysis of the fMRI data compared the sensory conditions, the subjects' responses and perception within auditory, visual and polysensory brain areas. Preliminary results reveal two distinct cortical networks for the perception of synchrony vs. asynchrony: In particular, synchrony perception was associated with the modulation of activation in the fusiform gyrus, the STS, and the Planum temporale/Insula within the right hemisphere; By contrast, activations specifically associated with the perception of asynchrony were seen in the fusiform gyrus, the IPS and the IFG/MFG bilaterally. Analysis of the sensory conditions and the subjects' decisions revealed modulations of early visual, auditory and multisensory areas. Taken together, these results suggest that perception of audiovisual synchrony and asynchrony might be mediated by two different albeit overlapping neural systems.

Poster #29
THE EFFECTS OF MOTOR RESPONSES ON THE ADDITIVE AV-(A+V) MODEL: AN ERP STUDY
Neil Harrison, Georg Meyer & Sophie Wuerger
School of Psychology, University of Liverpool

An additive model is widely used in multimodal research, particularly to assess crossmodal ERP interactions where the sum of the unimodal ERPs is compared to the bimodal ERP. Problems in interpreting the model are caused by factors other than sensory processes which elicit common processes that are subtracted twice but added only once. The current study tests the time-point at which motor processes begin to confound the ability of the model to accurately assess crossmodal interactions. One group of participants responded to a stationary stimulus (either A,V,

or AV) by pressing a button, while a separate group of participants made no motor response to the same stimulus. A typical pattern of crossmodal interactions was observed, consisting of a positivity at around 180 ms and a negativity at around 260 ms post-stimulus. Significant amplitude differences between the button-press and non-button-press groups were observed from 250 to 300 ms over central and frontal electrodes, and also from around 350 ms. No significant differences were observed between the groups before 250 ms post-stimulus. This data supports the view that the additive model can accurately predict crossmodal ERP interactions up to around 250 ms post-stimulus.

Poster #30
EFFECTS OF ALPHA OSCILLATORY POWER DURING PRESENTATION OF NATURALISTIC MULTISENSORY EVENTS
Simon Kelly, Daniel Senkowski, Dave Saint-Amour, John Foxe, NKI, New York

In a recent study, the temporal dynamics of neural processes involved in cross-modal integration of naturalistic objects in motion were examined through ERP analysis of high-density EEG. A tri-phasic pattern evident in the ERP, showing a temporally stable scalp topography, alluded to the presence of stimulus-evoked oscillations within the alpha (8-14Hz) frequency band. To further investigate, we performed time-frequency analysis on the data contrasting effects of alpha power following each of 6 stimulus types: combined auditory-visual (AV), and the respective unisensory auditory (A) and visual (V) components of both a naturalistic motion stimulus (i.e., a water splash) and a non-naturalistic control stimulus, which were presented in a randomized stream. Evoked alpha power over bilateral occipital cortex observed following visual and multisensory stimulation exhibited a distinctly more inferior topography from that of ongoing alpha power measured from the pre-stimulus period, suggestive of a process distinct from ongoing oscillatory activity. This effect paralleled the previous findings of the tri-phasic ERP pattern and thus suggests an involvement of alpha oscillations in naturalistic multisensory processing. Additionally, a significant desynchronization of parieto-occipital alpha power was observed for naturalistic auditory-alone stimuli but was absent in the non-naturalistic condition. This possibly reflects increased visual imagery following naturalistic auditory stimulation.

Poster #31
INVESTIGATING MULTISENSORY INTEGRATION USING SPREAD SPECTRUM STIMULATION.
Edmund Lalor, Richard Reilly, School of Mechanical, Electrical and Electronic Engineering, University College Dublin; Barak Pearlmutter, Hamilton Institute, NUI Maynooth; John Foxe, Cognitive Neurophysiology Lab, Nathan Kline Institute

The visual evoked potential (VEP) is a routinely used and extremely valuable tool in both research and clinical settings for the evaluation of visual sensory and perceptual processing. A method for rapidly and continuously measuring the visual evoked response would be of great scientific benefit. We describe a method which facilitates the rapid acquisition of a VEP with a complete temporal profile and high SNR. This is accomplished by smoothly modulating the luminance of a visual stimulus using underlying Gaussian noise waveforms to rapidly estimate the time-domain impulse response, termed VESPA (Visually-Evoked Spread Spectrum Response Potential). Despite their unobtrusive nature, the richness of the stimuli accelerates the process of response acquisition compared to conventional binary stimuli. Furthermore these non-saturating stimuli may have the advantage of being more sensitive to changes in brain state. This method, which we show to be useful in evoking visual responses, could be extended to other modalities, especially audition. By investigating the difference in responses obtained when stimulating both modalities with the same spread spectrum waveform and with different waveforms the method described in this study may have significant impact on experiment design for research into multisensory integration.

Poster #32
FITTING INTRACRANIAL MULTIMODAL ERPS TO AN EXPLORATORY, HIERARCHICALLY ARRANGED NEURAL MASS MODEL.
Rosalyn Moran, Richard Reilly, School of Electronic, Electrical and Mechanical Engineering, University College Dublin, Ireland; Sophie Molholm, John Foxe, Nathan Kline Psychiatric Research Institute

A recent neural mass model of ERP generation (David, Friston et al. Modelling event-related responses in the brain. NeuroImage 25, 2005.) has identified different ERP patterns dependent on the type of hierarchy in which a given cortical area is embedded. These hierarchies include (i) bottom-up processing with intrinsic excitation, where the feedforward structure may extend for one to many areas, (ii) top-down processing from high-level cortical areas and (iii) lateral processes with excitation from anatomically local neuronal pools. Here, in the area of the lateral superior parietal lobule Event Related Potentials have been extracted for unimodal audio and visual, and multimodal AV behavioural, button-press response tasks using

intracranial EEG. This study presents a methodology where this neural mass model may be fitted to these ERPs, for the purpose of examining multimodal integration. Results show that pertinent ERP features, including important late components, are best fitted to real data by the optimisation of delay and area connectivity parameters. Model parameters that describe intrinsic area connections and operation (e.g. max EPSP, max IPSP, maximum firing rate) are less significant when attempting to fit the model set to real intracranial EEG. This work is a necessary precursor to developing an optimisation scheme for multimodal, data-driven models.

Poster #33
MULTISENSORY ENHANCEMENT FOR COST-EFFECTIVE MOTION SIMULATORS
Aleksander Väljamäe, Ana Tajadura, Pontus Larsson, Daniel Västfjäll, Mendel Kleiner
Chalmers Room Acoustics Group, Chalmers university of Technology

The sensation of illusory self-motion (vection) and presence can be reliably elicited in motion simulators with large visual displays. However, many low-cost multimedia applications use smaller screens and therefore might benefit from multisensory enhancement of motion simulation. The current psychophysical study represents the evaluation of a low-cost motion simulator prototype for the POEMS (Perceptually Oriented Ego-Motion Simulation) project. In this study we examined the feasibility of eliciting self-motion sensation using a visual display with a small field-of-view (FOV: 37H x 30V deg). To compensate for reduced visually-induced vection, rotating scenes were enhanced by concurrent presentation of additional multisensory cues (vibrating seat, spatial sound delivered via stereo bone conduction headset) and manipulation of viewing conditions (restricted FOV). Our findings demonstrate that multisensory cues make feasible self-motion simulation with a small visual display. These findings may be implemented in commercially available multimedia technologies (e.g. computer games, low-cost motion simulators).

Poster #34
INTEGRATING INFORMATION FROM MULTIPLE SIGNALS FOR THE ROBUST DETECTION OF NEONATAL SEIZURES
Barry Greene, School of Electrical, Electronic and Mechanical Engineering, University College Dublin; Geraldine Boylan, Department of Paediatrics and Child Health, University College Cork; Sean Connolly, Department of Clinical Neurophysiology, St. Vincent's University Hospital, Dublin; Richard Reilly, School of Electrical, Electronic and Mechanical Engineering, University College Dublin, Ireland

Neonatal seizures are the most common central nervous system disorder in newborn infants. Long term neurological damage and impairment may result from prolonged untreated seizures. As clinical detection of seizures in the newborn is known to be unreliable, a robust and reliable automated system would be of great clinical value. This study focused on the development of detection of neonatal seizures based on fusion of pertinent information from simultaneously acquired electroencephalogram (EEG) and electrocardiogram (ECG) data. A dataset of 11 recordings from 9 neonates containing 633 seizure events, labelled by an expert in neonatal EEG, were recorded and analyzed. Each recording contained 7-12 channels of EEG and one channel of simultaneously acquired ECG. The seizure detection performance based on the multimodal fusion of EEG and ECG data was found superior to the performance of either the EEG or ECG unimodal seizure detection systems. On a patient-specific basis, 627 of 633 (99.05%) expert-labelled seizures were correctly detected (false detection rate: 23.64%). On a patient-independent basis, 422 of 633 (73.02%) of expert labelled seizures were correctly detected (false detection rate: 36.67%). The multimodal combination of EEG and ECG data represents a new approach in seizure detection and a significant improvement on previous reported methods.

Poster #35
ADVANCING DTI TRACTOGRAPHY ALGORITHMS BASED ON QUALITATIVE AND QUANTITATIVE COMPARISON OF ALGORITHMIC PERFORMANCE
Stephen Meredith, Steve Crettenand
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Diffusion Tensor Imaging (DTI) is a relatively recent and intensely researched imaging modality based on the principles of MRI. Tracking of nerve fibre pathways within the brain using DTI is known as fibre tractography. Despite the importance of tractography and the number of proposed algorithms, few comparisons of these algorithms have been reported. A platform for qualitative and quantitative comparison of tractography algorithms has been developed. The motivation for this platform arises from the need for a feedback driven approach to the development of new and improved algorithms. Such an approach is of particular relevance in the

absence of an anatomical gold standard. This research focuses on the development of a Level Sets based DTI Tractography algorithm, with the definition and optimisation of propagation conditions and speed functions being driven by the outputs of comparative studies using both a publicly available synthetic dataset and real datasets. Comparison of two existing tractography algorithms, Streamlines Tracking Techniques (STT) and Tensor-Deflection (TEND), has been made using parameters such as length, average FA, minimum FA, curvature and maximum angle. Results such as the fact that STT fibres exhibit higher curvature than those from TEND are applied in developing robust Level Set based tractography algorithms.

Poster #36
THE INFLUENCE OF PSYCHOPHYSICAL PROCEDURE AND STIMULUS TYPE ON ESTIMATES OF HUMAN PERFORMANCE IN DETECTING AUDIO-VISUAL ASYNCHRONY
Rob L.J. van Eijk, Armin Kohlrausch, Steven van de Par, James F. Juola, Eindhoven University of Technology, Netherlands

Human perception of audio-visual synchrony is typically characterized by two quantities: the point of subjective equality (PSE) and human sensitivity to asynchrony. The PSE can be derived from the 50% point in a temporal order judgment (TOJ) procedure or from the average of both intersections of the synchronous response curve with the non-synchronous response curve(s) in a synchronous-successive response paradigm. Sensitivity is derived from the steepness of the response curve in the TOJ paradigm. In this contribution we present data that show that PSE estimates derived from TOJ measurements are much more variable across observers than those based on synchronous-successive data. Two synchronous-successive methods were used with different response categories: (1) 2 categories: asynchronous, synchronous, and (2) 3 categories: audio first, synchronous, video first. Both synchronous-successive methods yielded similar results. Two stimuli were used: (1) a flash-click stimulus, and (2) a simple animation of a bouncing ball. PSE estimates derived from synchronous-successive data were larger for the bouncing ball stimulus. Furthermore, we analysed discriminability values obtained with a 2-alternative forced-choice procedure. Discriminability is better near the edge than in the middle of the synchronous response category. This suggests that categorical perception might play a role in audio-visual synchrony perception.

Poster #37
ASSESSMENT OF VISUO-AUDITORY COGNITION BY IMMERSION IN VIRTUAL REALITY
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The present study investigates visuo-auditory spatial cognition with a navigation task in visual virtual environment (VE) integrating the auditory modality. Subjects (n=37) were equipped with a head-mounted display coupled with an electromagnetic sensor system and immersed in a virtual town. They also weared headphones, which delivered a soundscape updated in real-time according to their movement in the virtual town. Their task was to explore the VE to find auditory and visual landmarks. After immersion, subject made a recognition task with bimodal elements and a recall of landmarks on a schematic map of the town. Results showed that subjects performed very well in exploration task (number of landmarks found, short time spent in the VE) and had a relative good report of landmarks. They presented a high level of presence (feeling of immersion). Subjects performance in the recognition task were quite good; errors were mainly rejected target items rather than false recognition. Researches on multimodal VR have to develop more accurate knowledge of human spatial abilities and VR setup have to be improved specially in the mapping between the motor outflow and the multiple sensory feedbacks.

Poster #38
SOUND-INDUCED ILLUSORY FLASHES: ISSUES FOR A PSYCHOPHYSIOLOGICAL INVESTIGATION.
Hamish Innes-Brown & David Crewther
Brain Sciences Insitute, Swinburne University

Introduction: The first clear case where auditory information radically affects unambiguous visual perception was documented some years ago (Shams, Kamitani and Shimojo, 2000). Varying the number of auditory beeps presented coincidently with visual flashes was found to vary the number of perceived visual flashes. The illusory effect is phenomenological rather than qualitative, is stable with respect to many experimental variables and as such is thought to reflect an extensive property of polysensory mechanisms in the brain. Methods: Classic time-locked averages (ERPs) and event-related spectral perturbation (ERSP) are compared for this data set. Results: Although the behavioural data indicated that the illusion occurred on 53% of one-flash/two-beep trials, no differences were found in the ERP's between illusion and non-illusion trials. Examination of ERSP plots revealed that

illusion trials showed a transient increase in gamma-band activity (40-45Hz) at around 170ms, while non-illusion trials showed a decrease in gamma-band power at the same time, and a transient increase in beta (20-30Hz) power at around 100 ms. Discussion: Although no ERP differences were found between the illusion and non-illusion trials, non time-locked dynamic changes in brain activity were found to exhibit different patterns between illusion and non-illusion trials.

Poster #39
EEG-THETA ASSOCIATED WITH AUDIO-VISUAL BINDING
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Audio-visual binding - as subset of crossmodal integration - describes the combination of information across both these senses to the subjective unified perception of a bound object. Brain-physiological correlates of audio-visual binding are investigated by using a bias-effect of crossmodal integration, the “ventriloquism-effect”(VE). VE indicates the mislocation of an auditory stimulus towards a simultaneous visual stimulus. Two synchronous stimuli (disc and beep) alternating with a single visual stimulus were presented in the experimental condition, the occurence of VE (localization bias towards disc) indicates binding. Asynchronously presented stimuli (no localization bias) formed the control (no-binding) condition. EEG was recorded during task performance (n = 19 subjects) in order to investigate effects of the binding process in the theta and alpha range. Theta has been proposed to play an associate-cognitive role, while alpha components respond to differences between adequate/inadequate stimulation (Demiralp & Basar, 1992). Comparing trials of the experimental condition, in which a ventriloquism-effect was reported, with trials without localization bias in the no-binding condition different theta responses were found in frontal, central and parietal electrodes. We consider these theta responses to be related to the consciousness-related audio-visual binding.

Poster #40
MODELING THE DYNAMICS OF VISUO-MOTOR ADAPTATION BEHAVIOR WITH A KALMAN FILTER
Johannes Burge, Vision Science Program; UC Berkeley; Marc O. Ernst, Max Planck Institute for Biological Cybernetics; Martin S. Banks, Helen Wills Neuroscience Institute, UC Berkeley

When the introduction of a prism makes visually guided reaching biased and inaccurate, adaptation occurs to restore accuracy. Bias in everyday life usually accumulates from a series of small changes, a process well simulated with a random walk. If bias were the only source of error, recalibration would be simple: correct the last error. But reaching behavior is also subject to random error. How does the visuo-motor system balance the need to filter random error with the need to adapt to time-varying bias? We investigated whether the Kalman filter, the optimal algorithm for this problem, models the dynamics of visuo-motor adaptation. The filter predicts that adaptation rate will be determined by the relative variances of current measurements and changing bias: rate should decrease with feedback variance and increase with variance in bias. Subjects pointed rapidly with an unseen hand to a brief visual target. Visual feedback indicated the endpoint of the motor movement. Feedback variance was increased with blur. The relationship between visual feedback location and the movement endpoint was altered with a random walk. Trial-by-trial pointing was measured. Subjects performed with a high level of efficiency and responded to changes in relative variances as predicted by the Kalman filter.

