
Thirteenth European Conference on Eye Movements ECEM13



Abstracts

Editors:

*Marina Groner, Rudolf Groner, René Müri,
Kuzuo Koga, Simon Raess & Philipp Sury*

M. Groner et al.:
***Abstracts of the 13th European Conference
on Eye Movements ECEM13***

In memory of Dieter Heller (1945-2003) and Lawrence W. Stark (1926-2004)

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UNIVERSITÄT
BERN

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Thirteenth European Conference on Eye Movements ECEM13
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Rudolf Groner, Marina Groner and René Müri, Conference Organizers

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Preface

This volume contains the abstracts submitted for presentation at the Thirteenth European Conference on Eye Movements (ECEM13), Bern, August 14 – 18, 2005, and reviewed by the Scientific Board, consisting of W. Becker, Ulm; C.J. Erkelens, Utrecht; J.M. Findlay, Durham; A.G. Gale, Derby; C.W. Hess, Bern; J. Hyönä, Turku; A. Kennedy, Dundee; K. Koga, Nagoya; G. Lüer, Göttingen; M. Menozzi, Zürich; W. Perrig, Bern; G. d'Ydewalle, Leuven; D. Zambarbieri, Pavia.

A quarter of a century ago, in 1980, initiated by Rudolf Groner and Dieter Heller, a trans-disciplinary network called European Group of Scientists active in Eye Movement Research was founded. This group included scientists who used eye movement registration as a research tool and developed models based on oculomotor data obtained from a wide spectrum of phenomena, ranging from the neurophysiological to the perceptual and the cognitive level. The group was intended to serve the purpose of (1) exchanging information about current research, equipment and software, (2) organizing a conference (ECEM) at a different location all over Europe every other year.

Over the years ECEM has grown. At the first conference in Bern the relatively small number of participants made it possible for the organisers to avoid conflicting parallel sessions, whereas with the ECEM's steady growth, the introduction of parallel sessions soon became necessary. Although we are very happy about this year's new record of 273 scientific contributions, we regret at the same time that this large number of participants necessitated the introduction of no less than four parallel sessions for oral presentations.

Part of the ECEM culture are the books with a selection of edited contributions which have traditionally always been published after the conferences. Unfortunately, over the years the sale prices of books have become prohibitively expensive and book chapters have increasingly been given a low rating in comparison to publications in peer reviewed journals. As a consequence of this trend, we are now considering to launch an online journal Eye Movement Research which would publish scientific papers either on the base of individual submissions by the authors or as a follow-up of workshops or thematic sessions at ECEM. In either case, a fair peer reviewing process should guarantee a high quality of the contributions.

Last but not least, we are happy to express our deep gratitude to the main sponsors of our conference and to all the people who helped to keep it going. The Max and Elsa Beer-Brawand Foundation generously funded the invited speakers. The Swiss Academy of Humanities and Social Sciences (SAGW) sponsored the organization of workshops and made it possible for us to reduce fees for students. *Novartis Neuroscience* sponsored the reception at the Zentrum Paul Klee Bern. The University of Bern hosted the conference in its magnificent historical building.

Preface

A team of devoted young scientists acted as staff during the conference: Liliane Braun, Miriam Lörtscher, Esther Schollerer, Daniel Stricker, Simon Raess, Philipp Sury, Bartholomäus Wissmath, Linda Bodmer, Martina Brunthaler, Daniela Häberli, Nadine Messerli, Felicie Notter, Didier Plaschy, Svetlana Ogjanovic, Barbara Siegenthaler, David Weibel.\$

We dedicate this book to the memory of two important men in eye movement research: Dieter Heller as one of the founders of the ECEM group, and Lawrence W. Stark as pioneer in cognitive modelling of oculomotor control. In an early planning stage of ECEM13 both had been invited as keynote speakers, but their untimely death made this plan impossible. In many sessions of ECEM13 the influence of their work will prevail.

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Invited Lectures

Invited Lectures

IA-1**Monday 12:00****Skipping, jumping and standing still: Some unresolved issues in eye movement control in reading.**

A. Kennedy (University of Dundee, Psychology Department, DD1 4HN Dundee, UK. E-Mail: a.kennedy@dundee.ac.uk)

Why are some words skipped? In spite of a great deal of research, it is still unclear whether the eyes are sent to specific locations within a word ("targeting"); whether the movement is initiated when processing at a specific location has been completed ("leave-on-completion"); or whether it is directed to the most strongly activated target ("competitive activation"). Why make large inter-word regressions? Such saccades cannot be visually guided and I have argued that their control derives from an accurate underlying spatial representation of text. However, the accuracy of this putative "spatial code" has recently been challenged and I shall present new evidence bearing on this dispute. "Serial" or "parallel": Which metaphor best captures the dynamics of eye movement control in reading? Parafoveal-on-foveal effects in reading plainly challenge the notion of strictly serial processing, but the strength of this challenge increases in proportion to the cognitive level at which the alleged cross-talk occurs. I shall discuss parallel processing of (1) low-level visual features; (2) initial letter constraint; (3) lexical; and (4) pragmatic properties.

IB-2**Monday 15:30****Cortical control of eye movements.**

C. Pierrot-Deselligny (Salpêtrière Hospital Paris)

Eye movements are generated in the brainstem but are controlled by the cerebral cortex. At this level, two main areas trigger saccades, the parietal eye field (PEF), located in the intraparietal sulcus, and the frontal eye field (FEF), located in the precentral sulcus. The PEF is more involved in reflexive visual saccades, externally triggered by a suddenly appearing peripheral visual target, whereas the FEF mainly controls intentional saccades, which are internally triggered toward a target already present (intentional visual saccades) or no longer (memory-guided saccades) or not yet (predictive saccades) visible. The supplementary eye field, located in the paracentral sulcus, also contributes to saccade programming and triggering, in particular when these eye movements are combined with other body movements or are grouped in sequences. [...] Reflexive saccades are inhibited by the dorso-lateral prefrontal cortex (DLPFC). The DLPFC also controls predictive saccades and memory-guided saccades (with short-term spatial memory, up to 25 seconds), being finally involved in all decisional eye movement processes. Saccades using medium-term spatial memory (between 25 seconds and a few minutes) could depend mainly upon the parahippocampal cortex. Lastly, the cingulate eye field could contribute to prepare all types of intentional saccades. [...]

IC-3**Tuesday 09:00**

Saccadic eye movements in neurodegenerative disorders.

U.P. Mosimann (Wolfson Research Centre Newcastle)

This session will review saccadic eye movement changes of common neurodegenerative disorders such as Alzheimer's disease (AD) and Parkinson's disease with (PDD) and without dementia (PD). Possible reasons for inconsistent and controversial findings will be considered and the potential of saccadic eye movement testing as a useful clinical method for differential diagnosis in dementia will be discussed. Neurodegenerative disorders are associated with neuron loss and specific intracellular and extracellular protein aggregations. These neuroanatomical changes are likely to disrupt the integrity of cortico-cortical and subcortico-cortical networks involved in saccade generation. The brain areas predominantly affected in dementia are disorder specific, and neural networks involved in saccade generation are task-dependant. Therefore testing of saccades using different tasks should be a useful tool for differential diagnosis. In a recent study¹ we have assessed reflexive and complex saccades in patients with PDD and dementia with Lewy bodies (DLB). We found that impaired saccade execution, was helpful to differentiate PDD from Parkinson's disease without dementia and DLB from Alzheimer's disease.

ID-4**Wednesday 09:00**

Brainstem and cerebellar control of saccades: Paradoxes and new hypotheses.

R.J. Leigh (VA Medical Center Cleveland, USA)

Although the neural control of saccades is very well known, there are still some important paradoxes to resolve: 1) what is the mechanism of slow saccades? It has been thought that disorders affecting burst neurons cause slow saccades. However, inactivation of omnipause neurons cause saccadic slowing. One hypothesis is that omnipause neurons not only inhibit burst neurons, but also increase the initial burst by interacting with glutamate receptors. 2) how do high-frequency saccadic oscillations arise? A new hypothesis is that the inherent instability of burst neurons arises as a consequence of the circuitry of the network, with inhibitory burst neurons inhibiting other inhibitory burst neurons. 3) what is the explanation for transient decelerations of the eye during the course of saccades? The suggestion is that there is a defect of a hypothetical latch circuit by which omnipause neurons are inhibited until the saccade has got the target. 4) why are saccades hypermetric with cerebellar lesions? Patients of a family with a recessive spinocerebellar ataxia and axonal peripheral neuropathy showed saccadic hypermetria. We postulated that delayed conduction in parallel fibers of the dorsal vermis could cause the stop signal to arrive late, causing saccades to be hypermetric.

Invited Lectures

IE-5**Wednesday 16:00****Ambiguity in Art and the Brain.**

S. Zeki (University College London, UK)

One of the primordial functions of the brain is the acquisition of knowledge. The apparatus that it has evolved to do so is flexible enough to allow it to acquire knowledge about unambiguous conditions on the one hand (colour vision being a good example), and about situations that are capable of two or more interpretations, each one of which has equal validity with the others. However, in the latter instance, we can only be conscious of one interpretation at any given moment. The study of ambiguity thus gives us some insights into how activity at different stations of the brain can result in a micro-consciousness for an attribute, and also tell us something about interactions between different cerebral areas that result in several potential micro-conscious correlates, even if only one predominates at any given time. Ambiguity is also related to the "unfinished" and the power of the unfinished as exemplified in some major works of art reflects the capacity of the brain to give a work several interpretations that are of equal validity, thus heightening its evocative powers. It follows that the study of ambiguity gives us insights into the neurological machinery that artists such as Dante, Michelangelo, Wagner, Cezanne, Klee and others have tapped to create the ambiguity that is commonly a hallmark of great works of art.

IF-6**Thursday 09:00****Driver visual information acquisition.**

H.T. Zwahlen (Ohio University, Ohio Research Institute for Transportation and the Environment (ORITE), 114 Stocker Center, OH 45701-2979 Athens, USA.
E-Mail: zwahlen@ohio.edu)

Selected driver eye scanning behavior study results are presented. The basic feature of the driver visual information acquisition process is the eye fixation, a coordinated positioning and focusing of both eyes on a point in the driving scene, usually less than a second, during which the visual information is processed and a driving control decision, either an action or no action, is made. Driving a car involves a string of consecutive discrete eye fixations. Driver eye scanning behavior is described in terms of spatial x-y eye fixation distributions, temporal eye fixation time duration distributions, eye travel distance distributions between two consecutive eye fixations, activity based measures such as the number of eye fixations per time unit, and object specific eye fixation percentages. The study results presented provide a sample of how driver eye scanning behavior data can be analyzed and used to provide information to highway designers, traffic engineers and traffic safety professionals to solve problems in areas such as the design and evaluation of traffic signs, pavement markings and other traffic control devices.

Workshops

WA-7**Monday 09:30**

Tracking the mind during reading: The influence of past, present, and future words on fixation durations.