Poster #41
EARLY MAXIMUM LIKELIHOOD INTEGRATION OF RAPID FLASHES AND BEEPS REVISITED
Tobias Andersen, Laboratoire Psychologie de la Perception, CNRS & Université Paris 5

One rapid flash presented with two tone beeps can be perceived as two flashes. We have previously presented Early Maximum Likelihood Integration as an optimal model for the multisensory information processing underlying this and some related illusions [Andersen, TS, Tiippana K, and Sams M; Neurosci Lett. 2005; 380(1-2):155-60]. Here we reformulate and simplify Early MLI employing translation and scaling invariance of the internal representation of the number of perceived flashes. We validate this new version of Early MLI using the likelihood ratio test. We also formulate and test a model where the multisensory interactions are entirely based on response bias and show that this model cannot account for the multisensory interactions as well as Early MLI.

Poster #42
WHEN ARE THREE CUES BETTER THAN TWO? STATISTICAL ROBUSTNESS IN COMBINING INFORMATION FROM VISION, TOUCH, AND SOUND.
Carmel A. Levitan, Joint Graduate Group in Bioengineering at UCSF/UC Berkeley; Martin S. Banks, Vision Science Program, Department of Psychology, Helen Wills Neuroscience Institute, UC Berkeley

When multiple sensory signals are available concerning a given environmental property, the brain generally combines them in a nearly optimal way. When signals have similar values, human behavior is well predicted by a maximum-likelihood model in which the signals are weighted in inverse proportion to their variances. When the signals are quite different from one another, it may be more sensible to not combine because the conflicting information might be due to a faulty sensor or to the signals coming from different sources. We tested whether the brain manifests statistical robustness – the reduction in weight given to an outlier – in selecting which signals to combine. We examined spatial localization of targets that were visual, auditory, and haptic while varying the amount of conflict between the signals. When the conflicts were small, performance was consistent with the weighted-average model; this is an appropriate strategy because small conflicts are usually caused by measurement noise. When the conflicts were large and one signal specified a value quite different than the others, we observed robustness: the weight given to the outlier was significantly reduced. We conclude that the brain exhibits statistical robustness in combining signals from three sensory modalities.

Poster #43
BAYESIAN FUSION OF VISUAL AND AUDITORY STIMULI DURING SACCADES: AN INVERTED VENTRILOQUIST EFFECT
Maria Concetta Morrone, Paola Binda, Aurelio Bruno, Faculty of Psychology, Vita-Salute S Raffaele University; David Charles Burr, Dipartimento di psicologia, Università di Firenze

During a critical period just before and during saccades, visual space is grossly distorted, undergoing a strong compression towards the saccadic target (Ross et al., Naure, 1997). In this study we investigated spatial localization of peri-saccadic visual and/or auditory stimuli. Subjects were asked to report which of two stimuli (both visual, acoustic or bi-modal) was more "rightward": one displayed centrally well before the saccade, the other peri-saccadically at a variable position. Peri-saccadic auditory clicks were perceived veridically (as given by the PSE of the psychometric function), with a similar precision (slope of the psychometric function) as during fixation. Peri-saccadic visual blobs, however, were seen mislocalized towards the saccadic target, with far less precision than during fixation (similar acoustic precision). Audio-visual stimuli were mislocalized much less than the visual stimuli presented on their own. The perceived position of the bimodal stimuli was well-predicted by assuming statistically optimal Bayesian combination of visual and auditory signals. The accuracy of the bimodal localisation was also better than either the visual or acoustic stimulus presented in isolation, again quantitatively predictable from Bayesian fusion. The results provide further support for the idea that distorted saccadic perception may result from optimal trans-saccadic integration (Niemeyer et al., Nature, 2003), and for a Bayesian explanation of the ventriloquist effect (Alais and Burr, Curr. Biol., 2004).

Poster #44
MORE THAN JUST THE SUM OF ITS PARTS: HIGH-DENSITY ELECTRICAL MAPPING OF THE INVERSE EFFECTIVENESS PRINCIPLE IN HUMANS
Daniel Senkowski, The Cognitive Neurophysiology Laboratory, Nathan S. Kline Institute for Psychiatric Research; Dave Saint-Amour, Department d'ophtalmology, Université de Montréal, Montréal, Canada; Sophie Molholm, John J. Foxe, The Cognitive Neurophysiology Laboratory, Nathan S. Kline Institute for Psychiatric Research

The well-known principle of inverse effectiveness (IE) posits that the amplitude of a multisensory integration effect will be inversely related to the strength of the unisensory responses. Evidence for IE comes primarily from animal studies, while IE in humans has not been extensively investigated yet. Here we used high-density electrical mapping to examine multisensory audio-visual (AV) integration effects as a function of stimulus intensity by changing the contrast and the sound level of basic stimuli (gratings and tones). A continuous stream of unisensory auditory (A), unisensory visual (V) and multisensory AV of low, middle, and high stimulus intensity was centrally presented while subjects were instructed to make a speeded response to any stimulus presentation. Multisensory integration effects were tested by the additive model where ERPs to multisensory stimuli are directly compared with the linear summation of the ERPs to the respective unisensory stimuli. As predicted by the principle of IE, early (<100 ms) super-additive (AV>A+V) integration effects were found for the low and middle stimulus intensities. In contrast, multisensory integration effects for the high stimulus intensity level showed a sub-additive (AV) effect.

Poster #45
INVERSE EFFECTIVENESS AND THE SUPERADDITIVITY OF MULTISENSORY INTERACTIONS IN AUDITORY ASSOCIATION AREAS OF THE AWAKE MACAQUE MONKEY
Monica N O' Connell, Peter Lakatos, Aimee

Mills, Tammy McGinnis, Charles Schroeder
Cognitive Neuroscience and Schizophrenia Program Nathan S. Kline Institute for Psychiatric Research

Prior anatomical and physiological studies have defined the posterior auditory cortices as sites of multisensory convergence and interaction. This study examined the effects of stimulus intensity on unimodal responses and multisensory interactions in caudomedial (CM) auditory cortex and the adjacent retroinsular (RI) area. We sampled laminar field potential and multiunit activity profiles with linear array multielectrodes from both areas in awake monkeys. We focused on the timing, laminar profile and quality (super-or sub-additive) of bimodal interactions. Auditory (A) stimuli consisted of binaural 60 dB clicks. Somatosensory (S) stimuli consisted of mild electrical pulses applied bilaterally to the median nerve at the wrist; recordings concentrated on the hand representations in CM and RI. We compared bimodal A-S response with the sum of the A and S unimodal responses using t-tests to determine the timing and laminar distribution of super- or sub-additive multisensory interactions. Super-additive interactions in CM were biased toward the super and infragranular layers and occurred in the 20-80ms time range post-stimulus. In RI super-additivity mainly occurred in the same time frame and throughout all the cortical layers. Manipulation of stimulus intensity revealed increase in super-additivity near threshold ("Inverse Effectiveness") in most of CM but not RI.

Poster #46
TIMING: A CRITICAL FACTOR IN MULTISENSORY INTEGRATION
Benjamin Rowland, Stephan Quessy, Terrence Stanford, Barry Stein, Dept. of Neurobiology and Anatomy, Wake Forest University School of Medicine, USA

When cross-modal stimuli appear within the overlapping receptive fields of a multisensory superior colliculus (SC) neuron, the number of impulses evoked is typically greater than that evoked by either stimulus alone and can be greater than their predicted sum (superadditivity). This multisensory enhancement is dependent on high-level corticotectal inputs. Here we explored the temporal evolution of the multisensory response in cat SC and how it is affected by alterations in stimulus effectiveness and the interval between stimuli (SOAs). Continuous-time cumulative multisensory, unisensory, and predicted impulse counts were compared. At optimal SOAs multisensory stimuli produced shorter latency responses, with firing rates often elevated above those predicted by superposition of unisensory responses. SOA had linear effects on response latency but nonlinear effects on multisensory enhancement magnitude. Furthermore, the neurons appeared to engage in a true fusion of inputs, as the only responses evident (even at long SOAs) involved a unisensory response to the first stimulus and a fused multisensory response to the second. Enhancement was manifested at the very onset of the multisensory response. These data suggest that multisensory integration involves substantial interactions between subthreshold inputs, and coordination of multiple tectopetal inputs requiring very rapid conduction along pathways ending at the corticotectal synapse. Supported by NIH grants NS 36916, NS22543.

Poster #47
MULTISENSORY LANDMARKS IMPROVE ROUTE MEMORY PERFORMANCE IN HUMANS : A VIRTUAL REALITY STUDY
Alexandre LEHMANN, Vincent Ducrot, Alain Berthoz, LPPA - College de France

Real world perception rarely involves separate sensory modalities. When remembering one's way in an unknown city we make a simultaneous use of several cognitive strategies. One of them is to remember chosen encountered landmarks and associate them with egocentric actions (such as "turn right at the fountain"). Navigation studies in humans have rarely focused on multisensory simulated environments. We investigated the extent to which non-visual cues (namely auditory cues) from environmental landmarks could modulate a spatial route memory performance. Subjects navigated in a maze in which landmarks were made the only available source of route information. These landmarks could be either purely visual or audio-visual. We hypothesised that extra auditory cues would lead to an increase in route recalling performance, and more specifically, that the added value of such cues lies in the temporal organisation of the landmark sequence. We found that response latencies were significantly modulated in the presence of audiovisual landmarks whereas purely visual landmark showed no effect. We conclude that auditory information from landmarks does improve the navigation performance. And that it also leads to the use of a different, sequence-based, spatial encoding strategy, that we consider as reflecting a more ecological process at stake.

Poster #48
THERE CAN BE ONLY ONE! INTEGRATING VISION AND TOUCH AT DIFFERENT EGOCENTRIC LOCATIONS
Hannah Helbig & Marc Ernst, MPI for Biological Cybernetics, Germany

Ernst and Banks (2002) showed that humans integrate visual and haptic signals in a statistically optimal. Integration seems to be broken if there is a spatial discrepancy between the signals (Gepshtein et al., 2005). Does knowledge that two signals belong to the same object facilitate integration even when they are presented at discrepant locations? In our experiment, participants had to judge the shape of visual-haptic objects. In one condition, visual and haptic object information was presented at the same location, whereas in the other condition there was a spatial offset between the two information sources, however, subjects know that the signals belong together. In both conditions, we introduced a slight conflict between the visually and haptically perceived shape and asked participants to report the felt (seen) shape. If integration breaks due to the spatial discrepancy we expect subjects' percept to be less biased by visual (haptic) information. We found that in both conditions the shape percept was in-between the haptically and visually specified shapes and did not differ significantly. This finding suggests that multimodal signals are combined if observers have reason to assume that they belong to the same event, even when there is a spatial discrepancy.

Poster #49
VISUAL AND AUDITORY CUES FOR LOCALIZATION COMBINE IN A STATISTICALLY OPTIMAL WAY.
Laurence Harris, Bahar Salavati, Phil Jaekl
Psychology, York University

To assess how different senses contribute to our ability to localize events we presented two stimuli separated by 0.5s and asked subjects to judge whether the first stimulus was above or below the second while the distance between them was varied by the method of constant stimuli. Stimuli were lights, sounds or bimodal stimuli. Lights were made more difficult to localize by smearing them with a Gaussian distribution, sounds were made more difficult by asking them to be localized vertically. Each comparison was subject to sources of noise that could either be added together if the events were unrelated, such as the first and second stimulus, or in a statistically optimal way if both contributed to the estimate. The noise when bimodal stimuli were involved in the comparison was accurately predicted by a statistically optimal combination of visual and auditory information implying a multimodal localization mechanism.

Poster #50
MULTISENSORY-MEDIATED AUDITORY LOCALIZATION
Fabrizio Leo, Claudia Passamonti, Caterina Bertini & Elisabetta Làdavas, Università degli Studi di Bologna, Italia

Multisensory integration allows us to integrate information from different senses, enhancing the ability to detect, locate and discriminate objects and events in the surroundings. The purpose of the present study is to examine whether the location and relative intensity of a seemingly irrelevant visual stimulus influences auditory localization. Subjects were asked to localize by pointing a sound in a condition in which a neutral visual stimulus was either suprathreshold (Experiment 1), or subthreshold (Experiment 2). In the crossmodal condition, the spatial disparity of the audio-visual stimuli was systematically varied. The results show that the efficacy of the visual information has substantially different effects on auditory localization with respect to visual capture and adherence to the spatial principle of multisensory integration. When the visual stimulus is presented suprathreshold, vision dominates and captures sound, regardless of the location of the visual stimulus. By contrast, a visual stimulus at threshold level improves auditory localization accuracy only when the two stimuli are spatially coincident.

Poster #51
THE EFFECT OF NON-INFORMATIVE SOUND ON HAPTIC SCENE PERCEPTION
Jason Chan & Fiona N. Newell, Institute of Neuroscience, Trinity College Dublin

Previous research has investigated if haptic scene perception is affected by 'non-informative' vision (Newport et al., 2002). Participants were asked to haptically match the orientation of two bars. They had difficulty orienting the bars when no visual cues were provided. This is in accordance with the belief that haptic space is non-Euclidian (Kappers & Koenderink, 1999). However, when irrelevant visual cues were given participants accuracy improved. We have also shown a similar effect in haptic scene perception with non-informative vision. In this study, we explore whether non-informative sound also affects haptic scene perception. Participants were blindfolded and wore circum-aural headphones before entering the experimental room. This was done to minimize any external cues that could affect performance. Participants learned the haptic scene for one minute, followed by a 20 second ISI. Then the unspeeded test phase began where participants were asked to explore and then point to the two objects that were switched. Fifty percent of participants received non-informative auditory white noise through 3 loudspeakers during the experiment. The remaining participants did not receive any sound. The implications of this study will be discussed.

Poster #52
EFFECTS OF THE VISUAL EXPERIENCE ON SPATIAL UPDATING OF HAPTIC SCENES
Achille Pasqualotto & Fiona N. Newell, Trinity College Dublin, Ireland

In a previous study we reported that visual and haptic egocentric representations of scenes are updated with observer motion. Furthermore, our findings suggested that visual flow information plays an important role in updating both visual and haptic representations. To assess the role of visual flow, we tested haptic scene updating in persons who were congenitally or adventitiously blind. Specifically, our participants learned a configuration of novel objects through touch and scene recognition was subsequently tested. During testing, participants remained at the same position as learning or moved to a new position 60º away. The scene either remained in the same learning position or was rotated by 60º. The results showed that the adventitiously blind generally outperformed the congenitally blind group, suggesting a role of early visual experience in haptic scene perception. Furthermore, we found no evidence that the congenitally blind group could update the haptic representation of scenes with observer motion although adventitiously blind showed evidence of updating. These results suggest that the absence of visual experience interferes with scene updating, suggesting that early experience of visual flow mediates spatial updating. These findings may also suggest that congenital blindness impairs the integration of the cues arising from self-motion.