R. Kliegl (University of Potsdam, Psychology, Postfach 60 15 53, 14415 Potsdam, Germany. E-Mail: kriegl@rz.uni-potsdam.de), A. Nuthmann, R. Engbert

Frequency, predictability, and length of fixated words are established contributors to fixation durations in reading. With data from 222 readers of single sentences, we show that frequency, predictability, and length of neighboring words as well as incoming and outgoing saccade amplitudes and fixation position in the current word also influence the duration. We find simultaneous effects of last and next word frequency and predictability, incoming saccade amplitude, and relative position within words as well as four disputed parafoveal-on-foveal effects and offer an explanation in terms of cued memory retrieval. Lexical lag and successor effects are attenuated in two-fixation cases. Reading fixations reflect distributed processing relating to cognitive, perceptual, and oculomotor needs. We reconcile divergent results from corpus analyses and experimental research and propose a mixed-model perspective on eye movements in reading.

WA-8**Monday 09:50**

Cross-linguistic differences in the Dundee corpus.

J. Pynte (CNRS and University of Provence, 29 av. R. Schuman, 13621 Aix-en-Provence, France. E-Mail: pynte@univ-aix.fr), A. Kennedy (University of Dundee, Scotland)

In contrasting serial and parallel models (e.g. E Z reader vs. SWIFT) attention has focussed on such phenomena as skipping timing and dynamics, regressions, large saccades, parafoveal effects, etc... We propose providing data on some of these from a relatively new corpus. Eye movement data were acquired from a sample of ten native English-speaking and ten native French-speaking participants. They read texts taken from extended articles in *The Independent* and *Le Monde* newspapers, respectively, comprising more than 50,000 tokens and approximately 10,000 types each. French and English data sets comprise about 500,000 data points each. Multiple regression analyses have revealed parafoveal-on-foveal effects consistent with those reported by Kennedy and Pynte (2005) (e.g., the number of fixations and the duration of the last fixation recorded on word n were influenced by the length and frequency of word $n+1$). Moreover intriguing cross-linguistic differences have been obtained (e.g., concerning the role of parafoveal orthographic familiarity) which seem to challenge both the serial and parallel account.

WA-9**Monday 10:10**

Modelling saccade latencies in reading as a consequence of independent visual processing in the two hemifields.

S. McDonald (University of Edinburgh, Psychology, 7 George Square, EH7 4AN Edinburgh, UK. E-Mail: scott.mcdonald@ed.ac.uk), R.H.S. Carpenter (University of Cambridge), R. Shillcock (University of Edinburgh)

In reading, the uptake of visual information from a foveated word is initially divided between the hemifields, implying that for a centrally-fixated word, the task of visual processing is distributed across the two visual cortices. In an extension to Carpenter's (1981) LATER model of saccadic response times, we simulated saccade latencies in reading as a race between two stochastic rise-to-threshold units, where the rate of rise of each hemispheric unit is influenced by the letter sequence statistics in the contralateral hemifield. Simulations generate realistic latency distributions, replicate the dependence of latency on fixation position known as the inverted optimal viewing position effect (Vitu, McConkie, Kerr and O'Regan, 2001), and provide a partial account of spillover effects from the previous fixation.

WA-10**Monday 10:30**

Comparing reading in English and Thai: The role of spatial word unit segmentation in distributed processing and eye movement control.

R. Reilly (University College Dublin, Belfield, Dublin 4, Ireland. E-Mail: Ronan.Reilly@ucd.ie), R. Radach, D. Corbic, S. Luksaneeyanawin

The Thai language uses an alphabetic writing system with no spatial segmentation at word boundaries. We were interested in the degree to which established principles of oculomotor control can be generalized to these conditions. Participants in Thailand and the United States were asked to read equivalent corpora of text in their respective languages. Analyses of eye movement pattern revealed the existence of an attenuated preferred viewing position phenomenon in Thai reading. The steepness of the Gaussian distribution of initial saccade landing position was a function of the frequency with which specific letters occur at the beginning and end of words. We conclude that in the absence of visual segmentation orthographic information can serve as a base for the parafoveal specification of saccade target units. This mode of oculomotor control requires a substantial degree of distributed processing where word segmentation may be a result rather than a precondition of lexical access.

WA-11**Tuesday 11:50**

Distinguishing serial and parallel processing accounts of a parafoveal preview function in reading.

F. Vitu (CNRS, Université de Provence, Laboratoire de Psychologie Cognitive, 3 Place Victor Hugo, Bâtiment 9, Case D, 13331 Marseille Cedex 3, France. E-Mail: Francoise.Vitu-thibault@up.univ-mrs.fr), G. W. McConkie (University of Illinois)

On at least some eye fixations in reading, visual information is acquired from more than the fixated word. Obtaining information from the next word before sending the eyes to it is commonly referred to as parafoveal preview. In this paper we consider whether information is obtained from different words serially or in parallel. A-posteriori analyses of a large corpus of eye movement data for adult readers were conducted. A relationship was observed between the prior fixation location (or launch site) and the duration of the present fixation: launch sites less than 4 letter positions before a word produce increasingly shorter fixations suggesting peripheral preview for nearby, non-fixated words. Predictions were derived from the serial processing position regarding temporal characteristics of this peripheral preview function, and these were tested. The predictions were not confirmed suggesting that the acquisition of information from multiple words during a fixation occurs in parallel.

WA-12**Monday 11:10**

Do readers obtain preview benefit from word n2?

K. Rayner (University of Massachusetts, Amherst, Psychology Department, Tobin Hall, 1003 Amherst, MA, USA. E-Mail: rayner@psych.umass.edu), S.J. Brown, B.J. Juhasz (University of Massachusetts)

Readers clearly obtain preview benefit from the word to the right of fixation (word n1): if there is a valid preview of word n1, fixations are about 30 ms shorter on that word when it is subsequently fixated (see Rayner, 1998). Do readers also obtain preview benefit from word n2? MacDonald (2005) recently argued on the basis of corpus data analyses that preview benefit does not accumulate over successive fixations. We tested the extent to which readers get preview benefit over a distributed region of text by presenting either a valid preview or random letters for word n2. We examined situations in which readers made an intervening fixation on word n1 and found no evidence for preview benefit from word n2 (though there was a highly reliable preview benefit for word n1). Implications of the results will be discussed.

WB-13**Monday 09:30**

How to calibrate eye position data for the infant without verbal communications.

K. Koga (Nagoya University, Research Institute of Environmental Medicine, Furo-cho Chikusa-ku, 464-8601 Nagoya, Japan. E-Mail: koga@riem.nagoya-u.ac.jp), A. Nakagawa, M. Sukigara (Nagoya City University)

It is extremely difficult to record the eye position of the infant due to the lack of verbal communications between subject and experimenter. Without performing calibration prior to the measurements, quantitative analysis cannot be applied to the data. Normalization and linearization follows the calibration phase by applying linear regression equations both for the horizontal and vertical components of the raw eye position data. In the case of animal experiments, animal psychophysics based on classical conditioning can be applied to calibrate the eye position data. However infant (animal) psychophysics do not work because non-invasive method is mandatory. To solve the problem for the non-transactional situation in the experiments for the infant, we propose the analysis of cumulative distribution of the landing position data for gaze and head to estimate most likely frequent landing position. The method of the analysis can be applied not only with infants, but also in animal experiments or any other research when verbal transaction is impossible.

WB-14**Monday 09:50**

Recording the eye movements of mantis shrimps and men.

M.F. Land (University of Sussex, Dept. of Biology and Environmental Science, Falmer, BN1 9QG Brighton, United Kingdom. E-Mail: m.f.land@sussex.ac.uk),

Mantis shrimps (stomatopods) have remarkable compound eyes in which their 12 visual pigment colour system is confined to a linear band of 6 rows of ommatidia running across each eye. To use this they need to make special scanning eye movements, in addition to saccades, tracking and optokinesis. To measure these movements non-invasively from videotapes I devised a system in which outline models of the eyes were rotated in a computer, until they matched the image of the eye itself. This was done frame by frame, and although laborious it gave excellent results. Potentially this method can be used for eye movements in other animals, and it became the basis of a system that I now use for human eye movements (which, because the eye is spherical, are much easier to record!).

WB-15**Monday 17:40**

Eye movements of goldfish under the micro-gravity environment.

A. Takabayashi (Fujita Health University, School of Health Sciences, 1-98 Dengakugakubo, Kutsukake, 470-1192 Toyoake, Japan. E-Mail: takaba@fujita-hu.ac.jp), K. Iwata (Fujita Health University)

An otolith organ on ground behaves as a detector of both gravity and linear acceleration, and plays an important role in controlling posture and eye movement for tilt of the head or translational motion. Under the micro-gravity environment, a gravitational acceleration ingredient to an otolith organ disappears. However, linear acceleration can be received by otolith organ and produce a sensation that is different from that on Earth. In space experiment using Space Shuttle, goldfish showed looping or rolling behavior. In this study, we analyzed vertical and torsional eye movements of goldfish evoked by the changes of acceleration. Torsional eye movements to head down were larger than that to head up. In the fish whose left otolith was removed, the vertical eye movements of right eye were larger than that of left eye for rightward tilting. These results suggested that torsional and vertical eye movements were most sensitive to force acting otolith from caudal to rostral and from lateral to medial respectively.

WB-16**Monday 10:30**

Mini telemetric system continuously recording field of gaze and movements of eye and head.

M. Menozzi (Swiss Federal Institute of Technology Zurich, Helmholtz Institut für Arbeitswissenschaft, Bodenfeldstrasse 29, 8906 Bonstetten, Switzerland. E-Mail: mmenozzi@ethz.ch),

Recording movements of eyes and head can be problematic in ergonomics as instruments may limit the subject's freedom of movement. Wiring of the subject is known as psychological issue. In some recording systems, heavy weight of the instruments may bias head movements and the natural head rest. We developed a small, lightweight telemetric system, simultaneously recording the movements of the eye and the head. Additionally, the field of gaze is captured as viewed from the observers position. The system consists out of a frame for lenses equipped with two cameras, two video broadcasting units and an infrared source, illuminating the eye. Power is delivered by a 9V battery. One camera records the image of the pupil. The image is used for computing the orientation of the eye. The other camera captures the field of gaze as seen from the observer's position. The same camera records infrared sources of light, which are fix in space. The positions of the lights are used to compute the orientation of the head. For the visual representation of the fixation in space, fixation is combined with the video showing the field of gaze. A very descriptive tracking of the focus of attention is achieved.

WC-17**Monday 17:00**

Cortical mechanisms smooth pursuit (SP) eye movements driven by retinal or extraretinal signals.

W. Heide (General Hospital Celle, Dept. of Neurology, Siemensplatz 4, D-29223 Celle, Germany. E-Mail: wolfgang.heide@akh-celle.de), M. Nagel, S. Zapf, C. Erdmann, A. Sprenger, F. Binkofski, R. Lencer (University of Lübeck)

To investigate visual and non-visual processing during SP, we correlated fMRI activation with SP parameters. In 16 subjects SP velocity (SPV) and the number of saccades during tracking of a target moving at 10 °/s without and with target blanking were assessed in the scanner. During target presentation SPV was positively correlated with the BOLD-signal in right area V5 and negatively with the left frontal eye field and dorsolateralprefrontal cortex. With target blanking, we found additional activation in the left parieto-insular cortex and the left angular gyrus, negatively correlated with SPV. Saccadic frequency was negatively correlated with activation of the right intraparietal sulcus (IPS). We conclude, that V5 is directly related to the optimal maintenance of SPV with visual feedback, whereas the other areas appear to compensate for SPV decreases in darkness. Only IPS activation may reflect spatial attention and saccadic suppression, possibly in the ventral intraparietal area.