Poster #53
A COMMON EXTERNAL REFERENCE FRAME FOR TACTILE LOCALIZATION
Tobias Schicke & Brigitte Röder, Dept. of Psychology, University of Hamburg

Performance in temporal order judgements (TOJ) of two tactile stimuli, one presented to each hand, is worse when the hands are crossed as compared to a parallel hand posture, indicating a remapping of tactile stimulus location from an anatomical into a non-anatomically, possibly external spatial reference frame. Such use of external coordinates has been suggested to facilitate efficient visual-manual control. The present studies tested if the use of a non-anatomical reference frame for tactile localization is restricted to those regions of space that are accessible by sight, and if it is a specific feature of hand use. In experiment 1, participants made TOJs while they held their hands in front of or behind their trunk. TOJs were equally impaired by hand crossing in both regions of space, demonstrating that the use of non-anatomical coordinates are not restricted to visible space. In experiment 2, participants made TOJs about stimuli delivered to the hands, the feet, or one hand and one foot. The stimulated limbs were either uncrossed or crossed. TOJs similarly declined due to limb crossing in all conditions, even when two different types of limb were stimulated. The two studies suggest that all body parts are remapped into common external coordinates and that this remapping is therefore not a specific feature for eye-hand-coordination. Common coordinates may be of advantage for action control, which often involves an updating of the location of all body parts with respect to an external action goal.

Poster #54
ILLUSORY SPATIAL PERCEPTION INDUCED BY THE TEMPORAL DISCREPANCY BETWEEN MODALITIES IN DYNAMIC VISION-HAPTICS INTEGRATION
Kohske Takahashi & Jun Saiki, Graduate School of Human and Environmental Studies, Kyoto University

We demonstrated that the illusory spatial perception occurred because of the temporal discrepancy between modalities when the dynamic event was estimated through vision and haptics. The observers estimated the amount of deformation of an object which was looked at and touched, and the perceived amount of deformation was measured. The stimulus was a rectangular solid object with 40 mm depth that compressively deformed along the depth axis. The observers asked to answer the interval of the larger deformation (2IFC paradigm). In experiment 1, the duration of deformation was 500 ms and the temporal asynchrony between modalities (+/- 60, 30, 0 ms) was introduced in one interval. The larger asynchrony made the perceived amount of deformation smaller than the physical amount. The illusory perception was quantitatively predicted by the modified weighted linear summation model. In experiment 2, the asynchrony was +/- 60 ms and the duration of deformation was different between modalities (500 ms for haptic and 500, 440, 380 ms for vision). The different duration between modalities induced the different illusory effect, suggesting that the different dynamics between modalities destructed the linear integration. The discrepancy of the dynamics between modalities affects the integration process, resulting in the illusory spatial perception.

Poster #55
DECIDING WHEN NOT TO INTEGRATE: AN INVESTIGATION OF THE SPATIOTEMPORAL LIMITS OF AUDITORY-VISUAL INTEGRATION
Neil Roach & Paul McGraw, Visual Neuroscience Group, School of Psychology,

The University of Nottingham, UK

When a particular stimulus property can be encoded by more than one sensory system, combining estimates from different modalities provides an effective means of noise reduction. However, these benefits only apply if the estimates being integrated relate to a common source. In contrast, integrating information associated with independent objects or events has the potential to be highly disadvantageous. To minimise mismatches between sensory signals, mechanisms of multisensory integration implement a limited tolerance to discrepancies between estimates in the spatial and temporal domains. At present, relatively little is known about the factors that determine the limits of this tolerance. We investigated the integration of auditory and visual information in the classic ventriloquist effect (spatial judgements) and in an interval bisection task (temporal judgements). By systematically mapping out the tolerance of cross-modal effects in each task to audio-visual discrepancies we show that the spatial and temporal limits of integration (i) span multiple JND units in either modality; (ii) are robust to changes of stimulus properties; (iii) remain reasonably constant across different tasks and (iv) act independently of one another. These results suggest that the brain implements a remarkably rigid strategy for ensuring cross-modal correspondence during integration.

Poster #56
SPATIAL REFERENCE FRAMES USED FOR TACTILE ATTENTION DEPEND ON DEVELOPMENTAL VISION: EVIDENCE FROM EVENT-RELATED POTENTIALS
Brigitte Roeder, Julia Foecker, Kirsten Hoetting, Biological Psychology and Neuropsychology, University of Hamburg: Charles Spence, Experimental Psychology, University of Oxford

Studies manipulating the direction of eye gaze or limb posture suggest that an eye-centred or external spatial reference frame is used to bind stimuli crossmodally. In contrast to sighted individuals, the congenitally blind do not seem to be detrimentally affected by changes in limb posture (such as crossing the hands) in tasks such as tactile temporal order judgments. This suggests that they use an anatomically- rather than an externally-anchored reference system as the default for tactile localization. Twelve congenitally blind and twelve matched sighted adults were instructed to detect tactile deviant stimuli on the hand indicated by a preceding tone while ignoring stimuli presented to the other hand and all frequent stimuli at both hands. The task was performed with the hands placed in either an uncrossed or crossed posture. While sighted participants performed much less accurately when they crossed their hands, the congenitally blind participants did not show any such crossed hands deficit. For the sighted participants, a frontal negativity was observed between S1 (the tone) and S2 (the tactile stimulus) contralateral to the position of the hand in space. By contrast, the congenitally blind participants hardly showed any signs of such an attention-directing negativity. Attention effects on somatosensory ERPs (to S2) were delayed and markedly attenuated in the sighted when their hands were crossed as compared to when they were uncrossed. By contrast, ERPs to S2 were indistinguishable for both posture conditions in the blind. The results from the sighted participants suggest that both attention control mechanisms and spatial attention mechanisms enhancing the processing of stimuli presented at a task-relevant location remap tactile events into an external reference frame. The set-up of the former and the default activation of the latter attention mechanism would appear to depend on developmental vision.

Poster #57
"LOOK OVER HEAR;" SPATIAL CONGRUITY AND THE VENTRILOQUIST ILLUSION
Jeannette R. Mahoney, Cognitive Neurophysiology Lab, Nathan Kline Institute; Helen Bates, Department of Psychology, Trinity College Dublin; Manuel Gomez-Ramirez, Daniel Senkowski, Walter Ritter, Sophie Molholm, John J. Foxe, Cognitive Neurophysiology Lab, Nathan Kline Institute, USA

Visual stimuli can alter the perceived location of auditory stimuli. This so-called ventriloquist illusion has been attributed to the superior spatial acuity of the visual system over the auditory system. Here, we investigated the intensity of the ventriloquist illusion when spatial processing conditions are optimal for both auditory and visual stimulation (i.e., when spatial motion direction of both auditory and visual inputs can best be discriminated). Participants were presented with audiovisual (AV) compound stimulus pairs (AV1-AV2) in such a way that they experienced apparent motion for each of the auditory and visual stimuli. The simultaneously presented auditory and visual elements of AV1-AV2 pairs were either spatially congruent or spatially incongruent, and participants judged whether the auditory and visual stimuli moved in the same or different directions. As would be expected, participants perceived a high percentage of AV1-AV2 congruent pairs as congruous (90%). Surprisingly, they also perceived 75% of AV1-AV2 incongruent pairs as being congruous; thus, demonstrating a strong ventriloquist effect. The existence of illusory congruent trials indicates cross-modal

binding mechanisms between auditory and visual inputs. Electrophysiological results from the same study are being processed to examine the neural correlates of this cross-modal illusion.

Poster #58
PARALLEL ACQUISITION OF MAP-BASED (ALLOCENTRIC) AND ACTION-BASED (EGOCENTRIC) STRATEGIES IN HUMAN NAVIGATION
Kinga Igloi, Alain Berthoz, Laure Rondi-Reig, LPPA Collège de France

Learning a spatial task involves encoding and organizing multisensorial information of the environment (Berthoz and Viaud-Delmon, 1999). Two main cognitive strategies have been described in navigation: the allocentric or map-based strategy and the egocentric or action-based strategy. Our primary research interest is to investigate how multisensorial information is organized to produce multiple and parallel navigation strategies during a spatial task. Hitherto, we developed a virtual version of the 'Starmaze' test designed in animals (Rondi-Reig et al., 2005), which allows specific characterization of spontaneously used navigation strategies. The virtual environment represents a pentagonal 'starmaze' in countryside landscape and various sensorial inputs can be used to solve the task. We have shown that, to navigate, subjects use the map-based or the action-based strategy or both and specified to what extent their way of execution differs. Regardless of spontaneous strategy preference, the subjects execute bi-directional shifts from one strategy to the other and whatever the strategy used, performance is similar. This indicates that simultaneously encoded multisensorial information can be computed alternately to the two strategies and comforts the idea of mental coexistence of spatial strategies.

Poster #59
THE FUNCTIONAL EFFECTS OF NEUROPLASTIC CHANGES IN VISUALLY-DEPRIVED SIGHTED SUBJECTS.
Naomi Bass Pitskel, Thomas Kauffman, Erin Abrigo, Center for Noninvasive Brain Stimulation, Beth Israel Deaconess Medical Center, Harvard Medical School; Hugo Theoret, Departement de Psychologie and Hopital Sainte-Justine, Universite de Montreal; Alvaro Pascual-Leone, Center for Noninvasive Brain Stimulation, Beth Israel Deaconess Medical Center, Harvard Medical School

Functional neuroimaging of visually-deprived sighted subjects shows occipital cortex activation during tactile discrimination tasks. Similar activation observed in early blind subjects has been shown to be functionally relevant in task performance. To determine whether this activation is also functionally relevant in visually-deprived sighted subjects, repetitive transcranial magnetic stimulation (rTMS) was used to disrupt performance in a Braille character discrimination task in blindfolded sighted subjects and sighted controls. Blindfolded subjects were blindfolded for the duration of 5 days, and all received intensive Braille training over the 5-day period. On day 5, 1-Hz rTMS to the occipital cortex did not affect task performance in sighted controls, but significantly impaired performance in visually-deprived subjects. This effect on performance disappeared by day 6, less than 24 hours after removal of the blindfold. The results indicate that the occipital cortex activation is causally related to the blindfolded subjects' ability to read Braille. The disappearance of this effect by day 6 reveals a very rapid reversal of plastic changes. The rapid time course of this recruitment and its reversal is a testament to the dynamic nature of brain organization.

Poster #60
HIGH VISUO-AUDITORY INTEGRATION PERFORMANCES IN DEAF SUBJECTS WITH COCHLEAR IMPLANTS
Pascal Barone, Cerveau et Cognition, CNRS UMR 5549, Toulouse; Sebastien Lagleyre, Service ORL, Hopital Purpan, Toulouse; Julien Rouger, Cerveau et Cognition CNRS UMR 5549, Toulouse; Marie-Laurence Laborde, Bernard Fraysse, Olivier Deguine, Service ORL, Hopital Purpan, Toulouse, France

Visual information derived from lipreading allows an improvement of speech comprehension in noisy environment. Because patients that received a cochlear implantation (CI) are highly sensitive to presentation of speech in noise, we have investigated the role of visuo-auditory interactions in speech intelligibility. In a previous study we have shown that patients present a greater word recognition using lipreading compared to control that remains stable several years after implantation. We have then compared visuo-auditory performances of patients to that of normal hearing subjects (NHS) submitted to paradigms with different acoustic degradations of the auditory stimuli. In a "masking" protocol we combined A and AV words with a white noise signal. In a "simulation" protocol, we applied the acoustic treatment of a cochlear implant, using speech-spectrum shaped noise in which the global temporal and amplitudes information of the envelop signal are preserved but the fine temporal cues within each spectral components are removed. Our results show that when considering subjects at similar levels of auditory performances, CI patients present a higher visuo-auditory gain than that observed in

NHS through-out the degraded protocols. Our results suggest that patients have developed specific skills in visuo-auditory interaction leading to an optimization of the integration the visual temporal cueing in absence of fine temporal spectral information.

Poster #61

CHANGE BLINDNESS IN NON-SIGNERS DEAF INDIVIDUALS AND COCHLEAR IMPLANT PATIENTS

Davide Bottari, Dipartimento di Scienze della Cognizione e della Formazione, Università di Trento; Francesca Bonfioli, Gruppo Rovereto Impianti Cocleari, Unità Operativa dell'Ospedale, Santa Maria del Carmine; Massimo Turatto,
Dipartimento di Scienze della Cognizione e della Formazione, Università di Trento Italy. Centro interdipartimentale Mente e Cervello, Università di Trento; Chiara Abbadessa, Gruppo Rovereto Impianti Cocleari, Unità Operativa dell'Ospedale, Santa Maria del Carmine; Silvana Selmi, Millo Achille Beltrame, Gruppo Rovereto Impianti Cocleari, Unità Operativa dell'Ospedale, Santa Maria del Carmine; Francesco Pavani, Dipartimento di Scienze della Cognizione e della Formazione, Università di Trento. Centro interdipartimentale Mente e Cervello, Università di Trento, Italy

Deaf individuals using sign language may show improved performances in visual tasks with respect to hearing controls, particularly at the periphery of the visual field. However, the role of sign language in these findings and the potential consequences of reafferentation after cocheal implant (CI) remains unclear. Here, we compared performance of early and late deafness individuals as well as CI patients, all educated to lip-reading only, with that of normal-hearing controls in a change blindness task. Two sets of simple drawings were presented simultaneously near the centre and periphery of the computer display for 200ms each, separated by a 500ms gap. Participants were instructed to detect whether one drawing changed in the second set. Across blocks their visual attention was either focused on central or peripheral stimuli, or divided across the whole scene. In all groups change sensitivity (d') was neither modulated by stimulus eccentricity nor by stimulus side. Instead, sensitivity advantages reliably emerged during focal than divided attention for all groups except for early-deafness individuals, for whom no sensitivity costs emerged in the divided attention condition. These findings suggest enhanced divided attention abilities in early deafness, and a remarkable return to normal distribution of visual attention after CI surgery.

Poster #62

VISUAL-TO-AUDITORY SUBSTITUTION LEARNING: BEHAVIORAL FINDINGS AND NEURAL CORRELATES

Jung-Kyong Kim, Robert Zatorre
Montreal Neurological Institute, McGill University

We investigated visual-to-auditory substitution learning in sighted subjects using the conversion algorithm developed by Meijer (1992). Over the course of approximately three weeks, eight sighted subjects participated in nine ~1.75-hour training sessions during which they learned the relationship of various visual images with their corresponding converted sounds. The visual images included abstract figures, pictures of real-life objects, and pictures of scenes. Subjects were evaluated with forced-choice recognition tasks at the end of every three training sessions using both the items encountered during training and new items designed to test for generalization. Significant improvement was observed over time in recognizing the corresponding converted sounds for novel visual images, with the biggest improvement found in identification of the abstract figures. Drawing tasks also demonstrated subjects' abilities to extract overall shapes of the visual images from the corresponding converted sounds. Based on these findings, we are conducting an fMRI study using the same training protocol for a period of five consecutive days. We expect that the behavioral improvement in visual judgments of the converted sounds will be accompanied by changes in occipital cortex activity as a result of the structured training. Such findings would indicate that cross-modal cortical interactions underlie visual-to-auditory substitution learning.

Poster session 2
(abstracts in order of poster number)

Poster #1
VARYING T1 DIFFICULTY INFLUENCES A CROSS-MODAL ATTENTIONAL BLINK
Marieke van der Hoeven, Florence Kleberg, Adelbert Bronkhorst, TNO Human factors, Human Interfaces, The Netherlands

The attentional blink (AB) is a deficit in reporting a second target (T2), when two targets are presented closely in time (200-500ms) in a rapid serial presentation. Different studies showed that this deficit appears not only in visual but also in auditory and cross-modal conditions. In the present study we investigate if the cross-modal AB is influenced by the difficulty of T1. We presented subjects a RSVP (rapid serial visual presentation) containing a visual first target (T1) and a synchronous RSAP (Rapid serial auditory presentation) containing an auditory T2 (a spoken letter). First target difficulty was varied by presenting 3 letter-words, 3 letter-pseudowords, 3 letters, or 3 symbols. Results show that there is indeed a cross-modal AB when T1 is a word or consists of 3 letters, whereby the magnitude of the AB is significantly larger for letters than for words. No AB was found.when T1 was a pseudoword. Unfortunately, no clear results were obtained for the condition with symbols as first targets because T1 scores were very low. We conclude that there is indeed a cross-modal attentional bottleneck, influenced by the difficulty of T1.

Poster #2
TACTILE SUPPRESSION AND VISUAL ATTENTION: EFFECTS ON TACTILE DISCRIMINATION PERFORMANCE
Marco Vitello & Marc Ernst, Max Planck Institute for Biological Cybernetics, Germany

The aim was to investigate tactile discrimination performance under various active and passive conditions and explore the influence of visual information. Participants had to discriminate the direction of lateral pin strokes on their fingertip under three conditions. In one condition ("static") only tactile stimulation was provided. In a second condition ("active") the shear force device was mounted on a kinesthetic feedback device so that tactile stimulation was accompanied by active arm movements. In a third condition ("passive") the arm was moved passively using the kinesthetic device while subjects performed the discrimination task. In this first experiment vision was not controlled. Therefore, to investigate the influence of vision on tactile discrimination performance participants had to perform the tactile discrimination task in the "active" condition with either direct gaze on their hand, gaze on a live image of their hand and without sight of their hand. Results show that tactile discrimination performance was higher in the "static" compared to the "active" condition. Moreover, participants performed better when they were gazing on their hand compared to the no-sight condition. We conclude that active movement impairs tactile discrimination performance. However visual spatial attention can compensate to some degree for this loss of tactile sensibility.

Poster #3
INDIVIDUAL DIFFERENCES IN ATTENDING TO TOUCH VERSUS VISION UNDER THREATENING AND NON-THREATENING CONDITIONS: IMPLICATIONS FOR MEDICALLY UNEXPLAINED SYMPTOMS
Ellen Poliakoff, Richard Brown, Matthew Kirkman
School of Psychological Sciences, University of Manchester, UK

Health professionals frequently encounter patients with "medically unexplained symptoms" (MUS), defined as disabling physical symptoms that defy organic explanation. A recent model suggests that MUS arise from the repetitive allocation of attention onto the body, particularly under conditions of threat (Brown, 2004). We investigated this hypothesis by examining individual differences in attention to touch versus vision in non-clinical participants with either high or low scores on a measure of MUS (the somatoform dissociation questionnaire; SDQ-20). Participants viewed body and non-body pictures that were either threatening or non-threatening before responding to a visual or tactile stimulus. Tactile performance (inverse efficiency) was subtracted from visual performance to provide an index of "tactile bias" in each condition. High scorers on the SDQ-20 showed a larger tactile bias following threatening body pictures at a short stimulus onset asynchrony (SOA; 250ms). In addition, across SDQ-20 groups, tactile bias following body picture stimuli at a short SOA correlated negatively with scores on the Somatosensory Amplification Scale, a measure of the tendency to experience and interpret bodily sensations as unpleasant. The study provides initial support for the hypothesis that people with a tendency to develop MUS attend more to their bodies under conditions of somatic threat.

Poster #4
MODULATING TACTILE CROSSED-HANDS DEFICIT BY WAY OF AUDITORY AND VISUAL CAPTURE.
Elena Azañón & Salvador Soto-Faraco
GRNC - Parc Científic de Barcelona, Spain

The representation of tactile space during perception depends on crossmodal organisation (remapping) between different sensory modalities such as somatosensation, vision and proprioception. As a consequence of this remapping process, the perceived order of two tactile events applied to different hands is often reversed when the observers adopt a crossed-hands posture. This happens because information about different spatial reference frames is set in conflict. However, the way in which this remapping is carried out, and the kind of information relevant for this crossmodal organization of tactile space is largely unknown. In order to help answer these questions, we addressed whether auditory stimuli can influence tactile temporal processing, thus alleviating the cross-hands deficit by way of auditory capture. In a second study, we attempted to modulate the crossed-hands deficit by way of visual capture of touch with rubber-hands. The potential of sounds modulating tactile perception was limited, whereas there was a clear influence of vision information about hand posture. We will discuss these results in the context of current theories of spatial representation of touch and multisensory integration.

Poster #5
CROSSMODAL CHANGE BLINDNESS BETWEEN VISION AND TOUCH
Malika Auvray, Alberto Gallace, Charles Spence
Department of Experimental Psychology, Oxford University

Change blindness is the name given to people's inability to detect changes introduced between two consecutively-presented scenes, when they are separated by a distractor that masks the transients that are typically associated with change. Change blindness has been reported to occur within vision, audition, and recently within touch as well, but has never previously been investigated when successive patterns are presented to different sensory modalities. We investigated people's ability to detect the presence of positional changes when the two to-be-compared patterns belonged to the same sensory modality (i.e., both visual or both tactile) and when one of the stimulus patterns was tactile while the other was presented visually. The two patterns of stimulation delivered on participants' body were presented consecutively, separated by a 250 ms empty interval, or else separated by a masked interval of similar duration. Change blindness was elicited when a mask (either tactile or visual) was inserted between the two consecutively-presented patterns. The magnitude of this change blindness effect was similar nomatter whether both patterns were tactile or one pattern was presented in either modality. These results suggest that the detection of positional changes may be related to a multisensory/amodal underlying mechanism.

Poster #6
A VISUAL WORKING MEMORY TASK INTERFERES WITH TACTILE SELECTIVE ATTENTION.
Polly Dalton, Department of Experimental Psychology, University of Oxford; Nilli Lavie, Department of Psychology, University College London; Charles Spence, Department of Experimental Psychology, University of Oxford

Working memory has been shown to play an important role in the control of visual selective attention (Lavie et al., 2004). Here, we investigated whether tactile attentional control also depends on the availability of working memory resources. Participants performed a tactile selective attention task in which they were asked to respond to continuous target vibrations whilst ignoring pulsed distractor vibrations. While carrying out this task, participants also had to remember a sequence of digits, presented either in numerical order (low working memory load) or in random order (high load). Distractor interference in the tactile task was found to be greater under high (vs. low) working memory load. This finding is particularly striking given that the working memory task required the retention of visually-presented material. Our results therefore suggest that, just as for the case of visual selective attention, the successful control of tactile selective attention requires the availability of working memory resources.

Poster #7
THE SUPPRESSION OF REFLEXIVE VISUAL AND AUDITORY ORIENTING WHEN VOLUNTARY ATTENTION IS ENGAGED
Valerio Santangelo, Department of Experimental Psychology, University of Oxford; Marta Olivetti Belardinelli, Department of Psychology, University of Rome "La Sapienza"; Charles Spence, Department of Experimental Psychology, University of Oxford

Several recent studies have examined whether or not abrupt onsets are capable of reflexively capturing attention when they occur outside the current focus of attention, as would be expected if exogenous spatial attention operates in a truly automatic fashion. Typically, these previous studies have induced a highly-

focused attentional state in participants by means of the presentation of informative central arrow cues. However, given that unpredictive central arrows have been shown to elicit reflexive spatial orienting effects, they may not provide an appropriate means of studying focused attention. In order to overcome this potential problem, we established a highly-focused attentional state by means of the central presentation of a rapidly-presented visual (or auditory) stream which participants sometimes had to monitor. Over 4 experiments, participants had to perform various intramodal and crossmodal exogenous audiovisual orthogonal cuing tasks either in isolation (as in a traditional reflexive cuing study) or else together with the central focused attention monitoring task. To our surprise, no reflexive cuing effects were observed (in either audition or vision) under the dual-task conditions. These result suggest a strict top-down control of reflexive orienting that appears to be far from truly automatic in either unimodal or crossmodal settings.

Poster #8
PRIMING IN A VISUAL AND AUDITORY ATTENTIONAL BLINK TASK
Thomas Koelewijn, Erik van der Burg, Adelbert Bronkhorst, Cognitive Psychology; Vrije Universiteit, Amsterdam, The Netherlands and TNO Human Factors, Soeterberg; Jan Theeuwes, Cognitive Psychology; Vrije Universiteit, Amsterdam, The Netherlands

Participants performed an unspeeded attentional blink (AB) task within the visual domain containing digits as targets and letters as distractors. Prior to the rapid serial visual presentation a visual prime was presented in the form of a digit which was similar to the second target (T2) on 50 percent of the trials. Surprisingly, additional to the AB effect shown for T2 there was an overall drop in performance on T2 for the trials on which T2 was similar to the prime. In a subsequent experiment we determined whether similar inhibitory effects would show up when participants performed the same visual (AB) task but this time preceded by an auditory prime in the form of a spoken digit. Results showed an AB effect for T2 but this time there was no additional inhibition effect on T2 for the trials on which T2 was similar to the prime. Further study using a rapid auditory presentation containing spoken digits and letters preceded by an auditory prime, showed an overall drop in performance on T2 for the trials on which T2 was similar to the prime, but no typical AB effect. These results suggest that the observed inhibitory effects are modality specific.

Poster #9
THE ABSENCE OF AN AUDITORY-VISUAL ATTENTIONAL BLINK USING PURE TONES
Erik van der Burg, Christian Olivers, Adelbert Bronkhorst, Thomas Koelewijn, Jan Theeuwes Cognitive Psychology, Vrije Universiteit Amsterdam, The Netherlands

An auditory-visual attentional blink (AB) paradigm is often used to explore the temporal dynamics of processing two targets from different modalities. Typically, visual target (T2) performance is impaired after the processing of an auditory target (T1). However, in the current study we show that processing a pure tone among different filler tones did not impair detection of a visual target letter among distractor letters. One explanation for the absence of a cross-modal AB is that participants postponed auditory processing. However, T2 performance remained unaffected when we forced subjects to immediately process T1 (the target tone),. Another explanation is that an AB pattern is only present when the auditory distractors (e.g., letters) are from the same alphanumeric class as the visual T2 (e.g., letter). We explored this notion by replacing the pure filler tones with spoken auditory letters. Again a pure target tone among spoken letters did not impair a visual target letter among distractor letters. Therefore, we suggest that an auditory-visual AB can only be observed when both T1 and T2 are semantically related .

Poster #10
THE EFFECT OF SPATIAL SELECTIVE ATTENTION ON AUDITORY-SOMATOSENSORY INTERACTIONS. A HIGH-DENSITY ERP STUDY
Jennifer Montesi, Nathan Kline Institute for Psychiatric Research, Cognitive Neuroscience Department, USA

The aim of this experiment was to determine whether selectively attending to stimuli on one side of space produces the early Auditory-Somatosensory multisensory interaction effect and eliminates or reduces this effect on the unattended side. The stimuli consisted of vibrations delivered to the tip of the index and the middle finger of the right or the left hand. The auditory stimuli were vibratory sounds delivered through speakers that were spatially aligned with the hand positions. This was done to maintain maximal possible ecological validity. Subjects were required to selectively attend to the stimuli on just one side (e.g. their right) while ignoring stimulation on the other side. The attended side was counterbalanced across stimulus blocks. The subject's task was to respond when rare target stimuli were detected. This was done to ensure that the subjects were attending to the stimuli. Task difficulty was calibrated psychophysically on an individual subject basis. Analyses: ERP

multisensory interactions for standard (non-target) stimuli on the attended side were compared to the multisensory interactions for standard (non-target) stimuli when they were presented to the same side but were ignored (unattended standards). Results: As expected, preliminary electrophysiological results reveal attentional modulation of the multisensory ERP responses.

Poster #11
EFFECTS OF SUPERVISED AND UNSUPERVISED CATEGORIZATION ON VISUAL AND HAPTIC OBJECT REPRESENTATIONS
Theresa Cooke, Christian Wallraven, Heinrich Buelthoff, Max Planck Institute for Biological Cybernetics, Germany

The way we perceive objects can be shaped by how we learn to categorize them, such as increasing the saliency of diagnostic dimensions, but most evidence of this comes from unimodal studies in vision. Does category learning have comparable effects when objects are perceived using touch? In this study, subjects learned to categorize a set of 25 novel, 3D objects which varied parametrically in shape and texture, using either vision or touch, and then provided similarity ratings on the objects. Multidimensional scaling (MDS) was used to construct a perceptual stimulus space and estimate the relative importance of shape and texture dimensions for each subject. The effects of categorization were quantified by comparing dimension weights when similarity ratings were performed 1) without prior categorization experience, 2) after an unsupervised categorization task, and 3) after a supervised task in which subjects learned groupings based on texture. In preliminary results (5 subjects per condition), significant differences between unimodal dimension weights found in condition 1 (shape dominating for vision; shape and texture equally weighted for touch) were not observed in conditions 2 and 3. These findings suggest that externally as well as internally-guided categorization could serve as a mechanism for reducing initial differences in unimodal representations of novel objects.

Poster #12
OBJECT REPRESENTATION IN VISUAL/HAPTIC CROSSMODAL MEMORY
Simon Lacey, Christine Campbell, Southampton Solent University, UK

How can objects perceived solely by touch be recognised solely by vision and vice versa? Recent behavioural studies into the format of the representation of objects in visual/haptic crossmodal memory have provided findings suggestive of multisensory representations for familiar objects as well as spatial representations for unfamiliar objects (Lacey & Campbell, Q J Exp Psychol, 2006). Visual and verbal interference during both visual and haptic encoding significantly reduced subsequent crossmodal recognition of unfamiliar objects, but not familiar ones. Haptic interference had no effect. This suggests that encoding in the haptic as well as visual modality could depend on visual representations, and could potentially be mediated by covert verbal descriptions during encoding. In a follow-up study, we found that spatial interference tasks during either encoding or retrieval disrupted crossmodal memory, whilst non-spatial interference had no effect. The modality of spatial interference, whether visual or haptic, made no difference. This work points to a common spatial representation underlying both visual and haptic object recognition.

Poster #13
COMBINING VISION AND TOUCH IN OBJECT LENGTH PERCEPTION
Kazunori Terada, Akinori Kumazaki, Akira Ito
Gifu University, Japan

When a human recognize length of an object while exploring it with their index finger, haptic and visual sensation both provide information for estimating the length of the object. The present study examined the contribution of tactile and visual cues to the subjective estimation of object length. The subject's index finger was passively moved laterally along a straight path by an apparatus driven by a linear actuator with slide guides. The subjects see his/her hand through a LCD which was located at about chest level horizontally. The visual stimulus velocity was controlled by a real time image processing system so that the subject could perceive different visual length from tactile length. The finger pad touched the raised dot surface during each trial and edge of the stimulus object both beginning and completion of stimulus presentation. Then the subject gave a magnitude estimate of the length. The subjects were tested under two experimental conditions: (1) bimodal condition in which visual and tactile length varied from 10 to 15 cm respectively; (2) unimodal condition in which only visual or tactile length was presented (control condition). The results were as follows: (1) mltisensory enhancement was not observed when the visual and tactile presented length was the same; (2) visual cues were weighted 69% and tactile cues 31% in the bimodal judgements.

Poster #14
SELF-ATTRIBUTION OF A VIEWING OBJECT MODULATES TACTILE DISCRIMINATION PERFORMANCE

Kumiko Enokizono, Taku Konishi, Kobe University, Graduate School of Humanities and Social Sciences; Satoshi Maekawa, National Institute of Information and Communications Technology; Takaji Matushima, Kobe University, Faculty of Letters, Japan

The aim of the present study is to clarify whether vision of body affects tactile perception. For this purpose, participants were required to make speeded finger discrimination responses to unseen tactile stimuli in the crossed finger posture, each fingers of both hands positioned alternately with palm-side down, while either viewing or not their fingers. In Experiment 1, we demonstrated that participants mislocalized the target tactile stimuli to the visually adjacent finger. This result revealed that the position of tactile event was represented in relation to the visual environment. In Experiment 2, we manipulated the appearance of the fingers, using photograph of the fingers, line drawing of the fingers, or photograph of a neutral object (wooden block). The result showed that the tactile mislocalizations to the visually adjacent finger decreased when participants viewed the photograph and line drawing of the fingers in comparison with when they viewed their own fingers directly. These results suggest that effectiveness of visual representation for coding tactile event depends on whether participants identify the viewing object as their own body.