WC-18**Monday 17:20**

The role of cortical attentional systems in eye tracking dysfunction.

S.B. Hutton (University of Sussex, Department of Psychology, University of Sussex, BN1 9QH Brighton, United Kingdom. E-Mail: s.hutton@sussex.ac.uk),

Attentional processes have traditionally been linked to the production of saccadic eye movements, but recent research suggests they may also play an important role in the initiation and maintenance of smooth pursuit. As attentional dysfunction is considered to be a core feature of schizophrenia, the possibility arises that disturbances in attentional processes may mediate eye tracking dysfunction in this population. Indeed one of the first modern studies into eye tracking dysfunction in schizophrenia made this very claim. I will present data addressing this hypothesis from eye tracking studies in patients with first-episode and chronic schizophrenia, and from dual task and repetitive Transcranial Magnetic Stimulation (rTMS) studies in healthy controls. The results suggest that attentional processes play an important role in the control of smooth pursuit, and add weight to the recent suggestion that a similar functional architecture underlies both pursuit and saccadic eye movements.

WC-19

Monday 17:40

Reduced neuronal activity in the V5-complex underlies smooth pursuit deficit in schizophrenia..

R. Lencer (University of Luebeck, Psychiatry and Psychotherapy, Ratzeburger Allee 160, 23538 Luebeck, Germany. E-Mail: lencer.r@psychiatry.uni-luebeck.de), M. Nagel, S. Zapf, A. Sprenger, F. Binkofski, W. f (University of Luebeck)

Constant velocity ramps ($10^\circ/s$) were presented to 17 schizophrenic patients and 16 matched controls while assessing smooth pursuit velocity (SPV) during fMRI. Reduced SPV in schizophrenic patients was significantly correlated with a decrease of the hemodynamic response in the V5 complex. Comparison of the main effects revealed decreased neuronal activity related to the right ventral premotor cortex and the right frontal eye field, and increased activations of the left dorsolateral prefrontal cortex, the right thalamus and a focus within the left cerebellar hemisphere in schizophrenic patients. Our results imply that reduced neuronal activity in V5 is one major factor underlying abnormal SPV in schizophrenia and suggest impaired motion perception. Reduced neuronal activity of frontal areas supports the hypothesis of Hypofrontality in schizophrenia, whereas the DLPFC, the thalamus and cerebellar hemispheres are suggested be involved in compensatory strategies during reduced SPV.

WC-20

Monday 14:00

Neuronal correlates of eye tracking deficits in schizophrenia.

G. Thaker (University of Maryland School of Medicine, Psychiatry, Maryland Psychiatric Research Center, PO Box 21247, 21228 Baltimore, MD, USA. E-Mail: gthaker@mprc.umaryland.edu), E. Hong, M. Avila, M. Tagammets, I. Wonodi (University of Maryland)

In the current study, patients were selected based on similar performance on closed-loop gain compared with control subjects prior to the fMRI study, although patients showed consistent deficits in predictive pursuit (i.e., response based on extraretinal motion processing). In the magnet, subjects were tested using a SPEM task that elicits closed-loop response. Group comparisons of pursuit-related brain activity showed that patients had reduced activation in known extraretinal motion processing areas including frontal eye fields, supplementary eye fields, medial superior temporal cortex, and anterior cingulate. Patients also showed increased activation in MT region. Results provide evidence supporting reduced function in the extraretinal motion processing pathway in schizophrenia. Increased activation in MT suggests a compensatory increased dependence on immediate retinal motion.

WC-21**Monday 18:20**

Altered cortical and behavioral responses to visual motion in schizophrenia: Sensory processing for eye tracking.

Y. Chen (Harvard Medical School/McLean Hospital, Psychiatry, RM123D, MRC, 115 Mill Street, 2478 Belmont, MA, USA. E-Mail: ychen@wjh.harvard.edu), E. Grossman (University of California Irvine), L.C. Cinnamon (University of Colorado), D. Yurgelun Todd, S. Gruber, D. Levy, K. Nakayama, P. Holzman (Harvard)

Eye tracking dysfunction, a biomarker for schizophrenia, may involve sensory, cognitive and motor systems in the brain. We studied motion processing, the presumed sensory signal for eye tracking, in schizophrenia. Using psychophysical approach, we found degraded motion discrimination in patients, a behavioral finding that implicates neural processing in the posterior extrastriate cortex. Using neuroimaging approach, we found that in the posterior area MT, cortical activations of patients, measured with fMRI BOLD signal, were significantly reduced during the motion, but not during the non-motion, tasks. In contrast, cortical activations of patients were significantly increased in the inferior convexity of the prefrontal cortex. Neural processing of visual motion, normally mediated in the posterior cortex, is shifted towards the anterior cortex in schizophrenia, suggesting a functional reorganization across sensory and cognitive systems.

WD-22**Monday 17:00****Oculomotor behaviour in simultanagnosia: A longitudinal case study.**

Th. Nyffeler (Perception and Eye Movement Laboratory, Departments of Clinical Research and Neurology, University of Bern, 3010 Bern, CH. E-Mail: thomas.nyffeler@insel.ch), T. Pflugshaupt, R. von Wartburg, P. Wurtz, C.W. Hess, R.M. Müri (University of Bern)

The aim of the present single case study was to investigate oculomotor recovery in a patient with simultanagnosia due to biparietal hypoxic lesions. Applying visual exploration as well as basic oculomotor tasks in three consecutive test sessions – i.e. 8 weeks, 14 weeks, and 37 weeks after brain damage had occurred – differential recovery was observed. While visual exploration remarkably improved, an impaired disengagement of attention persisted. The improvement of exploration behaviour is interpreted within an oculomotor network theory and implications for a deficit-specific recovery from simultanagnosia are discussed.

WD-23**Monday 17:20****Volitional action and the inhibition of reflexive saccades in patients with focal lesions of the prefrontal cortex and schizophrenia patients.**

B. Reuter (Humboldt-Universität zu Berlin, Institut für Psychologie, Rudower Chaussee 18, DE-12489 Berlin, Germany. E-Mail: reuter@psychologie.hu-berlin.de), Ch. Ploner, G. Juckel (Charité Universitätsmedizin), E. Herzog, N. Kathmann (Humboldt-Universität Berlin)

Ploner et al. recently showed that reflexive errors in the antisaccade task are enhanced in patients with brain lesions affecting Brodmann's area 46 (BA 46) but not in patients with other prefrontal lesions. In the present study two patients with left-sided lesions affecting BA 46 and sparing the frontal eye fields and 24 control participants performed standard and supported antisaccades. Both tasks required saccades away from a peripheral stimulus but in supported antisaccades the required saccade direction was additionally cued by a centrally presented arrow. Both patients had enhanced reflexive saccade rates in standard but not in supported antisaccades, suggesting that BA 46 is mainly involved in the internal activation of action goals. A study in 24 schizophrenia patients suggested that a deficit in goal activation may also contribute to the robust antisaccade deficits in schizophrenia.

WD-24**Monday 17:40**

Effects of eye movement rehabilitation on stroke patients.

G.B. Wilhelmsen (Huseby Resource Center, Gamle Hovsetervei 3, N-0768 Oslo, Norway.
E-Mail: Gunvor.B.Wilhelmsen@statped.no),

The intention of this study was to test the effect of eye movement rehabilitation training on the visual capacities, eye movements and reading in a group of stroke patients. The study group consisted of 20 patient's ages 29-68 years. Nearly all of them had disturbed eye movements, including saccades and fixation, and 75 % had loss in their visual field. On the whole their reading abilities had greatly decreased and they had a significantly higher number of fixations than normal. The participants were divided into two groups, which received different regimes of testing and training. The training lasted one hour daily for 3 weeks. After training they read more quickly both aloud and silently and made fewer mistakes. Their eye movements after training were on the whole more steady and controlled. A control was taken 2 months after the final training and still showed better results than before training. Waiting for training showed no positive affect on reading or eye movements.

WD-25**Monday 18:00**

The Functional Visual Field: A new method to analyse outcomes of visual field defects.

T. Pflugshaupt (Perception and Eye Movement Laboratory, Departments of Clinical Research and Neurology, Inselspital, 3007 Bern, Switzerland. E-Mail: tobias.pflugshaupt@dkf.unibe.ch), R. von Wartburg, P. Wurtz, Th. Nyffeler, C.W. Hess, R.M. Müri (University of Bern)

The term visual field corresponds to the angular field of view that is seen by the eyes when they are fixed on a point straight-ahead. In patients with brain damage, visual field function can be restricted, depending on lesion site and size. The extent of the visual field defect is evaluated with perimetric methods that allow neither head nor eye movements while patients respond to rather simple stimuli. In contrast, the term functional visual field describes the area of visual field responsiveness under more ordinary viewing conditions. In our laboratory, we developed a new method to assess the functional visual field, conceptualised as the area that a patient actively scans with eye movements to detect predefined targets placed on everyday scenes. With this experimental design, we can address two clinically important issues: a) Do patients with visual field defects compensate for their defect with an appropriate eye movement strategy? b) Do they benefit from specific exploration training aimed at making more and larger saccades towards the area of their field defect?

WD-26**Tuesday 17:40****Evidence from enhanced predictive saccade behaviour for a dysfunction of fronto-striatal circuits in obsessive-compulsive disorder.**

D. Spengler (University of Lübeck, Psychiatry and Psychotherapy, Ratzeburger Allee 160, 23538 Luebeck, Germany. E-Mail: dietmar_spengler@web.de), P. Trillenber, A. Sprenger, A. Kordon, K. Junghanns, W. Heide, F. Hohagen, R. Lencer (University of Luebeck)

To investigate the integrity of frontal oculomotor circuits in obsessive-compulsive disorder (OCD), performance during reflexive and predictive saccades, antisaccades and smooth pursuit was compared between 22 patients with OCD, 21 patients with schizophrenia and 24 healthy subjects. Eye movements were recorded by infra-red reflection oculography. In both patient groups, enhanced predictive behaviour indicated by higher frequencies of anticipatory saccades with reduced amplitudes was observed. This finding gives evidence for an over-activation of the circuit between the frontal eye field and the basal ganglia in both groups. Additionally, increased error rates in the antisaccade task and reduced smooth pursuit eye velocity with increased saccadic intrusions imply additional deficits in patients suffering from schizophrenia which involve the dorsolateral prefrontal cortex and the cortical network for smooth pursuit.

WD-27**Monday 18:40****Inhibitory control of saccades in Parkinson's Disease and Alzheimer's Disease in relation to effects of normal aging.**

T.J. Crawford (Lancaster University, Department of Psychology, Fylde Building, LA1 4YF Lancaster, United Kingdom. E-Mail: t.crawford@lancaster.ac.uk), S.J. Higham

This study explored the relationship between cognitive function and saccadic eye movements and distinguished between age-specific and disease-specific effects on the inhibitory control of saccadic eye movements. The experimental population comprised patients with Parkinson's disease (PD), Alzheimer's disease (AD), elderly controls (EC) and young controls (YC). Participants completed a series of involuntary and voluntary saccadic tasks, and a battery of neuropsychological assessments. Examination of reflexive saccades revealed that there was no significant difference between-groups for the majority of saccade dynamics. However, PD patients' antisaccades were found to be significantly different to those of both YC and EC groups. Inhibitory error costs for the PD group on the antisaccade gap task were significantly higher than those of the EC and YC groups, but of lower magnitude than that of the AD group. However, in contrast to the AD, PD patients were able to correct their inhibition errors. The results indicate dissociation between inhibitory control and error correction in neurodegenerative disease.