Poster #15
CROSS-MODAL MEASUREMENT OF AUDITORY MENTAL IMAGERY ABILITY USING THE FAM (FOLEY ARTIST METHOD) APPROACH
Conor O'Malley & Aidan Moran, School of Psychology, University College Dublin

Historically, research on mental imagery, or the capacity to simulate in the mind information that is not currently being perceived by the sense organs, has been confined mainly to the visual modality. Accordingly, little progress has been made in theoretical understanding of imagery processes in other modalities such as audition. This neglect is attributable, in part, to methodological factors. For example, the mental rotation tasks commonly used to assess visual imagery abilities do not have any plausible auditory equivalents. In an effort to address this oversight, the present study reports an attempt to measure auditory mental imagery skills using a cross-modal technique derived from the work of “Foley artists” or technical experts who use their imagination to simulate the sounds of prop and clothes movements for film soundtracks. Using two conditions, the imagery task required participants (n=60) to match either silent video clips or verbal descriptions with designated sounds. Results suggest that those in the video condition (n=30) were more adept at creating and manipulating vivid images than were their counterparts (n=30) in the verbal description condition. One explanation for this finding is that many participants reported having to visualise the sound before attempting to match it with target sounds.

Poster #16
THE EFFECT OF HAPTIC INFORMATION ON VISUAL ILLUSION –ACTIVE TOUCH VS. PASSIVE TOUCH.
Keiko Omori, Keisuke Saito, Satoru Mimura, Yukio Itsukushima, Kaoru Noguchi, Department of Psychology, Nihon University, Japan

It has been pointed out that active touch is generally 'better' than passive touch for organizing the sensory information (Gibson, 1962). In the present study, we investigated the effect of haptic information by active and passive touch on visual illusion using the Hering and Wundt figures. Haptic stimuli which had various curvatures were made of different shapes of wooden board. (Also, no touching condition was prepared as a control.) We controlled the ways of touching: participants in active touch condition were allowed to touch haptic stimuli by themselves, while participants in passive touch condition were prohibited from moving their hands but haptic stimuli were moved by a mechanical device. Participants judged the extent of apparent curvature of each visual test figure. The result shows that visual illusion varied depending on whether haptic information was given or not: the amount of visual illusion was changed with haptic information in the sense that visual responses were biased to the attribute of haptic information. Although active touch affected vision more markedly than passive touch, the apparent curvature was biased toward the information given by active touch as well as passive touch.

Poster #17
MODULATION OF HAPTIC LENGTH REPRESENTATION BY MEANS OF A VISUAL ILLUSION AND OPTOKINETIC STIMULATION
Alberto Gallace & Charles Spence, Department of Experimental Psychology, Oxford University, Oxford, UK

Research shows that a variety of different sensory manipulations, including visual illusions, transcutaneous nerve stimulation, vestibular caloric stimulation, optokinetic stimulation, and prism adaptation can all influence people’s performance on spatial tasks such as line bisection. It has been suggested that these manipulations may act upon the “higher-order” levels of representation

used to code spatial information. In the present study, we investigated whether we could crossmodally influence haptic line bisection in neurologically-normal participants by varying the visual background that participants viewed. In Experiment 1, participants haptically bisected wooden rods while looking at a variant of the Oppel-Kunt visual illusion. Haptic bisection judgments were influenced by the orientation of the visual illusion (in line with previous unimodal visual findings). In Experiment 2, haptic bisection judgments were also influenced by the presence of a leftward or rightward moving visual background. These data provide the first empirical evidence to demonstrate the crossmodal effect of the Oppel-Kundt illusion and optokinetic stimulation on haptic line bisection performance. Taken together, our results suggest that the "higher-order" levels of spatial representation upon which such perceptual judgments are made have multisensory or amodal characteristics.

Poster #18
AUDITORY-VISUAL INTERACTIONS AFFECT SUBSEQUENT VISUAL RESPONSIVENESS: AN ELECTRICAL NEUROIMAGING STUDY USING RUDIMENTARY STIMULI
Raphaël Meylan & Micah M. Murray, The Functional Electrical Neuroimaging Laboratory, Neuropsychology Division and Radiology Service, Centre Hospitalier Universitaire Vaudois, Lausanne Switzerland

The effects of multisensory interactions on the later treatment of other incoming sensory input remain relatively unknown. We investigated whether multisensory interactions between rudimentary auditory and visual stimuli (3.5kHz beeps and circular flashes; 13ms duration) affect subsequent visual processing. A 2x2 design varied the number of beeps (0 or 1) with the number of flashes (1 or 2) presented on each trial, such that '1b2f' refers to the presentation of 1 beep with 2 flashes. Beeps, when present, were synchronous with the first flash, and pairs of flashes were separated by a 52ms ISI. Subjects indicated the number of flashes presented on each trial. Electrical neuroimaging of 128-channel event-related potentials assessed both the electric field strength and topography. Contrasting the difference between the 0b2f and 0b1f conditions with the difference between the 1b2f and 1b1f conditions [(0b2f-0b1f) vs. (1b2f-1b1f)] isolated the response to the second flash and removed responses to the initial flash or multisensory pair. We found significant differences beginning ~170ms after the onset of the second flash. The treatment of subsequent visual information was attenuated when preceded by a multisensory event. Multisensory events thus affect later sensory processing. (Supported by the Swiss National Science Foundation and Leenaards Foundation)

Poster #19
BUILDING NOVEL AUDIO-VISUAL OBJECTS FROM ABSTRACT AUDITORY AND VISUAL STIMULI
Oliver Doehrmann, Institute of Medical Psychology, Johann Wolfgang Goethe-University, Frankfurt am Main; Grit Hein, Notger G. Müller, Clinic of Neurology, Johann Wolfgang Goethe-University, Frankfurt am Main; Lars Muckli, Department of Neurophysiology, Max Planck Institute for Brain Research, Frankfurt am Main, Germany; Jochen Kaiser, Institute of Medical Psychology, Johann Wolfgang Goethe-University, Frankfurt am Main; Marcus J. Naumer, Institute of Medical Psychology, Johann Wolfgang Goethe-University, Frankfurt am Main, Germany

The aim of the present study was to investigate if it is possible to train novel semantic associations between Abstract, "object-like" auditory and visual stimuli. Eleven subjects participated in a first fMRI experiment (PRE), a training session and a second fMRI session (POST). The fMRI experiments utilized pictures and sounds of animals or of Abstract objects ("fribbles"; see http://www.cog.brown.edu/~tarr/stimuli.html). Moreover, in audio-visual (AV) conditions we varied the degree of semantic congruency between pictures and sounds. Regions of the posterior superior temporal sulcus (pSTS), the middle temporal gyrus (MTG) and the precentral sulcus (PrCS) were involved in both experiments during AV-integration of natural stimuli. After training, AV-stimulation with abstract material was associated with even more pronounced activation in the same cortical regions and, additionally, in medial frontal and inferior-parietal regions. Moreover, novel incongruency effects for abstract AV-conditions were found in inferior and medial frontal regions as well as the right anterior insula. As these latter regions are assumed to be implicated in semantical processing of natural stimuli, we conclude that our training successfully established novel semantic associations.

Poster #20
INTEGRATION OF SEMANTICALLY UNRELATED AND SEMANTICALLY CONTINGENT OBJECT FEATURES REVEALS CORTICAL HIERARCHY IN HUMAN AUDIO-VISUAL OBJECT RECOGNITION
Grit Hein, Brain Imaging Center, Cognitive Neurology Unit; Oliver Doehrmann
Institute of Medical Psychology, JW Goethe University; Notger G. Müller, Brain Imaging Center, Cognitive Neurology Unit; Jochen

Kaiser
Institute of Medical Psychology, JW Goethe University; Lars Muckli, Department of Neurophysiology, Max Planck Institute for Brain Research, Brain Imaging Center; Marcus J. Naumer, Institute of Medical Psychology, JW Goethe University, Institute of Medical Psychology

Object recognition often requires the neuronal integration of auditory and visual features. In many cases, for example human machine interfaces, these object features are **Abstract** and semantically unrelated. Using functional magnetic resonance imaging we investigated audio-visual integration of **Abstract**, semantically unrelated object features. Neuronal integration sites for semantically unrelated **Abstract** object images and sounds were compared to integration of animal sounds and images linked by varying semantic contingencies. Our results revealed a cortical hierarchy in audio-visual object recognition. Integration in precentral sulcus, the cortically highest integration level, was based on temporal and spatial contingencies, independently of semantic contingency. Posterior superior temporal sulcus (pSTS) preferred semantically contingent material. Semantically strongly related pairs were preferably integrated in dorsal portions of pSTS, object pairs with weaker semantic relationship in ventral pSTS parts. Auditory cortex, the cortically lowest integration level, was highest specialized, i.e., preferably integrated semantically strongly related object sounds and images.

Poster #21
CROSSMODAL OBJECT BINDING INCREASE PERCEIVED CONTRAST
Sascha Tyll, Martin Kanowski, Hans-Jochen Heinze, Toemme Noesselt, Department of Neurology II, Otto von Guericke University Magdeburg, Germany

In the present study we varied the contrast of a visual stimulus (defined by 60% and 80% hit rate respectively) while subjects performed a visual detection task. In half of the trials a task-irrelevant sound was presented as well. We found an increase in detectability for the 60% visual stimuli if paired with an irrelevant auditory stimulus but not for the 80% visual stimulus. To determine the neural correlate of this effect event related fMRI was used (n=6). In addition to multimodal structures (superior temporal sulcus) early visual areas in both the dorsal (superior occipital gyrus) and ventral stream (fusiform gyrus) were modulated in congruence with the behavioural effect. Further, unimodal auditory areas as early as Heschl's gyrus were modulated as well. The identified network of visual, auditory and multimodal areas indicates that the visual and auditory information - presented in both temporal and spatial proximity - is fused to form a multimodal object. This process of 'multisensory object binding' might generate a more salient representation of the unimodal object attributes as indicated by the increase of visual detectability.

Poster #22
DYNAMIC MODULATION OF OBJECT PROCESSING STREAM DURING CROSS-MODAL INTEGRATION
Lorina Naci, University of Cambridge

It has been suggested that, during object processing, auditory and visual object features are analyzed within hierarchically structured sensory processing streams from sensory-specific cortex to superior/inferior temporal cortex, and are integrated in antero-medial temporal regions (Simmons & Barsalou, 2003; Taylor et al., 2005). This EEG study aimed to investigate the timing of cross-modal effects on auditory/visual sensory processes and on conceptual-semantic processes involved in object processing. High-density (128 channel) ERPs were recorded from fifteen healthy participants while performing a congruency task on auditory, visual, and audio-visual stimuli. The activations' loci from an erFMRI study using the same stimuli and task [Taylor et al, 2005] were used to constrain the source analysis of the grand averaged ERPs. Cross-modal effects influence sensory processes from 60ms and conceptual-semantic processes between 150ms and 450ms. Auditory and visual sensory ERP components (P1, N1) are enhanced in the cross-modal condition. Cross-modal conceptual-semantic processes start at around 150ms and peak again between 400-450ms, times when the anterior-temporal cortex becomes significantly stronger than the posterior-occipital cortex. The later (400-500ms) effects are right-lateralized, as may be expected for the processing of non-linguistic stimuli. We discuss the implications of these findings with reference to hierarchical models of object processing.

Poster #23
MULTISENSORY OBJECT BASED ATTENTION
Sophie Molholm, Antigona Martinez, Marina Shpaner, Pierfilippo De Sanctis & John Foxe, Program in Cognitive Neuroscience and Schizophrenia, Nathan Kline Institute, USA

Selective attention to an object allows for the preferential processing of relevant information over other information, serving to protect limited capacity higher-order functions. In the visual domain, selective attention to one part of an object results in preferential processing of

other parts of the same object, even when they are task irrelevant. We tested if this within-object spread of attention occurs across the senses, such that attending to an object in one sensory modality results in enhanced processing of that object's features within another sensory modality. Visual, auditory, and visual-auditory objects were presented while subjects selectively attended to one of the objects in either the visual or auditory sensory modality. High-density recordings of electrical brain activity were made, and the selective attention components the visual SN and auditory PN were examined. A PN was elicited by auditory stimuli during visual attention, showing that the relevant object received preferential processing even when it was presented in the task-irrelevant sensory modality. However, there was no SN to visual stimuli during auditory attention. These data show that attention to an object in one sensory modality influences processing of the object in other, unattended, sensory modalities. However, this multisensory spread of attention is asymmetrical.

Poster #24
AUDIO-VISUAL INTEGRATION OF LETTERS AND SPEECH: FROM UNIMODAL TO BIMODAL SUBJECTIVE REPRESENTATION
Hans Colonius, Department of Psychology, Oldenburg University; Adele Diederich, School of Humanities and Social Science

Learning the correspondences between letters (graphemes) and speech sound units (phonemes) of a language is a crucial step in reading acquisition. Recent neurophysiological and –imaging studies suggest that multisensory brain areas play a role in the audiovisual integration of graphemes and phonemes similar to what has been observed for the integration of speech information with lip movements. In psychophysical experiments, the simultaneous presentation of visual and auditory target graphemes and phonemes leads to faster reaction times and more accurate recognition and discrimination performance compared to unimodal presentations. Little, however, is known about the subjective representation of graphemes and phonemes underlying these crossmodal effects. Is the subjective bimodal representation simply an amalgamation of unimodal features? Or do the crossmodal effects suggest the existence of bimodal characteristics not present in any unimodal context? Here we present a novel measurement technique to address these issues without requiring explicit assumptions about the set of relevant features. It is based on a version of the theory of dissimilarity developed by Dzhafarov and Colonius that permits the reconstruction of subjective distances among stimuli of arbitrary complexity from their pairwise discriminability. The approach is demonstrated on data from an experiment on audio-visual integration of letters and speech.

Poster #25
TEMPORAL VISUAL CUES AID SPEECH RECOGNITION
Xiang Zhou, City College of New York; Lars Ross, Nathan Kline Institute; Tue Lehn-Schiøler, Technical University of Denmark; John Foxe, Nathan Kline Institute; Lucas Parra, City College of New York

BACKGROUND: It is well known that under noisy conditions, viewing a speaker's articulatory movement aids the recognition of spoken words. Conventionally it is thought that the visual input disambiguates otherwise confusing auditory input. HYPOTHESIS: In contrast we hypothesize that it is the temporal synchronicity of the visual input that aids parsing of the auditory stream. More specifically, we expected that purely temporal information, which does not convey information such as place of articulation may facility word recognition. METHODS: To test this prediction we used temporal features of audio to generate an artificial talking-face video and measured word recognition performance on simple monosyllabic words. RESULTS: When presenting words together with the artificial video we find that word recognition is improved over purely auditory presentation. The effect is significant ($p<0.01$) for SNR at or above -12dB noise. For lower SNR the visual temporal information does not improve recognition confirming that our visual input does not contain useful lip-reading information in itself. CONCLUSION: Thus, we argue that temporal information is used in addition to articulatory features. This finding supports the notion that synchronous visual input aids auditory processing at an early parsing stage.

Poster #26
INFLUENCE OF VOICING, BACKGROUND NOISE AND NATURE OF THE VISUAL INPUT ON THE RT FACILITATION TO DISCRIMINATE SPEECH SYLLABLES
Julien Besle, INSERM U280, Lyon; Jean-Luc Schwartz, Institut de la Communication Parlée, Grenoble; Marie-Hélène Giard, INSERM U280, Lyon, France

Seeing the lip movements of a talker is known to speed up speech processing. However, it has been argued that this facilitation may be attributed to the visual information provided by the initial gesture cueing the speech sound. We thus tested wether such a facilitation in RTs can be obtained with visual cues providing only temporal information about the speech sound:

subjects had to discriminate between two auditory or audiovisual syllables having the same lip gestures and differing only by their voicing,. In addition, in half of the experimental blocks, we replaced the mouth by a rectangle with a surface varying as the open mouth area to evaluate the specificity of that cueing effect. We also manipulated the level of background noise. Depending on the voicing and noise level, we observed either benefits or costs in reaction times for audiovisual compared to auditory syllables. However, for any condition, the gain in reaction time was larger (or the cost was smaller) for natural gestures compared to rectangle deformations, suggesting that audiovisual facilitation in speech processing cannot be accounted for only by a cueing effect of the visual signal, and further that it presents some degree of specificity to speech stimuli.

Poster #27
EFFECTS OF SEEING AND HEARING SPEECH ON SPEECH PRODUCTION
Michelle Jarick & Jeffery Jones, Psychology, Wilfrid Laurier University, Canada

Speech is a multimodal event whereby people retrieve phonetic information not only from the auditory speech signal but also from the visual information afforded by the speakers' face. The revised Motor Theory of speech suggests that we perceive speech by deciphering the underlying intended gestures involved during speech production (Liberman & Mattingly, 1985). Indeed, recent studies have shown that listening and viewing speech excites the tongue and lip motor areas involved in producing speech. We investigated the relationship between speech perception and production using a Stroop-like paradigm. Participants observed video clips of a man producing either /aba/ or /aga/ in three conditions: visual-only, audio-only, and audiovisual. Target letters 'BA' or 'GA' were flashed over the speakers' face during the video and participants were asked to identify the target manually or verbally as quickly and accurately as possible. Our results showed that participants were fastest at responding verbally when the target matched the speech stimuli in all modality conditions. Indeed, verbal responses were facilitated by the visual-only matched stimuli and delayed by the mismatched stimuli. Conversely, only the audiovisual stimuli significantly affected manual responses. Our findings suggest that viewing speech might 'prime' our motor system for subsequent speech production.

Poster #28
SYNAESTHESIA AND THE MCGURK EFFECT
Gary Bargary, Kevin J. Mitchell & Fiona N. Newell
School of Psychology, Trinity College Dublin

Synaesthesia is a rare heritable condition in which normal sensory stimulation gives rise to abnormal additional experiences. Much debate exists regarding the nature of the association between the inducing stimulus and the concurrent synaesthetic experience, particularly where in the hierarchy of processing the association manifests itself. We were interested in the question of whether in cases of multisensory integration, would either of the unisensory inputs induce a synaesthetic experience or would the integrated multisensory percept act as the inducing stimulus. To address this question we carried out an audiovisual integration task with 12 linguistic-colour synaesthetes, using the well known McGurk effect using real words. For example the sound of 'bait' incongruently matched with the viseme 'gate' leads to the McGurk illusion percept 'date'. The experiment consisted of 3 conditions; audio only, visual only and incongruent audiovisual. The synaesthetes task in each condition was to first report what colour they experienced to each stimulus and then to report the word they perceived. The audio stimulus was correctly reported in 63% of audio only trials and correct viseme was reported in only 3% of the visual-only trials. In the audiovisual condition predicted McGurk illusions occurred in 72% of trials. Analysis of the colour data indicated that the colour reported invariably matched the colour of the integrated multisensory percept, i.e. the McGurk illusion trials and not either of the composite unisensory inputs for each synaesthete. Our results have implications for our understanding of the nature of the information that induces synaesthesia.

Poster #29
RECALIBRATION IN SPEECH PERCEPTION: LIPREAD VS. LEXICAL INFORMATION
Sabine van Linden, Tilburg University, Department of Psychology, Netherlands

The identification of a phoneme can be biased by both lipread speech (McGurk-effect) and lexical information (Ganong effect). Both information sources can also recalibrate auditory speech identification, as demonstrated by aftereffects. For example, exposure to an ambiguous sound intermediate between /aba/ and /ada/ dubbed onto a face articulating /aba/ (or /ada/) increases responses consistent with the visual stimulus on subsequent identification trials (Bertelson, Vroomen, de Gelder, 2003). Others have found aftereffects when the ambiguous sound is embedded in a word. Here, we directly compared biases and aftereffects induced by lipread and lexical information with the same materials and procedures. This allowed us to check whether

there is a fundamental difference between bottom-up perceptual information and top-down lexical knowledge. The immediate bias effects were bigger for lipread information than for lexical information. However, aftereffects induced by lipread and lexical did not differ in magnitude, dissipation rate, and stability over time. Thus, bottom-up lipread and top-down lexical information affect online speech perception differentely, but they induce similar recalibration effects.

Poster #30
DOES SOUND LOCATION INFLUENCE AUDIOVISUAL SPEECH PERCEPTION?
Kaisa Tiippana, Riikka Möttönen, Hanna Puharinen & Mikko Sams, Helsinki University of Technology, Finland

Multisensory interactions are generally stronger when stimulation arises from a similar location in space. Surprisingly, for audiovisual speech this doesn't seem to be the case. The McGurk effect, where conflicting visual speech alters the auditory speech percept, appears to be unaffected by spatial discrepancy between voice and face (e.g. Jones & Munhall, 1997). We hypothesized that allocation of spatial attention may be a factor, so that directing attention to a location would enhance audiovisual interactions there. Auditory attention was manipulated by varying the probability of auditory stimulus presentations from different locations (centre, i.e. face location, and 45/90 deg left/right). We replicated previous findings of independence of the McGurk effect of sound location in a condition where auditory stimuli were presented with equal probability from all locations. In another condition, attention was directed spatially by presenting the majority (90%) of auditory stimuli from one location. In Experiment 1, the major location was in the centre, which resulted in an enhanced McGurk effect there. In Experiment 2, the major location was 90 deg left, which resulted in a stronger McGurk effect on the left and centre relative to the right side. The results show that audiovisual speech perception can be influenced by sound location, and that this depends on the direction of spatial attention.

Poster #31
VISUAL INFLUENCES ON SPEECH SOUND DISCRIMINATION: A PARAMETRIC FMRI STUDY
Vera Blau, Nienke Van Atteveldt, Elia Formisano, Rainer Goebel, Leo Blomert, Department of Cogntive Neuroscience, Maastricht University, the Netherlands, Maastricht Brain Imaging Center (M-BIC), the Netherlands

The superior temporal cortex is activated during integration of letters and speech sounds [1] and has recently been implicated in the visual enhancement of speech intelligibility in the presence of acoustic masking noise [2]. The present fMRI study [N=9] used degraded auditory and visual input to unravel the relative contributions of visual letters on speech sound discrimination. Speech sounds were presented in isolation or with matching or non-matching letters (congruency factor). Speech sounds were degraded using pink noise enabling non-optimal identification; letters were degraded using a line mask corresponding to good, medium and low perceptibility of the visual letter (visual noise factor). Subject discriminated between speech sounds /a/ and /e/. Simultaneous presentation of a congruent visual letter facilitated subjects' speech sound discrimination performance compared to unimodal auditory conditions, whereas incongruent letters increased reaction time. Only well-perceivable visual letters in congruent presentations led to increased activation in superior temporal areas. In lateral occipito-temporal regions the difference between congruent and incongruent combinations of letters and speech sounds scaled parametrically with the levels of visual noise. The present study reveals a systematic influence of audiovisual congruency on the auditory discrimination of speech sounds in superior temporal and in occipito-temporal areas. References: [1] Van Atteveldt et al. (2004), Neuron, 43, 271-282. [2] Callan et al. (2003), NeuroReport, 14, 2213-2218.

Poster #32
TOP-DOWN TASK EFFECTS OVERRULE AUTOMATIC MULTISENSORY RESPONSES TO LETTER-SOUND PAIRS IN AUDITORY ASSOCIATION CORTEX
Nienke van Atteveldt, Elia Formisano, Rainer Goebel, Leo Blomert, Maastricht University, Faculty of Psychology, Dept. of Cognitive Neuroscience, Netherlands

In alphabetic scripts, letters and speech sounds are the basic elements of correspondence between spoken and written language. In two previous fMRI studies using blocked stimulus presentation and passive perception, we found a cross-modal modulation of the response to speech sounds in the auditory association cortex by letters, expressed as response enhancement by congruent letters and suppression by incongruent letters. Interestingly, temporal proximity was critical for this congruency effect to occur. In the present study, we used fMRI to investigate the effect of stimulus presentation mode (blocked vs. event-related) and task instruction (passive perception vs. active matching) on the neural integration of letters and speech sounds. The principle findings are

1) a replication of the previous results on passive integration using event-related fMRI, and 2) the absence of the effects of congruency and temporal proximity in the auditory association cortex during active matching. Finding 1 shows the suitability of event-related fMRI for studying letter-sound integration. Finding 2 indicates that the task demands overruled the automatic multisensory responses to letters and speech sounds, most likely because the task changed the behavioral relevance of the stimuli.

Poster #33
AUDIOVISUAL INTEGRATION OF SPEECH AND NON-SPEECH OBJECTS: AN ERP STUDY
Riikka Möttönen, Virpi Lindroos, Kaisa Tiippana, Mikko Sams, Laboratory of Computational Engineering, Helsinki University of Technology

Recent event-related potential (ERP) studies have shown that auditory N1 to audiovisual speech is suppressed compared with N1 to acoustic speech (Klucharev et al., 2003; Besle et al. 2004; van Wassenhove et al., 2005). In contrast, ERP studies using audiovisual non-speech stimuli have not found such suppressions, suggesting its specificity to audiovisual speech. However, as there have been no studies using both speech and non-speech stimuli, this issue has remained open. We recorded ERPs to acoustic (A), visual (V) and audiovisual (AV) stimuli in four conditions containing (1) A and V speech, (2) A speech and V non-speech, (3) A non-speech and V speech and (4) A and V non-speech. In the AV stimuli the onsets of A and V components were either synchronous or asynchronous (V onset preceded A onset by 200 ms, typical for natural AV speech). The subjects were faster in identifying synchronous AV targets than unimodal ones in all conditions. The auditory N1 to both synchronous and asynchronous AV stimuli (non-targets) was suppressed in the condition containing A and V speech. Such suppressions were not found in other conditions. The results suggest that the suppression of auditory N1 is generated by speech-specific multisensory integration mechanisms.

Poster #34
ELECTROPHYSIOLOGICAL CORRELATES OF MULTISENSORY INTEGRATION OF ECOLOGICALLY VALID AUDIOVISUAL EVENTS
Jeroen Stekelenburg & Jean Vroomen
Psychonomics Laboratory, Tilburg University

We investigated whether the neural mechanisms underlying the integration of auditory speech sounds and visual articulatory gestures are different from those underlying audiovisual integration of ecologically valid non-speech objects. Event related potentials (ERPs) of the syllables /bi/ and /fu/ were compared with ERPs evoked by the clapping of hands and the tapping of a spoon. Experiment 1 demonstrated that both speech and non-speech stimuli showed similar speeding up and amplitude depression of auditory N1 if the sounds were combined with visually congruent information. Experiment 2 explored which information of the visual stimulus – its content, its potential to predict when the sound is to occur, or both - was crucial for these effects. For speech and non-speech stimuli alike, visually congruent and incongruent information evoked a speeding up and amplitude depression of auditory N1, thus demonstrating that timing and not content was crucial. Visual speeding up and amplitude depression of auditory N1 is thus not a speech-specific phenomenon.

Poster #35
CROSS-MODAL ENHANCEMENT OF THE MMN TO PHONEMES INDICATES AUTOMATIC PROCESSING OF GRAPHEME-PHONEME CORRESPONDENCES.
Dries Froyen, Nienke van Atteveldt, Bonte Milene, Blomert Leo, Psychology neurocognition, University Maastricht

Learning the correspondences between graphemes and phonemes is a crucial step in reading acquisition. The aim of our study is to investigate whether in literate adults, grapheme-phoneme pairs are processed automatically as compound stimuli. Van Atteveldt, et.al. (2004) where the first to demonstrate neural binding of letters and speech sounds in cross-modal superior temporal regions with fMRI. To investigate the time course and automatic nature of this neural binding we conducted an EEG experiment, focusing on the Mismatch Negativity component. We compared MMN responses to passively perceived deviant phonemes in a single channel (speech sounds) and cross-modal (speech sounds - letters) context. If the same auditory deviant phoneme evokes a quantitatively different auditory MMN in both contexts, this would suggest that the presence of the grapheme has an influence on the auditory sensory-memory trace formed by the phoneme, i.e. on the neural processing of the speech sound. We found enhanced MMN amplitude to auditory deviants in the audiovisual context. Considering the timing of this EEG-component, this finding suggests automatic processing of grapheme-phoneme pairs as integrated compound stimuli. Furthermore, we show that the width of the time window between the presentation of letters and speech sounds is critical for neural

binding.

Poster #36
EVENT-RELATED POTENTIAL STUDY OF AUDITORY-VISUAL INTERACTIONS IN CHILDREN
Julie Vidal, INSERM U619, Tours; Marie-Hélène Giard, INSERM U280, Bron; Sylvie Roux, Catherine Barthélémy, Nicole Bruneau
INSERM U 619, Tours, France

Despite the importance of the integration of auditory and visual information in communication and language acquisition, little is known about the mechanisms of multisensory integration throughout childhood. The aim of this study was to investigate the maturation of the neurophysiological processes underlying auditory-visual interactions in children using event-related potentials (ERPs). ERPs were recorded from 31 scalp electrodes in 30 healthy children aged from 5 to 10 years while auditory and visual stimuli were presented separately (A and V) or simultaneously (AV) in a no-task paradigm. Multisensory interactions were assessed by comparing the ERPs in response to bimodal stimulation with the sum of the ERPs in response to the unimodal stimulations [AV-(A+V)] in three groups of age: 5-6, 7-8 and 9-10. Our results showed age-related modifications not only in the characteristics of the unisensory responses, but also in the interaction effects. The significant effects evidenced by [AV-(A+V)] analysis displayed spatio-temporal distribution which evolved with age. This reflects maturation of the networks involved in auditory-visual interactions. These findings throw light on the processes of multisensory integration that could be impaired in developmental disorders, especially those including communication and language disturbances.

Poster #37
THE ROLE OF ATTENTION IN AUDIOVISUAL SPEECH INTEGRATION: EVIDENCE FROM ERPS
Agnès Alsius, Cognitive Neuroscience Group, Parc científic de Barcelona, Universitat de Barcelona; Riikka Möttönen, Kaisa Tiippana
Helsinki University of Technology, Laboratory of computational engineering; Salvador Soto-Faraco
Cognitive Neuroscience Group, Parc científic de Barcelona, Universitat de Barcelona; Mikko Sams
Helsinki University of Technology, Laboratory of computational engineering

Behavioural studies have shown that audiovisual integration of speech can be influenced by attentional manipulations (Tiippana et al., 2004; Alsius et al., 2005). On the other hand, recent event-related potential (ERP) studies have shown temporal facilitation and amplitude reduction of the auditory N1 to audiovisual speech compared with that to acoustic speech (Klucharev et al., 2003; Besle et al., 2004; Van Wassenhove et al., 2005). The goal of the present ERP study was to ascertain whether neural correlates of audiovisual speech integration can be modulated by manipulating attention. ERPs were recorded while participants identified spoken syllables presented auditorily, visually, or audiovisually (incongruent “McGurk” stimuli). Attention was manipulated by introducing a dual task paradigm where, in addition to the syllable identification task, participants were required to perform a concurrent unrelated visual search task. This attentional manipulation was reflected as a decrement in the percentage of the visually influenced responses to audiovisual stimuli reported by participants (i.e. a weaker McGurk effect). We also confirmed the effect of visual speech on the auditory N1 latency and amplitude and found a trend to a smaller effect during the dual task condition, suggesting that attention might play a role in early neural processing of audiovisual speech.

Poster #38
VISUAL ENHANCEMENT OF TOUCH AND PRIMARY SOMATOSENSORY CORTEX
Andrea Serino, University of Bologna; Sonia Padiglioni, Centro studi e ricerche in Neuroscienze Cognitive; Patrick Haggard, University College London; Elisabetta Làdavas
University of Bologna

Tactile acuity improves when subjects look at their body (Kennett et al., 2001). However it is not yet clear whether this effect strictly depends upon the vision of the tactilely stimulated body part or arises because any body part provides an arousing stimulus relevant to bodily sensation. To study this issue, 32 normal subjects’ tactile acuity was assessed in three different body parts: the hand, the cheek and the foot. The test was performed twice, i.e. with or without visual stimulation. This consisted for half subjects in viewing their hand and for half in viewing a neutral object, presented in the same spatial position as the hand. Viewing the hand, but not the neutral object, improved subjects’ 2pdt thresholds on the hand and on the cheek, but not on the foot. We suggest that viewing the hand modulated tactile representation in early somatosensory cortex (SI). The hand and face representations are adjacent and lateral SI, while the foot representation is distant and more medial. The benefit of viewing the hand for touch on the hand and the cheek, but not the foot, suggests that viewing the body provides modulatory input that spreads across areas co-represented

in the SI homunculus.