WE-28**Tuesday 10:30**

Interaction of lexical and discourse factors during reading.

P. Gordon (University of North Carolina at Chapel Hill, Department of Psychology, CB# 3270, Davie Hall, NC 27599-3270 Chapel Hill, USA. E-Mail: pcg@email.unc.edu), C. Camblin (Duke University), K. Ledoux (Johns Hopkins University), T.Y. Swaab (University of California Davis)

Repetition and semantic association are powerful lexical factors that influence the processing of words in lists. Coreference and semantic congruity are powerful discourse factors that influence the processing of words in sentences. We report results from studies measuring eye movements during reading in which discourse factors and lexical factors were manipulated orthogonally so as to allow an assessment of how these levels of language analysis interact during the reading of coherent text. Strong effects of the discourse (repeated-name coreference and semantic congruity) were found on eye movement measures of both early and late processing. Effects of lexical factors (repetition and semantic association) were more fleeting. Results from parallel studies that use event-related potentials to measure brain activity related to discourse and lexical factors under circumstances where readers cannot move their eyes are discussed as well.

WE-29**Tuesday 10:50**

On the automaticity of language-mediated eye movements.

G. Altmann (University of York, Department of Psychology, Heslington, YO10 5DD York, United Kingdom. E-Mail: g.altmann@psych.york.ac.uk), A. Salverda (University of Rochester)

It is clear that language can guide attention about the visual world; less clear is whether language-mediated shifts in visual attention are similar to the automatic shifts observed in cases of oculomotor capture. Analyses of the time-course of language-mediated eye movements, and experiments in which spoken words referring to objects in a scene ‘competed’ with visual cues to move the eyes (e.g. colour changes or abrupt onsets), suggest that the mediation of visual attention by spoken language can indeed be automatic, at least as defined operationally through the interfering effects of spoken words on the attentional capture normally afforded by abrupt onset visual stimuli.

WE-30**Tuesday 11:10**

Where speakers look.

Z. Griffin (Georgia Institute of Technology, Department of Psychology, 654 Cherry st, GA 30332-0170 Atlanta, USA. E-Mail: zenzi.griffin@psych.gatech.edu),

When describing scenes, speakers look at objects during the second before naming them and these gazes reflect the difficulty of preparing the names (Griffin, 2001; Griffin & Bock, 2000; Meyer et al., 1998). Speakers even gaze at objects that they intend to name when they accidentally or intentionally misname them (Griffin, 2004; Griffin & Oppenheimer, submitted). When referring to removed objects and information, people look at their previous locations of (e.g., Levelt & Meyer, 2000; Spivey & Geng, 2001). A new experiment suggests that they look at the missing parts of objects while preparing to name the absent part. Altogether these studies indicate a tie between locations and word preparation that is as strong or stronger than a tie between visual object information and word preparation.

WE-31**Tuesday 14:00**

Interpreting eye-movements in visual scenes: evidence from conflicting processes during spoken comprehension.

M. Crocker (Saarland University, Department of Computational Linguistics, Gebäude 17.1, Room 1.15, 66041 Saarbruecken, Germany. E-Mail: crocker@coli.uni-sb.de),

Eye-movements in visual scenes during spoken comprehension reveal the operation of various underlying processes, including lexical access, reference resolution, anticipation of role fillers, and ambiguity resolution. Studies have also revealed the influence of diverse kinds of information such as linguistic and world knowledge, as well as referential and event information in the scene. The richness of the paradigm is thus tempered by the fact that the eye-movement stream is over-loaded. At any given moment, a variety of underlying processes vie to influence visual attention. In this talk I will focus on two experiments that tackle this issue directly, by investigating eye-movements patterns when two simultaneous processes or information types would predict differing gaze patterns. The aim is to shed further light on which information sources and processing mechanisms dominate, in the presence of conflict, and to better understand how eye-movements should be interpreted in such contexts.

WE-32**Tuesday 11:50**

The influence of concurrent linguistic information on fixation patterns during natural scene viewing.

F. Ferreira (Michigan State University, Department of Psychology and Cognitive Science Program, East Lansing, 48824-1116 Michigan, USA. E-Mail: fernanda@eyelab.msu.edu), G.L. Pierce, N.D. Patson, B. Bartek, J.M. Henderson

People tend to fixate objects that are mentioned in or implied by concurrent linguistic content. To date, these results have been obtained for simple utterances and schematic scenes. We used photographs of complex real-world environments that appeared simultaneously with onset of spoken stories consisting of four sentences. Sentences either explicitly mentioned three objects in the scenes or objects not visually present. Subjects determined whether the scene and story were well matched. In the matched condition, subjects fixated more of the target objects, and did so more quickly and for more time than the unmatched condition. Object fixations were time-locked to object mention. These findings are striking given that subjects had many objects to look at. Latencies to fixated mentioned objects were somewhat longer than previously reported with simplified utterances and displays. The findings suggest that language and vision are integrated online, and are consistent with the hypothesis that the cognitive system encodes visual information to tokenize linguistic input. These processes, however, take more time with realistic visual and linguistic input.

WE-33**Tuesday 12:10**

Interactions of language and vision restrict “visual world” interpretations.

S. Garrod (University of Glasgow, Psychology, 56 Hillhead Street, G12 8QB Glasgow, Scotland. E-Mail: simon@psy.gla.ac.uk), M.J. Pickering (University of Edinburgh), B. McElree (New York University)

The “visual-world” paradigm has had an enormous impact on recent language processing research. Although we welcome the new method, we argue that it does not provide a transparent “window” on language processing. Using examples of recent visual-world studies we show how information in the visual scene inevitably influences the processing of utterances about that scene. We conclude that findings from visual-world experiments may not always generalize to language processing in the absence of visual support, and that it is most appropriately applied to the question of how linguistic and visual information are integrated. Additionally, it offers exciting new insights into the interaction between language and vision when communicating about a visual scene.

WF-34**Tuesday 10:30**

Reminiscence of scanpaths past.

S.R. Ellis (NASA Ames Research Center, UC Berkeley, School of Optometry, CA 94035-1000 Moffett Field, USA. E-Mail: silly@eos.arc.nasa.gov),

Some approaches to capturing, modeling, and relating repetitive eye movement scanning patterns to cognition will be recalled from the experience of working in Professor Lawrence Stark's U.C. Berkeley bioengineering and robotics laboratory circa 1976-1978. Connections to D.O. Hebb's "cell assembly" proposal and various degrees of randomness will be discussed.

WF-35**Tuesday 10:50**

The top-down scanpath theory of vision and the role of bottom-up conspicuity information.

C.M. Privitera (UC Berkeley, School of Optometry, 582A Minor Hall, 94707 Berkeley, USA. E-Mail: claudio@scan.berkeley.edu), D. Chernyak, T. Fujita, M. Azzariti, L.W. Stark

The Scanpath theory introduced by Noton and Stark embodies a top-down approach to human vision; it firstly takes into account the dichotomy between low-resolution peripheral vision and high-resolution foveal vision; this dualism necessitates an important role for eye movements. It further develops that representation over distributed modules of the cortex generates the complex model of perception as an active process. Finally, the scanpath controls eye movement foveations that are the usual and natural means of directing visual attention. The dichotomy regarding the top-down (informativeness) and bottom-up (conspicuity) domination of human vision will be analyzed in this report and then integrated into a plausible biological-cognitive Bayesian framework of visual attention and scanpath eye movements control. Eye movement experiments with Pierre Bonnard's famous paintings will be finally discussed in the light of this framework.

WF-36**Tuesday 11:10**

Local scanpaths versus global scanpaths – Is it necessary to extend the Noton-Stark theory?

R. Groner (University of Bern, Psychology, VISLAB, CH-3000 Bern, Switzerland. E-Mail: rudolf.groner@psy.unibe.ch), E. Schollerer (University of Bern), B. Wissmath (University of Bern)

Noton & Stark's (1971) scanpath theory is probably the most influential model of eye movement control. In the formulation of Stark & Ellis (1981) it is a pure top-down processing model of visual information processing. Groner et al. (1984) extended Stark's original model with components responsible for bottom-up processing, arguing that top-down control is reflected by oculomotor control on a larger time scale ("global scanpaths"), in contrast to stimulus-controlled reflexive saccades which operate on a smaller time scale ("local scanpaths"). This model will be presented with the scanning data of observers under different viewing instructions.

WF-37**Monday 14:00**

Visual search: Impact of eye movements, task difficulty and spatial distribution.

S.A. Brandt (Berlin Neuroimaging Center, Charité, Neurology, Schumannstr. 20/21, 10117 Berlin, Germany. E-Mail: stephan.brandt@charite.de), E. Yago (University of Zürich), M. Olma (Berlin Neuroimaging Center), T. Donner (University of Hamburg)

We performed several psychophysical and fMRI studies in 20 normal subjects investigating the pattern of activation of the fronto-parietal network underlying selective attention as a function of visual search difficulty, eye movements and different types of selective visual attention. Experimental setups included different search scenes, eye movements recordings with an infrared oculography system (SMI) adapted to the MR and reaction time recordings. An overall consistent pattern of activation in three posterior parietal areas along the intraparietal sulcus and frontal areas (FEF, DLPFC) could be further characterized with regard to search difficulty, eye movements and types of visual attention. E.g. the change in the BOLD response over the anterior intraparietal cortex and the superior parietal lobe correlated with the task difficulty, suggesting the involvement of these areas in attentional effort and supporting a differential functional role of these cortical subregions.

WF-38**Tuesday 11:50****Parafoveal training and visual imagery in virtual hemianopic. Normal Subjects.**

W.H. Zangemeister (University of Hamburg, Neurological University Clinic, Clinical Neuroscience Unit, Martinistraße 52, 20251 Hamburg, Germany. E-Mail: zangemei@uke.uni-hamburg.de), Th. Liman (Neurological University Clinic)

We used parafoveal training and visual imagery in virtual hemianopic normal subjects viewing a series of search, realistic & abstract pictures under conditions of “easy”, “detailed” & “recollection” looking. We analysed their recordings using stringediting (RSE) methods developed by Stark and colleagues, which led us to three conclusions. RSE shows differentially the many significant differences that follow therapeutical masking of the foveal region during a [virtual, model] hemianopia. The visual imagery scanpath is done over a compressed mental image that needs longer fixation duration than the real image. The combination of different viewing tasks with different types of pictures permits to show how top down strategies of the scanpath can be enforced or diminished by a proper combination of task and picture - with bottom up mechanisms becoming more important with the additional loss of foveal viewing strategies in the mask condition.

WG-39**Tuesday 17:00**

Communication by gaze interaction - in search of new solutions.

P. Majaranta (University of Tampere, Department of Computer Sciences, Kanslerinrinne 1, 33014 Tampere, Finland. E-Mail: paivi.majaranta@cogain.org), K.-J. Rähä (University of Tampere)

Eye movement studies aiming at the understanding of the visual perception process have a long history. This workshop focuses on a newer trend, that of building interactive applications that react to eye movements. The presentations come from the COGAIN Network of Excellence that aims at the development of support tools for users with severe motor disabilities. The workshop provides examples of eye movement measures that help in the building of interactive applications, experiences with and approaches to text entry, and new types of applications that could help in moving eye gaze interaction into the mainstream software development.