Poster #39
CROSS-MODAL RECRUITMENT OF AUDITORY AND VISUAL CORTICES FOLLOWING BRIEF EXPOSURE TO BIMODAL STIMULI
Shahin Zangenehpour & Robert J Zatorre
Neuropsychology/Cognitive Neuroscience Unit, Montreal Neurological Institute, Montreal, Canada

Recent neuroimaging evidence suggests that exposure to only the visual component of words and musical notes can lead to activation of auditory areas, while familiar voices cause activation in the visual areas. In the present study we hypothesized that cross-modal cortical recruitment would occur when stimuli had been pre-associated. In condition 1, 13 healthy participants were exposed to simultaneous sequences of white-noise bursts and green LED flashes for 45 minutes while making perceptual unity judgments. On a subsequent day, the same participants underwent PET scans whereby they were exposed to either the visual or the auditory component of the bimodal stimuli in separate scans. In condition 2, the same auditory or visual stimuli as the first group were presented to a second group of participants, who had not been exposed to the simultaneous bimodal presentation. When presented with auditory or visual components of the bimodal stimuli alone, naïve subjects showed only modality-specific activation of cortical regions. However, subjects in condition 1 showed both cross-modal and modality-specific cortical regions in response to unimodal stimulus presentations. Thus, the association between auditory and visual stimuli carried was sufficient to produce activation in one sensory cortex when only the other modality was physically present.

Poster #40
EARLY RESPONSES IN THE LATERAL FRONTAL LOBE OF THE HUMAN BRAIN ARE SENSORY
Holle Kirchner, Emmanuel Barbeau, Simon J. Thorpe, Centre de Recherche Cerveau et Cognition, CNRS Toulouse; Jean Régis, Catherine Liégeois-Chauvel, Laboratoire de Neurophysiologie et de Neuropsychologie, Hopital de la Timone, Marseille, France

Recent studies have demonstrated a remarkably fast route between brain areas involved in complex scene processing and the oculomotor system (Kirchner & Thorpe, 2006). When, in a choice saccade task, two images are flashed to the left and right of fixation normal subjects can initiate saccades to the side containing an animal in as little as 120-130 ms. One possible route for such ultra-rapid processing could involve the frontal eye fields (FEFs), which in the monkey are known to contain neurons that respond rapidly to the presentation of visual and auditory stimuli. Here, we determined the onset of sensory processing in vicinity to the human FEF using intracranial recordings in a patient with drug-resistant partial epilepsy. When the patient listened passively to different auditory frequencies, the first peak of the auditory evoked potential occurred at an extremely short latency of 34 ms (-16.8 microV). Passive viewing of a checkerboard resulted in a first peak at 53 ms. Given that even these earliest responses in the human FEF were modulated by the stimulus attribute (auditory frequency or visual scene) we conclude that they are sensory in nature and that they might contribute to ultra-rapid processing in the choice saccade task.

Poster #41
MULTISENSORY PROCESSING IN 'UNIMODAL' NEURONS: EVIDENCE FOR SUBTHRESHOLD EXCITATORY CROSS-MODAL EFFECTS IN CAT VISUAL CORTEX
Brian Allman & M. Alex Meredith, Anatomy and Neurobiology, Virginia Commonwealth University School of Medicine

Most multisensory studies examine neurons that receive convergent excitatory inputs from different sensory modalities and consequently demonstrate multisensory integration. On the other hand, when multisensory convergence is not apparent, the multisensory capacities of seemingly 'unimodal' neurons often go unexamined. The present experiments tested the multisensory responses of 'unimodal' neurons in the well-known Posterolateral Lateral Suprasylvian (PLLS) visual area of the cat. A total of 204 visually-responsive neurons were presented separate- and combined-modality stimulation using natural visual and auditory cues. None of the neurons responded to auditory stimuli presented alone. When the visual and auditory stimuli were combined, 19% (39/204) showed a significant response increase. Furthermore, the overwhelming majority (82%; 167/204) of the neurons showed a combined response that was greater than that produced by visual stimulation alone, and this population response change was highly significant (paired 't'-test, $p<0.0001$). These data indicate that subthreshold excitatory effects can occur on apparently 'unimodal' neurons and that these response modulations are robust at the population level. Such subthreshold effects might more appropriately be considered as manifestations of multisensory processing than multisensory integration. Supported by NIH-NS39460.

Poster #42
CROSSMODAL BIAS EFFECTS IN PERCEPTION OF HUMAN BODY LANGUAGE
Jan Van den Stock, Cognitive and Affective Neuroscience Laboratory, Tilburg University, Tilburg, The Netherlands; Julie Grèzes, LPPA College de France, Paris; Beatrice de Gelder, Cognitive and Affective Neuroscience Laboratory, Tilburg University, Tilburg, The Netherlands

Research on emotions expressed by the whole body has been sparse. In two experiments we measured recognition of whole body expressions of emotion in combination with emotional sound fragments. In the first experiment, subjects were presented a sentence spoken in an emotional tone of voice while at the same time a still image of a whole body expression was presented. The emotion expressed in the body was congruent or incongruent with that of the voice. Instructions required rating of the emotion in the voice. Results indicate that perception of the vocal expression is biased towards the body emotion. In the second experiment, we combined dynamic images of body emotions with sound fragments. Sounds consisted of either human vocalisations or animal sounds (birds chirping and dogs barking). Preliminary testing indicated that emotions were equally well recognized when conveyed by human vocalisations and by animal sounds. Sound fragments were combined with emotionally congruent or incongruent video images. The task was to categorise the emotion expressed in the body. Results show that categorisation of body expression is influenced by incongruent human sounds but not by animal ones. The results indicate that semantic congruency by itself is not sufficient to explain crossmodal bias effects.

Poster #43
RECOGNITION OF HUMAN BODY MOVEMENTS: VIEW-DEPENDENCY, INVERSE EFFECT AND BIOMECHANICAL CONSTRAINTS.
Yasuyuki Inoue, Yasuhisa Fujiki, Department of Knowledge-based Information Engineering, Toyohashi University of Technology; Michiteru Kitazaki, Research Center for Future Vehicle / Intelligent Sensing System Research Center, Toyohashi University of Technology

Human body is represented multimodally as visual and motor in the brain. We reported that visual recognition of static body posture was affected by biomechanical constraints (Kitazaki and Inoue, VSS 2004), and action of the observer modulated the visual recognition of body posture (Inoue and Kitazaki, IMRF 2005). In this study, we investigated the effects of biomechanical constraints of human body on visual recognition of body movements, view-dependency and its inversion effects. First, we made twenty-seven different body movements with a three-dimensional computer modeling software. They were all biomechanically possible movements. Then, twenty-seven impossible movements were made by modifying possible ones. A pair of movements across viewpoints (0-180deg) was presented sequentially, and subjects were asked if they were identical or different movements regardless of the view difference. We found that recognition performance of possible movements was better and more view-independent than that of impossible ones. These effects decreased with using inverted bodies. Thus, recognition of human body movements was affected by biomechanical relationship of body parts and movements, and it was specific to upright body representation. These results suggest that the brain processing for human-body recognition is multimodal and utilizes both visual and motor information. [Supported by Nissan-Science-Foundation and MEXT-Japan]

Poster #44
STRENGTH OF THE RUBBER HAND ILLUSION VARIES AS A FUNCTION OF DISTANCE BETWEEN SEEN AND FELT HAND
Donna Lloyd & Lucy Lloyd-Roach
School of Psychological Sciences, The University of Manchester

This study aimed to quantify the strength of the rubber hand illusion as a function of distance between touch seen on the rubber hand and touch felt on the person's real hand. Fifty-two undergraduate students took part for course credit. On successive trials the rubber hand was moved to one of six unpredictable locations (order randomised between participants) from 17.5cm to 67.5cm. The rubber hand and the person's real hand were then stroked simultaneously. Participants indicated when they experienced the illusion by the extent to which they agreed with the statement 'it seemed as though I was feeling touch in the place where I saw the rubber hand touched' on a scale of +3 to -3. Non-parametric tests (Friedman and Wilcoxin) revealed a highly significant effect of position of the rubber hand on strength of illusion ($p < .001$) with significantly more participants responding to the illusion (with a rating of +3 or +2) when the distance between the real and rubber hand was 17.5cm than when it was 27.5cm (62% vs. 50%; $p = .016$). These results indicate a direct relationship between the spatial disparity of visual and tactile inputs contributing towards the perceptual illusion and the strength of the illusion.

Poster #45
AUDITORY-SOMATOSENSORY MULTISENSORY INTERACTIONS: EFFECTS OF SPACE AND POSTURE
Massimiliano Zampini, Diego Torresan, Department of Cognitive Sciences and Education, University of Trento, Italy; Charles Spence, Department of Experimental Psychology, University of Oxford, UK; Micah Murray, The Functional Electrical Neuroimaging Laboratory, Neuropsychology Division and Radiology Service, Centre Hospitalier Universitaire Vaudois

Combined sensory information facilitates perception and behaviour. In terms of auditory-somatosensory interactions, facilitative effects on simple reaction times and brain responses have thus far been demonstrated both when stimuli are presented to the same spatial location and also when stimuli are separated by ~100°. One implication is that brain regions mediating auditory-somatosensory interactions contain large spatial receptive fields. To further investigate this possibility as well as the question of whether auditory-somatosensory interactions are restricted to frontal spatial locations, 12 subjects performed a simple reaction time task to auditory, somatosensory, or simultaneous auditory-somatosensory pairs. Their posture was such that one arm was in front of them and the other behind them. Similarly, one loudspeaker was situated frontally and the other behind. Thus, there were a total of 8 stimulus conditions – 4 unisensory and 4 multisensory – to include all of the combinations of posture and loudspeaker location. Arms positions were counterbalanced across blocks of trials. Responses were made via a foot pedal. Our results indicate a significant facilitation of reaction times following multisensory stimulation, irrespective of the location of either the auditory or somatosensory stimuli. We interpret these results in terms of the likely receptive field properties of auditory-somatosensory brain regions.

Poster #46
IS BEAUTY IN THE EYES AND EARS OF THE BEHOLDER?
Sarah Casey, Psychology, Trinity College Dublin; Andrew Woods, University of Wales, Bangor; Fiona N. Newell, Trinity College Dublin

The overwhelming majority of research to date has investigated attractiveness in vision only however, recent research has demonstrated that an individual's voice also holds attractiveness value. Here we asked whether face and voice information is integrated in judgements of attractiveness or whether both are independently assessed. In Experiment 1 we investigated whether any relationship existed between attractiveness ratings for a set of still face images, silent moving images, and audio voice tracks. Rating to the silent movie and still visual stimuli were highly correlated, however there was no correlation between audio and either stills or silent movie attractiveness ratings. In Experiment 2a we generated multisensory stimuli by pairing the silent moving images and audio tracks to form movies in which the face and voice were either congruent or incongruent for attractiveness. Attractiveness ratings for both conditions correlated positively with those for the silent movies only. We also found no difference in attractiveness ratings for congruent and incongruent stimuli although ratings to these multisensory stimuli were significantly higher than the vision only stimuli. To test for possible visual capture of attractiveness, in Experiment 2b participants were instructed to rate only the voice in each movie. Again ratings for both congruent and incongruent conditions correlated positively with audio only attractiveness ratings suggesting that facial information had no influence on attractiveness of the voice. Our findings suggest that facial and voice information can act as independent signals for judgements of attractiveness.

Poster #47
THE NEURAL AND MULTISENSORY BASES OF HAND SELF-RECOGNITION: PRELIMINARY INVESTIGATIONS
Nicholas Holmes, Alessandro Farne, Patrice Revol & Yves Rossetti, U534, Espace et Action, Bron, Lyon

Can you recognise your own hands? The English phrase 'I know it like the back of my hand' suggests one can, but very little empirical work has addressed the issue directly. Recent results in studies of bodily self-recognition suggest that the congruence between vision, proprioception, and action is crucial for bodily self-recognition. But these studies typically involved the self-recognition of movements or actions, not of body parts per se. We therefore presented static digital images of healthy participants' own hands, and asked them to make, in different sessions, both left-right, and self-other speeded judgements concerning the hand images. In the first experiment, we systematically manipulated the duration of presentation, and found that participants required around 50ms of exposure to the hand images to make efficient self-other and left-right judgements. Subsequent and ongoing experiments manipulated the congruence between the proprioceptive (posture) and visual (hand image) information to assess the multisensory bases of hand self-recognition. Parallel and ongoing studies are addressing the causes and effects of hand self-recognition both in simple reaching movements in healthy participants, and in neuropsychological patients

using a number of experimental approaches.

Poster #48
AFFECTING EMOTIONAL EXPERIENCE WITH AUDITORY-VIBROTACTILE HEARTBEAT FALSE FEEDBACK
Ana Tajadura, Aleksander Väljamäe, Daniel Västfjäll, Chalmers Room Acoustics Group, Chalmers university of Technology

In 1890 William James hypothesized that emotions are our perception of physiological changes. Many different theories of emotion have emerged since then, but it has been demonstrated that induced physiological state changes can influence one's emotional responses to stimuli (e.g. Schachter and Singer (1962)). We tested how the presentation of false heartbeat feedback to participants (N=24) via auditory and (or) tactile stimulation can affect their physiological state and likewise their emotional attitude to positive and negative images. In addition, distant versus close sound reproduction conditions (loudspeakers vs. headphones) were used to identify whether an "embodied" experience can occur, i.e. participants associating the heartbeat with their own, and modulate the emotional responses. Self-reported valence (pleasantness) and arousal (activation) ratings for the pictures, participants' peripheral heartbeat signals, memory performance and individual imagery scores were collected. False heartbeat feedback significantly amplified emotional responses to pictures: high heart rate resulted in higher arousal values and enhanced picture memory, while slow heart rate revealed a relaxing effect when facing negative stimuli. Seat vibrations showed interaction with heartbeat sound depending on its spatial location (tactile capture of audition) and picture type. A relationship between auditory imagery and vibratory stimulation has been also observed.

Poster #49
THE AUDIOVISUAL PERCEPTION OF BIOLOGICAL MOTION
Ben Schouten & Karl Verfaillie, University of Leuven, Laboratory for Experimental Psychology

The perception of human actions is frequently studied using 'point-light figures'. This research on the perception of biological motion is traditionally restricted to the visual modality. In contrast, research on multisensory integration specifically concentrates on the interaction of different sensory modalities. A key finding in the latter work is that temporally, spatially or semantically congruent multimodal stimuli are recognized better and faster than unimodal or incongruent multimodal stimuli. Moreover, the recent discovery of audiovisual mirror neurons in the premotor cortex of the monkey and the finding that visual and auditory information about actions are integrated in the superior temporal sulcus have lead some researchers to conclude that actions may be represented audiovisually. The current research explores two methods to investigate the audiovisual perception of biological motion. The first method investigates to what extent a rhythmic sound can enhance the detection of a visually masked point-light walker by means of an adaptive staircase procedure. The second method assesses the applicability of perturbation analysis to estimate the weights given to the separate sources of action information (auditory and visual) and verifies whether humans integrate audiovisual information about actions in a statistically optimal fashion.