WG-40**Tuesday 17:00**

Providing eye control for those who need it most - a study on user requirements.

M. Donegan (ACE Centre, -, 92 Windmill Road, OX3 7DR Oxford, UK. E-Mail: donegan@ace-centre.org.uk), L. Oosthuizen (ACE Centre), R. Bates (De Montfort University), G. Daunys (Siauliu University), J. P. Hansen (IT University of Copenhagen), M. Joos (Technische Universität Dresden), I. Signorile (Politecnico di Torino), P. Majaranta (University of Tampere)

In Europe alone, the number of potential beneficiaries of eye tracking technology amounts to several hundreds or thousands but, as yet, only a fraction of these people are actually using eye control in order to make their lives easier and more enjoyable. For many of them, eye control is potentially the quickest, least tiring and most reliable form of access to technology - by far. The COGAIN project aims to make sure that as many of the needs of these people as possible can be met through eye control. We report the findings of a study on user requirements, including observations of difficulties users are experiencing and the results of a questionnaire on user needs. We describe what these needs actually are and provide an insight into the challenges that face everyone who wishes to use eye control to its fullest advantage, with both practical recommendations and recommendations for further research.

WG-41**Tuesday 17:20**

Design criteria for gaze typing systems.

J.P. Hansen (IT University of Copenhagen, Department of Innovation, Rued Langgaards Vej 7, DK-2300 Copenhagen, Denmark. E-Mail: paulin@itu.dk),

Gaze may be the only viable interaction and communication form for some users, e.g. in a full locked-in situation. Typing speed has increased with new keyboard designs and better tracking systems. The new designs accelerate gaze selections or reduce typing errors. Speed is not the only objective to consider, though. The system should be easy to install, maintain and update. It should consist of standard components that can be replaced immediately when something breaks down. Calibrations should be performed easily and quickly. Tracking should be sufficiently robust to allow for mobile use with occasional changes in light conditions, use of glasses, and minor changes in head position. Prolonged use should not cause fatigue or cause the eyes to dry out. The price of the system should not be prohibitively high. Finally, the system should not make the disabled person look awkward. This paper will define common design guidelines for gaze typing systems on basis of user need specifications.

WG-42**Wednesday 10:30**

EyeChess: A tutorial for endgames with gaze-controlled pieces.

O. Spakov (University of Tampere, Department of Computer Sciences, Kanslerinrinne 1, 33014 University of Tampere, Finland. E-Mail: Oleg.Spakov@cs.uta.fi), D. Miniotas (University of Tampere)

Advances in eye tracking have enabled the physically challenged to type, draw, and control the environment with their eyes. However, entertainment applications for this user group are still rare. We present EyeChess: a PC-based tutorial to assist novices in playing endgames. The player always starts first and is to checkmate Black King in three moves. To make a move, the player first selects a piece and then its destination square. A square with a green highlight indicates a valid move, whereas red denotes invalidity. There are three options for selection: blinking, eye gesture (i.e., gazing at off-screen targets), and dwell time. If the player does not know how to proceed, or starts making mistakes, the tutor provides a hint. This shows up as a blinking green highlight when the gaze points at the right square. Preliminary user studies revealed that dwell time was the preferred selection technique, and that the tutorial was rated helpful in guiding the decision-making process.

WG-43**Monday 11:10**

Towards communication of unusual things: Attention, consciousness and, perhaps, feeling.

B.M. Velichkovsky (Technische Universität Dresden, Applied Cognitive Research / Psychology III, Mommsenstrasse 13, 1062 Dresden, Germany. E-Mail: velich@psychomail.tu-dresden.de), J. R. Helmert, M. Joos, S. Pannasch, S.T. Graupner

The implementation of gaze-based-interaction systems will only be successful if underlying mechanisms are taken into account. A promising approach to this task is the classification of eye movements in relation to the two brains pathways variously called ambient vs. focal, dorsal vs. ventral etc. We summarise evidence that analysis of eye movements is sufficient for on-line identifying the extent to which these modes are involved. This opens a perspective on explicating perception, as only ventral and not dorsal pathway seems to be related to conscious representation. Furthermore, recent hypotheses on an interaction of search strategies with emotions make it promising to look for eye-movement indicators of affective valences. We present results of several studies covering related research topics, in particular, fixation maps vs. attentional landscapes, gaze-based recognition of hazard perception and eye-movement analysis of virtual social interaction - paralleled by an fMRI analysis.

WG-44**Tuesday 18:20**

Analysing and reducing the variability of gaze patterns on natural videos.

M. Dorr (University of Luebeck, Institute for Neuro- and Bioinformatics, Ratzeburger Allee 160, 23538 Luebeck, Germany. E-Mail: dorr@inb.uni-luebeck.de), M. Boehme, T. Martinetz (University of Luebeck), K. Gegenfurtner (University of Giessen), Erhardt Barth (University of Luebeck)

We investigate the variability of eye movement patterns on high-resolution natural videos as well as on movie trailers. Subjects watched each of the 9 image sequences several times. Those circular regions of 2 degrees diameter that were fixated most frequently were extracted by a clustering algorithm. For each frame, we then counted how many fixations fell within these regions. For natural videos, 7 to 18 such salient regions are required to predict 60% of fixations of all subjects, but there exist hot spots where even a single region can predict 60% of fixations. For professionally cut movie trailers, this number goes up to 90%. Furthermore, we show that the variability of eye movements can be reduced by an additional gaze-contingent stimulation such as to enable scan-path guidance. We plan to use such guidance to improve the efficiency of visual communication and perception by gaze interaction, see <http://www.inb.uni-luebeck.de/Itap>.

WG-45**Yuesday 18:40**

An eye tracking system using multiple near-infrared channels with special application to efficient eye-based communication.

D. Grover (Michigan State University, Electrical and Computer Engineering, 2120 Engineering Building, 48824 East Lansing, MI, USA. E-Mail: groverda@egr.msu.edu), T. Delbruck (University of Zurich), M. King (Red Cedar Foundation)

An eye tracking system based on a small sensor that can be clipped to eyeglasses measures multiple channels of reflected near-IR light from the eye and nearby tissue. The use of visible LEDs as emitters for sensing as well as targets allows use of communication techniques such as word-level disambiguation using a reduced set of targets (e.g., 8). Some advantages of such a pairing are efficient text production (nearing 1:1 symbol selection to letter generated), low cognitive load to the user (input method is spelling), no need for constant high-bandwidth visual feedback, and no need to track or constrain head position.

WH-46**Tuesday 17:00**

Eye movements in reading and other cognitive tasks: How stable are eye movement measures?

K. Rayner (University of Massachusetts, Amherst, Psychology Department, Tobin Hall, 1003 Amherst, MA, USA. E-Mail: rayner@psych.umass.edu), X. Li, C. Williams, K. Cave (University of Massachusetts)

We recorded the eye movements of native readers of English and native readers of Chinese as they engaged in the following tasks: reading English, reading Chinese, scene perception, face perception, visual search for objects, visual search for characters (English or Chinese). We were interested in the extent to which the characteristics of eye movements in one task reflect the characteristics of eye movements in other tasks. Data will be presented on eye movements in each of the tasks. Interestingly, whereas eye movements during reading did not correlate with eye movements in the other tasks for readers of English, there were strong correlations of reading eye movements with eye movements in the other tasks for Chinese readers.

WH-47**Tuesday 17:20**

Eye movements in reading and visuomotor development.

R. Radach (Florida State University, P.O. Box 1270, FL 32306-1270 Tallahassee, USA. E-Mail: radach@psy.fsu.edu), S. Huestegge, R. Piringger, L. Huestegge (University of Aachen)

Second and fourth grade elementary school students were asked to read aloud 120 sentences including target words varying in length and frequency. They also completed a pro- and antisaccade task and a naming experiment with identical target words. Using this design, we examined relations between local fixation patterns in reading, parameters of basic oculomotor development and single word recognition performance. Effects of word length on viewing time measures were much more pronounced in second grade readers, indicating the use of a more sequential reading strategy in both low and high frequency words. The most substantial grade level difference was a sharp reduction in total reading time per word, while the number of regressive saccades decreased only marginally. The associated reduction of the number of re-readings, a marked decrease of fixation durations and a rightward shift of initial saccade landing positions appear to be the primary oculomotor indicators of oral reading development. Relations between tasks will be discussed with respect to current theories of oculomotor control.

WH-48**Tuesday 17:40****Dyslexic readers: No evidence for deficits in oculomotor control or visual perception during reading.**

F. Hutzler (Free University of Berlin, Erziehungswissenschaft & Psychologie, Habelschwerdter Allee 45, 14195 Berlin, Germany. E-Mail: fhutzler@zedat.fu-berlin.de), A. Jacobs (Free University of Berlin)

It is still a matter of debate whether the divergent eye movement patterns of dyslexic readers during reading (i.e., more and longer fixations and a higher number of regressions) reflect an underlying problem in word processing or whether they are associated with deficient visual perception or oculomotor control. In the present study, a string processing task was applied that poses similar demands on letter identification and oculomotor control as pseudoword reading. Dyslexic readers did not differ from controls with respect to their eye movement patterns during the string processing task. In contrast, the same participants showed marked deviations when asked to read pseudowords. These results suggest that dyslexic readers neither seem to have difficulties with the accurate perception of letters nor with the control of their eye movements during reading – their reading difficulties therefore cannot be explained in terms of oculomotor and visuo-perceptual problems.

WH-49**Tuesday 11:50****Regression size is predicted by individual differences in Inhibition of Return.**

U. Weger (State University of New York, P.O. Box 6000, NY 13902-6000 Binghamton, USA. E-Mail: uweger1@binghamton.edu), A. Inhoff

Effective reading requires the eyes to keep track of previous fixation locations so that redundant or unintended regressions can be avoided. The role of Inhibition of Return (IOR) in this avoidance mechanism was investigated. A spatial cueing paradigm was used to identify subgroups of participants with a relatively slow or rapid build-up of IOR. Readers with a rapid IOR-effect made larger regressions than readers with a slow effect, suggesting that they sought to avoid the most recently attended location. There was no difference in forward saccade size or skipping rate between the two groups. It is suggested that the forward-directed selection of new words in the periphery may be accompanied by a complementary avoidance mechanism that ‘pushes’ the eyes away from previously inspected regions.

WH-50**Tuesday 18:20**

Relative contributions of working memory and vocabulary knowledge to the process of vocabulary acquisition in silent reading.

R. Williams (Florida Center for Reading Research, 227 N. Bronough St., Suite 7250, FL 32301 Tallahassee, USA. E-Mail: rwsmith@fcrr.org), R.K. Morris (University of South Carolina)

The purpose of this study was to examine the extent to which the process of acquiring new vocabulary during silent reading depends on readers' available working memory resources and vocabulary knowledge. Skilled readers' eye movements were monitored as they read single sentences that contained either a familiar or a novel target word. Sentence contexts provided information that constrained the meaning of unfamiliar words to a particular semantic category. Participants were sorted into groups based on their scores on the vocabulary subtest of the Nelson-Denny and a reading span measure (Hannon & Daneman, 2001). Following the reading task, a forced-choice memory test was used to examine whether participants retained the meanings of the unfamiliar words that they encountered during the reading session. Variance in eye movement measures of initial processing and reanalysis accounted for by working memory and vocabulary knowledge will be discussed. Results provide additional information regarding the processes involved in acquiring word meaning during a reader's first encounter with a new word.

WH-51**Tuesday 18:40**

Eye movements in reading: Modeling age differences with SWIFT.

J. Laubrock (University of Potsdam, Cognitive Psychology, P.O. Box 60 15 53, 14415 Potsdam, Germany. E-Mail: laubrock@rz.uni-potsdam.de), R. Kliegl, R. Engbert (University of Potsdam)

Relatively little is known concerning age difference in eye movements during reading. In our data gathered with the Potsdam Sentence Corpus, we have identified a number of effects. Patterns of fixation durations as a function of word frequency or length are very similar for younger and older adults (21 vs. 70 years), and mostly limited to age main effects. However, there is also an interaction with age, namely, the age difference in total fixation duration vanishes for very frequent words. With regard to probabilities, old adults skip more words at the cost of having to make more regressions. We will present results from ongoing investigations of how the SWIFT model can account for these age differences. Results will be discussed with respect to hypotheses generated from the cognitive aging literature, regarding (1) general cognitive slowing, and (2) specific age effects in (a) low-level vision, (b) eye movement control, and (c) lexical processing.

WI-52**Tuesday 17:00**

‘Dry Dissection’ of motor movements using independent component analysis.

J.L. Semmlow (UMDNJ, Robert Wood Johnson Medical School, 617 Bowser Road, NJ 08854 Piscataway, USA. E-Mail: semmlow@biomed.rutgers.edu),

Lawrence Stark coined the term ‘dry dissection’ to describe a general methodology that can provide information about internal neural signals without actually invading the body. Techniques involve the clever manipulation of input stimuli or the use of multiple responses to infer internal control activity. It is also possible apply the concept of dry dissection to a single stimulus-motor response as multiple responses can be obtained. In this approach, the normal movement-to-movement variability provides insight into internal processes. Applying a new application of Independent Component Analysis (ICA) to vergence eye movements, the underlying components were isolated. Results showed two components with different behaviors: one component is generated by a pulse-like transient signal while the other is the result of a step-like sustaining signal. ICA analysis also showed that the enhanced dynamics seen in adapted responses were due to an increase in pulse signal amplitude. The dependence of divergence dynamics on initial position has also been traced to the pulse-like control signal using ICA.

WI-53**Tuesday 17:20**

A hybrid model of attention and recognition by information maximization.

K. Schill (Universität Bremen, Kognitive Neuroinformatik, Bibliothekstraße 1, 28359 Bremen, Germany. E-Mail: kschill@informatik.uni-bremen.de),

The perception of an image by a human observer is usually modelled as a parallel process in which all parts of the image are treated more or less equivalently, but in reality the analysis of scenes is a highly selective procedure, in which only a small subset of image locations is selected and processed by the precise and efficient neural machinery of foveal vision. To understand the principles behind this selection of the "informative" regions of images we have developed a hybrid system, which consists of a combination of a knowledge-based reasoning system with a low-level pre-processing by linear and nonlinear neural operators. This hybrid system is intended as a first step towards a complete model of the sensorimotor system of saccadic scene analysis. In the analysis of a scene, the system calculates in each step which eye movement has to be made to reach a maximum of information about the scene. The possible information gain is calculated by means of a parallel strategy which is suitable for adaptive reasoning. The output of the system is a fixation sequence, and finally, a hypothesis about the scene.

WI-54**Tuesday 17:40**

The reading scanpath for variable top-down and bottom-up processing performance.

C.C. Krischer (Forschungszentrum Jülich, , Rotdornweg 5, 52428 Jülich, Germany. E-Mail: cckrischer@aol.com), **W.H. Zangemeister** (Neurological University Clinic, Clinical Neuroscience Unit), **R. Meißen** (Fachhochschule Aachen)

In an analysis of literature data we outline for the first time in eye movement research how the reading scanpath changes for insufficient visual acuity or reading skill. Rational scanpaths are achieved only with letter size increased inversely proportional to visual acuity or reading skill. Beginners and proficient readers then make full use of the high resolution in the retinal center with a scanpath of four foveal saccades per second, equivalent to a mean gaze velocity of about 8 deg/sec. Gaze velocity increases above normal when low visual acuity requires magnified letters and decreases when too small letters lead to increased fixation durations. Poor reading conditions can be detected by a slow gaze velocity and may be optimized by using the gliding text display mode: One selects the optimal gliding speed of 8 deg/sec and increases letter size until the optimal scanpath of four foveal saccades per second is reached. We conclude that the reading scanpath systematically depends both on visual acuity and reading skill.

WI-55**Tuesday 18:00**

Can we use eye tracking to support problem solving?

S. Bertel (Universität Bremen, FB3 Mathematics and Informatics, Cognitive Systems, P.O. Box 330 440, 28334 Bremen, Germany. E-Mail: bertel@informatik.uni-bremen.de), **C. Freksa** (Universität Bremen)

Along various lines of exploration, eye movements have been shown to be reflective of attentional shifts as well as of underlying functional organizations of mental representations and processes, both under conditions that involve visual perception or mental imagery. With respect to mental reasoning about spatial configuration problems, this contribution suggests that eye tracking during the mental construction phase of a solution model can be employed to robustly assess individual preferences for certain spatial configurations over others. This finding has further implications for human-computer collaboration scenarios, in particular in spatial reasoning, as for such collaboration to be satisfactory the computational side has to dynamically adapt to changes in the human reasoner's attentional focus as well as to the problem solving decisions that he takes along the way. Results from a recent eye tracking study will be presented.

WJ-56**Wednesday 12:00****Direction-specific properties of predictive smooth pursuit.**

C.J. Erkelens (Utrecht University, Helmholtz Institute, P.O. Box 80.000, 3508 TA Utrecht, The Netherlands. E-Mail: c.j.erkelens@phys.uu.nl),

Two phases, initial and sustained, can be distinguished in the smooth pursuit of sinusoidal target motion. The superior dynamics of sustained pursuit are ascribed to a predictive mechanism. It is unknown whether prediction is related to the motion of a target or a class of motion. This question was addressed by studying transitions between initial and sustained pursuit when subjects voluntarily changed pursuit from one oscillating target to another and vice versa. We varied amplitudes, frequencies, phases, and orientations of oscillation of the two motions. Pursuit remained sustained after voluntary saccades only if both targets moved identically, showing that prediction is related to a specific motion. If both targets oscillated in two dimensions of which one dimension was common and the other not, pursuit remained sustained in the common dimension and was interrupted in the uncommon dimension. This result suggests that predictive pursuit is governed by one-dimensional mechanisms.

WJ-57**Wednesday 12:20****The importance of expectation in the ability to control the speed, timing and direction of anticipatory smooth pursuit.**

G. Barnes (The University of Manchester, Faculty of Life Sciences, Moffat Building, PO Box 88, Sackville Street, M60 1QD Manchester, UK. E-Mail: g.r.barnes@manchester.ac.uk), C. Jarrett

Prediction can be revealed by investigating anticipatory smooth pursuit (ASP). ASP cannot normally be produced at will, but with appropriate expectation, remarkable control can be achieved. To reveal this we used the Remembered Pursuit Task, in which target motion is preceded 400ms earlier by an auditory cue. In one experiment, cues indicated the direction (left or right) and speed of ensuing ramp target motion. Subjects could appropriately direct ASP and scale its speed to future target motion, even though direction and speed were randomised. A second experiment showed cues could also be used to modify ongoing eye movement. The target moved at constant velocity to the right followed at randomised time by reversal and a similar ramp to the left. Non-motion-based cues indicating first ramp duration were given prior to the first ramp. Subjects were able to temporarily store timing information derived from the cues to successfully control reversal of eye movement in a predictive manner.

WJ-58**Wednesday 12:40**

Statistics and modeling of the timing of predictive saccades.

M. Shelhamer (John Hopkins University, Otolaryngology and Biomedical Engineering, 210 Pathology Bldg., 600 N. Wolfe St., MD 21287 Baltimore, USA. E-Mail: mjs@dizzy.med.jhu.edu),

Saccadic tracking is reactive at low frequencies and predictive at high frequencies, with an abrupt transition between the two modes. As shown by autocorrelation and spectral analysis, reactive saccade latencies are independent, while latencies of predictive saccades are correlated. For the latter, the autocorrelation decays as a power law and the spectrum decays as $1/f\alpha$, suggesting that the latencies form a fractional Brownian motion (fBm). Consecutive predictive saccades are correlated over ~ 2 sec regardless of pacing rate. Predictive saccades are generated when a sufficient number of previous saccades fall into this window, so that their timing error can be monitored. This also explains the transition between reactive and predictive tracking. The statistical structure of predictive saccades (fBm) has important implications, among which is the fact that correlations between saccades decay slowly. The window of correlation is also adjustable on the basis of long-term stimulus repetition. Models of predictive tracking should reproduce fBm statistics; our attempts at such a model are presented.

WJ-59**Wednesday 13:00**

A representation of cognitive expectation in the supplementary eye fields of the Macaque monkey.

M. Missal (Catholic University of Louvain, Laboratoire de Neurophysiologie, 54 av. Hippocrate, 1200 Brussels, Belgium. E-Mail: Marcus.missal@nefy.ucl.ac.be), C. de Hemptinne, P. Lefèvre

Anticipatory movements occur before likely sensory events in contrast to reflexive actions. We recorded neurons in the supplementary eye fields (SEF) of rhesus monkeys before anticipatory pursuit eye movements when the direction of the upcoming target motion was cued. Monkeys were trained in a step-ramp smooth pursuit task. In control trials, a green spot was used as fixation point and pursuit target. In test trials, the color of the fixation point, either yellow or red, was used to cue subjects about the direction of the upcoming target motion, to the left or to the right. In the absence of the cue, anticipatory smooth movements were frequent (70% of trials) but in the direction of previous target motion. In the presence of the cue, anticipatory movements were more frequent (90% of trials) and in the direction of upcoming target motion. Neurons in the SEF were more active and showed an earlier directional selectivity in the presence of the cue. We conclude that SEF neurons could contribute to a representation of cognitive expectation about future target motion that is used to build-up an anticipatory response.

WK-60**Wednesday 12:00**

Looking without seeing in works of Paul Klee.

B. Kersten (University of Bern, Department of Psychology, Muesmattstr. 45, 3000 Bern 9, Switzerland. E-Mail: bernd.kersten@psy.unibe.ch), D. Stricker (University of Bern)

Experiments on "change blindness" are showing that humans' internal representation of the visual field is much sparser than the subjective impression of visual richness suggests. That means only those objects were remembered that receive focused attention. In contrast, according to the visual rightness hypothesis a disruption of the balanced organization of a visually right work of art (i.e., "good" design) is perceptually salient. We tested 4 experts (Paul Klee Zentrum, Bern, Switzerland) and 16 naïve participants. Eye movements were monitored while participants performed a change detection task: An initial and a modified scene image (perturbed version of the art work) were displayed in alternation, separated by a blank interval (flicker paradigm). We will show results concerning the following questions and discuss them in terms of the visual rightness hypothesis. Change detection may be better (1) for works of art than for perturbed versions of the art work (i.e., distribution of attention), and (2) for objects learned at a specific level because of a more detailed representation formed (experts vs. novices).