Poster #50
FAKE HAND ILLUSION: THE ROLE OF HAND-SIZE AND HAND-DIMENSIONALITY
Francesco Pavani, Massimiliano Zampini, University of Trento, Italy

When a visible fake-hand is stimulated in synchrony with our own hand concealed from view, the felt position of the real hand can be biased towards the location of the fake-hand. This phenomenon, known as the fake-hand illusion, rely on the brain's ability to detect statistical correlations in the multisensory inputs (i.e., visual, tactile, and proprioceptive), but it is also modulated by the pre-existing representation of one's body. In the study reported here, we used a real-time video-image of the participant's hand to elicit the fake-hand illusion, and show that the illusion can emerge also for 2D images of the body. In addition, by changing hand-size in the video-image (reduced, veridical or enlarged with respect to the real hand) we show that reduced hand size prevents the illusion, while the illusion is stable for the enlarged image of the hand. Taken together, these novel findings demonstrate that specific aspects of our own body image (i.e., hand-size, but not hand-dimensionality) can constraint the multisensory modulations of the body schema subtending the fake-hand illusion. In addition, they reveal an asymmetric role of the fake-hand size on emergence of the illusion.

Poster #51
INTEGRATION OF FACIAL EXPRESSIONS AND EMOTIONAL VOCALIZATIONS TAKES PLACE IN UNIMODAL VISUAL AREAS
Hanneke Meeren, Corne van Heijnsbergen, Beatrice de Gelder, Cognitive and Affective Neuroscience Laboratory, Tilburg University, Tilburg, The Netherlands

Emotional signals provided by faces and voices

as well as emotional body language provide the primary tools of human emotional communication. How these hang together is not yet well understood. The correspondence between facial and vocal expressions is easily recognized, but the integration of these visual and auditory channels at the neural level is poorly understood. Traditionally it has been assumed that multisensory integration is a higher order process that occurs in multimodal regions after sensory signals have undergone extensive processing through a hierarchy of unisensory cortical regions. Recent findings, however, challenge this assumption and suggest a role for "unimodal" sensory areas. We recorded event-related potentials in 15 subjects, who watched videoclips of angry and happy facial expressions that were accompanied by congruent or incongruent emotional vocalizations. We show that the early visual P1 component is already sensitive for successful audiovisual integration at 107-ms after stimulus onset, i.e. P1 was enhanced when face and vocalization did not match as compared to when they formed a unified emotional percept. Importantly, the effects were not caused by low-level properties of the stimuli, since they were absent for the summated unimodal conditions. Our findings demonstrate that audiovisual integration of dynamic emotional signals already takes place during the early stages of processing in unimodal visual cortex.

Poster #52
CROSSMODAL INTEGRATION OF EMOTIONAL FACES AND VOICES IN PERVASIVE DEVELOPMENTAL DISORDER: AN ERP STUDY
Maurice Magnee, Child- and Adolescent Psychiatry, University Medical Center Utrecht, the Netherlands; Beatrice de Gelder, Psychology, Tilburg University, the Netherlands; Herman van Engeland, Chantal Kemner, Child- and Adolescent Psychiatry, University Medical Center Utrecht, the Netherlands

Pervasive developmental disorder (PDD) refers to a group of behavioral disorders of which autism is the most severe. Lack of social and emotional reciprocity counts among the most characteristic social-cognitive impairments of PDD and has been well documented for processing facial expressions. Here we investigated to what extent a deficit in recognition of facial expressions is associated with abnormal integration between the emotion seen in the face and heard in the voice. Electrophysiological responses to facial expressions and to face-voice pairs which were either emotionally congruent or incongruent were measured in adult PDD patients and matched controls. Increased P1 and N170 amplitudes were seen in response to the presentation of fearful faces as compared to happy faces in both groups. These results indicate normal processing of facial expressions among PDD patients. ERP responses to audiovisual presentation showed increased occipito-temporal amplitudes in response to fearful voices at 200 ms, only when presented in combination with a fearful face. This effect was observed in the control group, but not in the patient group. Because of the importance of rapid audiovisual integration of emotional information on social competence, the absence of such modulation in PDD might attribute to the observed deficits in their emotional behavior.

Poster #53
DEPERSONALIZED EXPERIENCE AND MULTIMODAL PROCESSING
Noriaki Kanayama, Nagoya University, Graduate School of Environmental Studies; Atushi Sato, University of Toyama, Faculty of Human Development; Hideki Ohira, Nagoya University, Graduate School of Environmental Studies

Depersonalized experience, the feeling that own proprioception was received not at own body, was reported with the traumatic event or Dissociative Disorder. In nonclinical populations, temporary depersonalized experiences were frequently seen. It could be hypothesized that this experience was caused by the disintegration of somatosensory and visual perception. In this study, we investigated the differences in the integration of multimodal perception between the groups with high and low frequent depersonalized experiences. According to rubber hand experience method (Pavani et al., 2000), participants were required to locate the somatosensory stimuli by the vibration motors, seeing the distracting visual stimuli by the LED to rubber hand. Reaction time (RT) and electroencephalogram data was analyzed. In this study, congruency effect for RT was divided two components; the promotion by the congruent stimulation and the inhibition by the incongruent stimulation. In the results, inhibition component was modulated by the frequency of the depersonalized experience. For EEG data, the outstanding power increase in the congruent condition was observed in high beta band response (25-30Hz) in 250-300 ms at parietal regions. Moreover, this component was synchronized in a whole brain for the populations which have the frequent depersonalized experiences compared with the control group. (198 words)

Poster #54
BODY IMAGE AND BODY SCHEMA IN EATING DISORDERS: FAKE HAND ILLUSION IN PATIENTS WITH ANOREXIA AND

BULIMIA NERVOSA

Massimiliano Zampini, Serena Nuccio, Department of Cognitive Sciences and Education, University of Trento; Gian Luigi Mansi, Alessandra Fumagalli, Massimo Molteni Scientific Institute for Research, Hospitalization and Health Care 'E. Medea', Bosisio Parini (LC); Francesco Pavani, Department of Cognitive Sciences and Education, University of Trento, Italy

Eating disorders, like anorexia or bulimia nervosa, have often been associated with distortions of the visual representation of the body (termed 'body image'). Here, we used the fake-hand illusion to investigate whether the multisensory construction of the body schema might also be altered in these patients. In the fake-hand illusion, people mislocalize the felt position of their hidden real hand towards the location of a visible fake-hand, when the two hands are stroked in synchrony. In our study, 10 eating disorders patients and 10 healthy participants were presented with a real-time video-image of their hidden left hand stroked by the experimenter. Intermanual pointing measures and questionnaire ratings were used as dependent variables. We also examined whether fake-hand size could modulate the illusion, by zooming differently on the left hand to obtain reduced, veridical or enlarged video-images of the hand. While healthy participants experienced the fake-hand illusion for both veridical and enlarged video-images of their hand, eating disorders patients did not show any effect of the visible fake-hand on the intemanual pointing of the position of their hidden hand. These results demonstrate that eating disorders patients were not affected by the multisensory modulations of the body schema subtending the fake-hand illusion.

Poster #55

MULTISENSORY INSECT WARNING DISPLAYS AND AVIAN PREDATOR PSYCHOLOGY

Emma Siddall & Nicola Marples, Zoology Dept. Trinity College Dublin

In an attempt to reduce predation pressure insects have evolved ways to make themselves less profitable as prey, they have also evolved signalling mechanisms to advertise their unprofitability to potential predators. Much research has been conducted on how visual cues operate as a warning signal, however, signals through other sensory pathways may also be important. Prey species may use several cues simultaneously in a multisensory warning display, the component signals of which often interact to elicit a response greater than the sum of the responses to the individual component signals. These multisensory displays may afford the defended prey greater protection from a predator through both innate and learned avoidances. This current project will use day old chicks (Gallus gallus domesticus) as a model avian predator to investigate how olfactory and auditory cues enhance innate and learned avoidance of warningly coloured defended prey. It will also examine whether multisensory warning displays increase the memorability of interactions with unprofitable prey. The effect of multisensory displays comprising novel and familiar component signals will also be examined in an attempt to determine how much generalisation occurs between multisensory displays. Some of the experiments will be replicated in the wild using blackbirds (Turdus merula) and robins (Erithacus rubecula).

Poster #56

MULTISENSORY AND MOTOR INTEGRATION IN STIMULUS DETECTION IN MONKEYS

Céline Cappe, Unit of Physiology - Dept. of Medicine - University of Fribourg and Centre de Recherche Cerveau et Cognition (UMR 5549) CNRS - University Paul Sabatie; Pascal Barone
Centre de Recherche Cerveau et Cognition (UMR 5549) CNRS - University Paul Sabatier Toulouse 3 - Faculty of Medicine Rangueil; Eric M. Rouiller
Unit of Physiology - Dept. of Medicine - University of Fribourg

On the psychophysical point of view, multisensory integration allows a decrease of reaction time and better performance in sensori-motor tasks, as reported for human subjects engaged in auditory-visual recognition task. As few data are available in behaving monkey engaged in similar protocols, the present study investigates the interaction between auditory and visual stimuli in monkey. Adult macaque monkeys (n=2) were trained in a visuo-auditory detection task. The monkeys had to generate a motor response in a reaction time paradigm whenever a visual, an auditory or a visuo-auditory signal was presented. Does, as in human, the synergy derive from the bimodal stimuli shorten the reaction time and improve detection when compared to unimodal conditions? At near threshold conditions of both visual and auditory stimuli, the bimodal condition has a significant facilitatory effect on reaction times and stimulus detection. Indeed, correct responses raised from 48% for unimodal conditions to 90% for bimodal conditions and the reactions times in multisensory conditions were 12% shorter on the average than unimodal conditions. These findings confirm in monkeys the rule of the inverted effectiveness feature of multisensory integration expressed as a significant gain in stimulus detection at near threshold condition

which disappeared at higher intensities.

Poster #57
CROSS-MODAL ASSOCIATIVE NETWORKS: ARE WE ALL SYNESTHETES?
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About 15 years ago, Marks and Melara did choice reaction time experiments with compound visual/auditory stimuli. In these experiments, observers had to respond to one stimulus dimension (e.g. brightness) while the second (i.e., pitch) was irrelevant. They found advantages for 'trials accompanied by informationally irrelevant "matching" versus "mismatching" stimuli from the other modality'. In the present experiment, we extend the previous experiments by including the tactile modality. 12 students did a speeded discrimination task with compound stimuli constructed from two brightness levels (high / low), two auditory pitch levels (high – 135 Hz / low – 60 Hz) and two vibration frequency levels (high – 135 Hz / low – 60 Hz; matched for subjective intensity). We found significant effects (p's $< .01$) in the conditions with the auditory stimuli as irrelevant modality only. Favourable effects on both the RT and the accuracy were present for matching stimulus dimensions, i.e., high pitch with high brightness or high vibration frequency, and low pitch with low brightness or low vibration frequency. This result underlines the assumption that the brain contains cross-modal associative networks in which not only place and time are associated across modalities but many other stimulus attributes, including pitch, brightness, colour, vibration frequency, and motion direction.

Poster #58
SYNAESTHESIA: CROSS-MODAL MECHANISMS AND THE ROLE OF VISUAL IMAGERY
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Synaesthesia has been defined as an involuntary sensory cross-activation whereby a stimulus in one modality elicits a perceptual experience in another modality. The most commonly reported forms involve the perception of colour in response to linguistic stimuli, but synaesthesia may also involve cross-activation between other modalities. Concepts can induce synaesthesia and colour in linguistic-chromatic synaesthesia is induced via the auditory or visual modality. We aimed to find out whether synaesthesia can be induced via a non-visual modality and to assess whether mental imagery might mediate synaesthesia. We tested the recognition of letters of the alphabet by touch in 5 synaesthetes using a virtual-tactile device. We also tested a further 38 synaesthetes using the Vividness of Visual Mental Imagery Questionnaire (VVIQ). We found that colour was evoked in synaesthetes upon recognition of a letter by touch, showing that synaesthesia can be induced via an alternative unfamiliar modality. We also found that synaesthetes report experiencing more vivid mental images. This strongly suggests that synaesthesia is associated with the propensity to form cross-modal associations and that such processes are mediated by enhanced mental imagery.

Poster #59
SENSORY PROCESSING DEFICITS ACROSS MODALITIES IN SCHIZOPHRENIA
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Schizophrenia research has recently focused on the search for endophenotypic or trait markers. In the race to develop a quantifiable, easily measured marker, the use of high density electrical mapping in patients and those at high risk of schizophrenia has played a key role. Sensory processing deficits in both the visual and auditory modalities have previously been established in patients with chronic schizophrenia. Our study aimed at looking for early visual deficits, in particular the P1, and the auditory MMN (mismatch negativity), in both frequency and duration, in clinically unaffected first-degree relatives and their probands. Of interest also was the degree of correlation between the two modalities in each individual subject. Twenty-five clinically unaffected first-degree relatives and their 16 probands were recruited. Their results were compared to 26 age-matched controls. Event related potentials revealed early visual processing deficits in the midline dorsal electrodes in the first-degree relatives and proband groups when compared to controls. The effect size was large ($d=0.09$). The result also supported previous studies showing magnocellular pathway deficits in patients. There was no difference observed in the MMN in the three groups. Because first-degree relatives share genes with their schizophrenic counterparts, we were confident that the changes observed here in this population would be invaluable as endophenotypes.

Poster #60
DOES AUDIO-VISUAL INTERACTIONS AFFECT WORKING MEMORY PERFORMANCE? EVIDENCE USING NON-SEMANTIC STIMULI
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The impact of bimodal stimulation on working memory has been examined in several studies. Typically, bimodal presentation (picture plus sound) leads to an enhancement of participants performance compared to unimodal presentation (either a picture or a sound). This enhancement can be attributed either to early stage of processing (e.g., automatic alerting effect) or a late stages of processing, as postulated by the dual coding theory. Previous studies exclusively used semantic stimuli to investigate this phenomenon, making the nature of this effect still unclear. In this study we used a n-back procedure, in which participants were asked to detect an item seen n-position before in a stream of stimuli, using unimodal (either visual or auditory) or bimodal (both visual and auditory) non-semantic stimuli presentation. We found a significant enhancement in participants performance for bimodal stimuli presentation, indicating that there might be an involvement of very early pre-semantic stages of memory processes.

Poster #61
COLOUR CUES INFLUENCE ODOUR DISCRIMINATION MORE THAN DO SHAPE CUES
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People's identification of odours can be influenced by the simultaneous presentation of irrelevant visual cues. In particular, both colour patches and pictures have been reported to influence olfaction, albeit at different levels of information processing. Here, we investigated whether simple drawings sharing different degrees of compatibility with odour targets would differentially interfere with odour discrimination performance. Participants in our study made speeded odour discrimination responses (strawberry vs. lemon) while viewing irrelevant visual information (i.e., a black line drawing of a square, a lemon, or a strawberry coloured either white, yellow, or red). The results showed that the accuracy of participants' odour discrimination responses was significantly influenced by odour-colour compatibility. In particular, participants responded to the lemon odour significantly less accurately when a red picture was presented than when a yellow picture was presented. By contrast, the congruency of the images (square, lemon, or strawberry) had no effect on the accuracy of participants' odour detection responses. These results provide the first empirical demonstration that different kinds of visual information may have differential effects on olfactory discrimination performance. What's more, our results would appear to demonstrate that colour compatibility may exert a stronger interference on odour discrimination than does image compatibility.

Poster #62
OLFACTORY PERCEPTUAL PRIMING IS RESISTANT TO AGING AND LONG-LASTING
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Previous work from our laboratory has shown not only crossmodal priming between vision and touch in young adults (Reales & Ballesteros, 1999) but also complete haptic priming in young adults, older adults and Alzheimer´s disease (AD) patients (Ballesteros & Reales, 2004). However, very few studies have investigated perceptual priming in other modalities such as smell and taste. In this paper, we present the results from a new study conducted to answer three main questions: 1) Does olfactory priming exist not only in young adults but also in older adults despite the well known age-related sensorial losses?; 2) does performance in olfactory priming as a measure of implicit memory dissociate from performance in explicit recognition; 3) olfactory priming will resist the passage of time and would it be still present after the long delay of a month after the previous study? In the study participated 20 young adults and 20 older adults that were tested in two occasions separated a month. The results showed significant olfactory perceptual facilitation in both groups and not interaction. Moreover, olfactory priming was still present after a month.