WK-61**Wednesday 12:20**

Unusual non-conjugate eye positions in Kabuki play and Ukiyoe wood prints.

K. Koga (Nagoya University, Research Institute of Environmental Medicine, Furo-cho Chikusa-ku, 464-8601 Nagoya, Japan. E-Mail: koga@riem.nagoya-u.ac.jp),

Human conjugate eye movement is quite common when the change of gaze occurs by means of saccadic and smooth pursuit eye movements. Non-conjugate eye movement mostly occurs when the eye gaze changes for the object in the 3-dimensional distant space. In old Japanese woodprints, Ukiyoe, Kabuki players were illustrated quite often. Since photography hadn't been invented yet, these pictures were valuable for the enthusiastic fan of star Kabuki players in similar ways as modern photographs of contemporary movie stars. In the Ukiyoe pictures, many illustrated Kabuki player show unusual eye positions, namely a non-conjugate eye position. In the actual modern Kabuki play on stage, some players can perform this kind of unusual eye position. So the illustration of Kabuki players on woodprint showing non-conjugate eye position was neither an exaggeration nor unrealistic. I introduce several examples of the close-up face both for Ukiyoe wood prints and Kabuki players, then introduce new explanations why those unusual eye position has been a source of fascination in contemporary modern art.

WK-62**Wednesday 12:40**

Art, aesthetics, and eye movements – a historical approach.

R. Müri (University of Bern, Perception and Eye Movement, Anna Seiler Haus, Inselspital, 3010 Bern, Switzerland. E-Mail: rene.mueri@insel.ch),

Since the 16th century, eye movements, the perception of art, and the aesthetic judgement had been considered to depend on one another. The eye was seen as “the mirror to the soul” and the early anatomical denomination of the eye muscles were associated with emotion. In the 19th and 20th century, the experimental approach by Fechner, Wundt, James, and others yielded new concepts, which were extended by Buswell, Yarbus, and later by Stark and co-workers. The aim of the presentation is to give a historical overview about the concepts of the role of eye movements in the perception of art.

WK-63**Tuesday 10:50**

The art of eye movements: Inspecting initially unseen objects.

B.W. Tatler (University of Dundee, Psychology, Perth Road, DD1 4HN Dundee, UK. E-Mail: b.w.tatler@dundee.ac.uk), N.J. Wade (University of Dundee)

Art has provided important stimuli for eye movement research since the development of eye trackers in the early 20th C. Stratton’s patterns, Judd’s illusions, Buswell’s and Yarbus’ paintings and Zanker and Walker’s recent op art all consist of elements that are clearly delineated. We consider a unique set of stimuli in which objects are not distinct, but are embedded within a geometric pattern (see Wade, 1990; 1995). We compared eye movements when viewing patterns with or without embedded objects. Knowing that objects were embedded in some patterns influenced both detection rate and eye movements. Eye movements differed between patterns with and without embedded objects, even when objects were not detected. Our embedded images allow a unique opportunity to study the evolution of a percept; upon first seeing such patterns, there is no percept of the embedded image, but this develops over time. Thus we can consider the link between constructing visual precepts and inspecting a scene.

WK-64**Wednesday 13:20****Eye movements and Op Art: How eye movements can generate motion illusions in Op Art paintings.**

J. Zanker (Royal Holloway University of London, Department of Psychology, Egham, TW20 OEX Surrey, England. E-Mail: j.zanker@rhul.ac.uk),

Since many centuries, artists have been puzzled by the problem of representing depth and motion – the four-dimensional world – on a two-dimensional, static surface. A long history of creative development eventually led to an innovative use of motion illusions by some Op artists, who elicit vivid sensations of movement using simple black and white patterns, and thus set the stage for a lively scientific debate about possible visual processing mechanisms. Here I review emerging evidence from an approach that combines perceptual judgements of motion illusions and observations of eye movements with computer simulations of the optic flow induced by shifting simple black and white patterns across the retina. This work suggests that small involuntary saccades would generate an incoherent distribution of motion signals that resemble the perceptual effects experienced when viewing such patterns. The combined experimental and computational evidence supports the view that the illusion is caused by involuntary image displacements picked up by low-level motion detectors, and also suggests that coherent motion signals are crucial to perceive a stable world.

WK-65**Wednesday 13:40****Processing of visual art: Insights through attention tracking.**

Ch. Scheier (MediaAnalyzer Software & Research GmbH, , Glockengießerwall 26, 20095 Hamburg, Germany. E-Mail: scheier@mediaanalyzer.com),

The visual processing of art pictures is analysed using a new method to map visual attention (“AttentionTracking”). In this paradigm, fixations and shifts of visuo-spatial attention are measured using the computer mouse instead of eye tracking hardware. After a short training procedure subjects are instructed to rapidly point (click) on visually salient parts of an image. Each image is shown for seven seconds. The test runs in a web browser and can thus be deployed over the internet. We present results of an experiment where several hundred subjects’ processing of visual art was measured using AttentionTracking. Analyses of the scanning paths and the distribution of fixations are presented. Results reveal the typical sequence with which visual art is processed, as well as the most salient regions. Implications of the results are discussed.

WL-66**Thursday 10:30**

Modelling eye-movement control via a constrained search approach.

M. Ferraro (Universita di Torino and INFN, Dipartimento di Fisica Sperimentale, via Giuria 1, 10125 Torino, Italy. E-Mail: ferraro@ph.unito.it), G. Boccignone (Universita di Salerno)

A model of visual search is presented where gaze shifts are driven by a hybrid deterministic/stochastic mechanism operating over a saliency field. The system performs a deterministic walk if in a neighborhood of the current position of the gaze there exists a point of sufficiently high saliency; otherwise the search is driven by a Langevin equation whose random term is generated by a Levy distribution, and by a Metropolis algorithm. Results of the simulations are compared with experimental data, and a notion of complexity is used to quantify the behaviour of the system in different conditions.

WL-67**Thursday 10:50**

Modeling the influence of top-down mechanisms on fixation behavior

W.F. Bischof (University of Alberta, Computing Science, ATH419, T6G 2E9 Edmonton, Canada. E-Mail: wfb@ualberta.ca), E. Birmingham, A. Kingstone (University of British Columbia)

Most current models of visual attention and eye-movement behavior ignore scene context and focus on bottom-up information in the processing of natural scenes. Bottom-up scene information is captured in the form of saliency maps developed by Koch, Itti and colleagues, and eye movement can be modeled on the basis of these maps. It is, however, well known that scene context and task strongly influence fixation behavior. In the present work, we compute differences between fixation maps and saliency maps, and we describe approaches to modeling the difference maps using scene context and task information.

WL-68**Thursday 11:10****SWIFT: A dynamical model of saccade generation during reading.**

R. Engbert (University of Potsdam, Psychology, POB 601553, 14415 Potsdam, Germany. E-Mail: engbert@rz.uni-potsdam.de), A. Nuthmann, E. Richter, R. Kliegl (University of Potsdam)

Mathematical models have become an important tool for understanding the control of eye movements during reading. Main goals of the development of the SWIFT model were to investigate the possibility of spatially distributed processing and to implement a general mechanism for all types of eye movements we observe in reading experiments. Here, we present an advanced version of SWIFT which integrates properties of the oculomotor system and effects of word recognition to explain many of the experimental phenomena faced in reading research. We propose new procedures for the estimation of model parameters and for the test of the model performance. A mathematical analysis of the dynamics of the SWIFT model is presented. Finally, within this framework, we present an analysis of the transition from parallel to serial processing.

WL-69**Thursday 11:30****The continuous wavelet analysis as a tool to investigate fixational eye movements.**

C. Paladini (University of Potsdam, Applied and Industrial Mathematics, Cotheniusstr.5, 10407 Berlin, Germany. E-Mail: paladini@math.tu-berlin.de), M. Holschneider, R. Kliegl, R. Engbert (University of Potsdam)

Fixational eye movements occur unconsciously and involuntarily during fixations. The fast component of fixational eye movements is due to microsaccades, which occur at a rate of about one per second. To characterize and automatically detect the microsaccades is a long-standing research problem. From a mathematical point of view, microsaccades behave like singularities through a wide range of scales. Here we apply the continuous wavelet transformation to detect these singularities and characterize their local geometry. We show that different subgroups of singularities with similar properties exist. These results may be used to derive an alternative procedure for the detection and classification of microsaccades.

WL-70**Thursday 11:50**

Stochastic latency mechanisms for modelling gaze durations.

R. Groner (University of Bern, Psychology, VISLAB, CH-3000 Bern 9, Switzerland. E-Mail: rudolf.groner@psy.unibe.ch), M. T. Groner (University of Bern)

A typical finding in most areas of eye movement research, especially in the cognitive domain, is a large variability of data. As a consequence, in most experiments large numbers of observations are needed for producing statistically significant results. In the classical experimental approach, variance is treated as statistical error. In our approach, variance is a characteristic constituent of the underlying search process that should be accounted for by a class of probabilistic models. In accordance with earlier work (Groner R. & Groner M.: A stochastic hypothesis testing model for multi-term series problems based on eye fixations. In R. Groner, Ch. Menz, D. Fisher & R.A. Monty (eds.), *Eye Movements and Psychological Functions: International Views*. Hillsdale (N.J.): Lawrence Erlbaum, 1983) we propose a class of stochastic latency mechanisms capable of generating probability distributions of gaze durations.

WM-71**Thursday 10:30****The development and usage of Dikablis (Digital wireless gaze tracking system).**

C. Lange (Technische Universität München, Lehrstuhl für Ergonomie, Boltzmannstraße 15, 85747 Garching, Germany. E-Mail: lange@lfe.mw.tum.de), H. Bubb

Within the scope of the presentation, the new at the Lehrstuhl für Ergonomie in cooperation with the SVS-Vistek GmbH developed gaze tracking system Dikablis will be introduced. Dikablis allows to track the probands gaze in realtime while this one can swing around because of the wireless data transfer. Furthermore there are no proband limitations because of the recording principle. The system is introduced at the Lehrstuhl für Ergonomie for a lot of purposes. Primary it is used for the evaluation of the human-machine-interface in cars to analyze the ergonomic quality of novel driver assistant and information systems. Anymore it is used to evaluate the ergonomic quality of software. In future the system will be employed in many other applications because of the wireless data transfer. For example the architectural rating of buildings like airports or super markets can be evaluated or the effect of car design solutions or the virtue of a booth.

WM-72**Monday 18:20****Eye movement behavior analysis and detection of information when driving in the Gotthard tunnel and on the open road: A pilot study.**

A.S. Cohen (University of Zurich, Institute of Psychology, ZUP 26, Zürichbergstrasse 43, 8044 Zürich, Switzerland. E-Mail: amos.cohen@access.unizh.ch), M. Menn, N. Studer (University of Zurich)

Perceiving driving obstacles too late or not at all is the most frequent cause of accidents in road traffic. These errors in perceiving dangers become even more significant if road conditions tolerate fewer errors. Small events can then have large effects, such as in tunnel traffic. We examined by means of driving gaze behavior analysis whether these errors, leading to information deficits, occur during driving in the Gotthard tunnel. As compared to driving on the open road, a number of indicators all revealed that there is reduced visual scanning in tunnel driving. The study participants' gaze was directed to redundant elements of the scene for longer periods of time, and the drivers showed low oculomotor activity instead of monitoring for potential dangers. These flaws could be avoided by (1) drivers taking particular care to scan for information, (2) improved tunnel lighting, and (3) eliminating as far as possible the monotony of the tunnel.

WM-73**Thursday 11:10**

Light and eye movement at workstations.

S. Hubalek (Environmental Ergonomics, Swiss Federal Institute of Technology (ETH), NW F 72, Clausiusstrasse 25, 8092 Zürich, Switzerland. E-Mail: shubalek@ethz.ch), Ch. Schierz (Swiss Federal Institute of Technology)

Aim: The aim of the study is to gather information on how illumination effects eye movements at office workplaces. Is there a difference in eye movements, e.g. towards the window, depending on the light situation? Indications shall be identified for the design of a visually comfortable luminance environment that does not constrain the eye movements. **Method:** In an ongoing field study in Zurich, Switzerland the eye movements of 22 subjects are being observed with a head mounted eye-tracking device during daily office work routines. In parallel to this, visual field luminance and illuminance measurements are carried out. Each participant is subjected to four different lighting situations: (A) daylight with diffuse sky, (B) daylight with sunlight, (C) artificial light and (D) artificial light with closed venetian blinds. The subjects work for approximately 40 minutes on daily work activities until they are interrupted by a 5-7 minute standardized telephone quiz. Subsequently, the persons fill out a questionnaire concerning the work trial during the measurements as well as a set of questions concerning the illumination. **Results:** Measurements will be finished at the end of March 2005. Results will be ready for presentation in July 2005.

WM-74**Thursday 11:30**

Orientation illusions and eye movements during high-speed artificial gravity (AG).

F. Mast (University of Zürich, Department of Psychology, Treichlerstrasse 10, 8032 Zürich, Switzerland. E-Mail: f.mast@psychologie.unizh.ch), N. Newby (NASA Johnson Space Center), T. Jarchow, L. Young (Massachusetts Institute of Technology)

This contribution aims at understanding and optimizing human neurovestibular adaptation to cross-coupled stimulation that occur during head movements on a rotating device. We investigate on the ground the effect of yaw head movements when subjects are lying supine on a platform rotating at 23 rpm about an earth vertical axis. The amplitude of slow phase velocity (SPV) of vertical nystagmus was normalized to head rotation and we computed the time constant of the decay. Subjects indicated the magnitude and duration of the illusory sensations elicited by cross-coupled rotational stimuli acting on the semicircular canals. The sensations are smaller and decay much quicker when the head is turned toward the side compared to when the head is turned nose-up. This asymmetry was not reflected in the SPV. These findings are discussed with regard to 1) the dissociation between eye movements and subjective reports, and 2) practical problems that may arise for astronauts pre-adapted to AG on earth.

Horizontal and vertical reading in Japanese.

N. Takahashi (Aichi Shukutoku University, Faculty of Medical Welfare, 23 Sakuragaoka, Chikusa-ku, 464-8671 Nagoya, Japan. E-Mail: nob@asu.aasa.ac.jp), M. Menozzi, E. Bergande (ETH)

The present study examined parameters of eye movements in reading horizontally and vertically arranged Japanese text. Twenty subjects of native and foreign speakers of Japanese were presented a Japanese text, which was printed either in horizontal lines (horizontal writing) or vertical lines (vertical writing) in a square, whose side length is 100mm on a paper. Results showed that the mean reading time for the vertical text is not significantly different from that for the horizontal text. However, the eye position in horizontal reading distribute wider than it is long, whereas the eye position in vertical reading distribute longer than is wide, though the whole arrangement of the text is a regular square. The ratio of standard deviation of horizontal to vertical condition in eye position was calculated, and a significant difference between the mean SD ratio on x-axis and y-axis was shown, which proves the distribution of eye position is deviated by the reading direction.

Thematic Sessions

Thematic Sessions

TA-76

Monday 09:30

Is motion imagery accompanied by a spatio-temporal evolution of attention?

H. Deubel (Ludwig-Maximilians-Universität, Allgemeine und Experimentelle Psychologie, Leopoldstr. 13, 80802 Muenchen, Germany. E-Mail: Deubel@mail.paed.uni-muenchen.de), C. de Sperati (San Raffaele University)

Subjects with the gaze in central fixation extrapolated in imagery the motion of a spot rotating on a circular trajectory after its vanishing. A saccade had to be made to a flash presented with various displacements relative to the position of the currently imagined spot. Saccadic latency was delayed by as much as 50 ms when the flash appeared displaced, either backward or forward, from the imagined spot. In an "Observation" condition, in which the spot did not disappear, latencies were similarly delayed, but only for backward displacements. In 25% of the trials a beep was presented instead of the flash, with various SOA. Subjects made a saccade to the currently imagined spot position. Mental rotation speed, estimated by the saccadic direction/latency ratio in the beep trials, was on average 9% slower than stimulus speed. Compensating for individual mental rotation speed confirmed the latency cost of making a saccade to a location different from the currently imagined location.

TA-77

Monday 09:50

What do eye movements reveal about mental imagery? Evidence from visual and verbal elicitations.

R. Johansson (Lund University, Cognitive Science Dept., Kungshuset, Lundagård, 222 22 Lund, Sweden. E-Mail: roger_json@hotmail.com), J. Holsanova, K. Holmqvist (Lund University)

This paper shows evidence that the spatial locations of objects both in a verbal description and from a complex picture are indicated by the eye movements that occur during a visualization of these objects. In two experiments, eye movements were recorded while test subjects recalled objects that were either previously observed in a complex picture or presented in a verbal description. In both cases, the subjects spontaneously looked at regions on a blank board that reflected the spatial locations of the objects they recalled. These results contribute to evidence that the eyes are connected with the cognitive processes that occur during imagery. In the discussion the results are related to the current debate on mental imagery.

TA-78**Monday 10:10**

When peripheral motion impinges on central motion perception.

M.R. Dürsteler (University Hospital of Zurich, Neurology, Frauenklinikstrasse 26, CH-8091 Zurich, Switzerland. E-Mail: max.duersteler@usz.ch),

When using head mounted devices to generate optokinetic stimuli a puzzling percept of stimulus stabilisation can be observed if the observers moves his head against the motion direction of the stimulus. This is not a consequence of vestibulo-visual interaction, since similar effects of illusionary motion stabilisation have been observed when swaying a computer monitor with a moving full-screen pattern in front of an observer. Suspecting a purely visuo-visual interaction between peripheral and central motion perception we reimplemented a classical experimental design of Gestalt psychology (Duncker K. Über induzierte Bewegung. Psychol. Forschung 12:180-259. 1929) on a PC: a central disk was rotating with constant speed in front of a background, which was rotated back and forth. There was a strong impression of acceleration and deceleration of the central disk.

TA-79**Monday 10:30**

Trans-saccadic integration of form: Evidence from visual after-effects.

D. Melcher (Oxford Brookes University, Psychology, Gypsy Lane, OX3 0BP Oxford, United Kingdom. E-Mail: dmelcher@brookes.ac.uk),

How is visual information combined across saccadic eye movements? While there is evidence for re-mapping of object position (Duhamel et al, 1992) and motion integration (Melcher & Morrone, 2003) across eye movements, visual patterns do not integrate across saccades (Irwin, 1991). What is the role of trans-saccadic integration in form processing? We examined visual form after-effects with and without saccades. The location of the adapter and test was either matched (spatiotopic integration) or mis-matched across the saccade. We found that the magnitude of the face after-effect was modulated by whether or not the adapter and test were spatiotopically matched, but the contrast adaptation after-effect did not survive the saccade in any condition. An intermediate result was found with the tilt after-effect. These results suggest that useful and predictive object information is combined across saccades without requiring pattern integration.

Thematic Sessions

TA-80

Monday 10:50

The relationship between saccade curvature, distractor distance and saccade latency.

E. McSorley (University of Reading, Department of Psychology, Earley Gate, RG6 6AL Reading, UK. E-Mail: e.mcsorley@reading.ac.uk), R. Walker (Royal Holloway), P. Haggard (University College London)

The sensitivity of saccade trajectories has been shown to be low with distractors at large distances from the target causing curvature away. Here we addressed differential spatial sensitivity of saccade trajectories to unpredictable target locations. Distractors were presented at systematically greater distances from the target. We found that saccade trajectories curved away from the distractor. Curvature was found to be inversely related to distractor distance from target while latencies increased with distractor distance from target. Landing position was not related to curvature magnitude. Two further experiments in which fixation was removed at various temporal intervals relative to the stimuli showed that saccade curvature was related to latency with quicker saccades deviating towards distractors and slower ones away. The relationship between latency and trajectory curvature suggest changes in the evolution of a non-spatial signal which suppresses an eye movement to the distractor.

TA-81

Monday 17:00

Reversibility and depth in the perception of biological motion.

J. Vanrie (Laboratory of Experimental Psychology, Department of Psychology, University of Leuven, Tiensestraat 102, B-3000 Leuven, Belgium. E-Mail: Jan.Vanrie@psy.kuleuven.ac.be), K. Verfaillie (University of Leuven)

Prolonged viewing of certain stimuli yield perspective reversals in which the percept repeatedly changes from one interpretation to another (cf. Necker cube). We investigated whether such reversals also occur during extended viewing of a special type of ambiguous stimuli, bistable point-light figures, and look for eye-movement correlates of different percepts and perceptual switches. Observers continuously reported the perceived depth orientation (facing the viewer or facing away) of point-light figures lacking ordinal depth cues while the action (walking or jumping), the viewpoint (frontal or $\frac{3}{4}$ -view) and the instructions (as much reversals as possible or as little) were manipulated. Results indicate observers indeed experience alternations for this complex stimulus and are sensitive to the different manipulations. The pattern of eye-movements is argued to be an important indication of the stimulus features relevant for the process of depth assignment in biological-motion stimuli.

TB-82**Monday 09:30**

The temporal impulse response underlying saccadic decisions.

C. Ludwig (University of Bristol, Experimental Psychology, 8 Woodland Road, BS8 1TN Bristol, UK. E-Mail: c.ludwig@bristol.ac.uk), I. Gilchrist (University of Bristol), E. McSorley (University of Reading), R. Baddeley (University of Bristol)

Saccadic eye movements are among the most frequent perceptual decisions the brain has to make. Perceptual decision-making is generally assumed to involve accumulation of sensory information over time until a criterion level of evidence in favour of one alternative is reached. We used stochastic visual stimuli to probe the decision-making process underlying saccade generation. Our analyses showed that, regardless of saccade latency, the decision where to saccade to was based on the visual signals presented in the first 100 ms. after display onset. The decision when to saccade was largely unrelated to the signals presented within this time window. Under these conditions, humans do not accumulate sensory evidence up to some criterion level, but instead base their decision on the output of early filters in the visual system tuned to rapid onsets. We speculate that the saccadic decisions were mediated through direct projections from striate cortex to the superior colliculus.

TB-83**Monday 09:50**

Spatial scale of attention modulates saccade latency.

L. Madelain (Université Ch. De Gaulle - Lille III, URECA - Dept Psychologie, Domaine universitaire du Pont de Bois BP 149, 59653 Villeneuve d Ascq Cedex, France. E-Mail: laurent.madelain@univ-lille3.fr), M. Harwood (College University New York), R. Krauzlis (Salk Institute for Biological Studies), J. Wallman (College University New York)

We have discovered a phenomenon in which attention has a large and consistent influence on saccadic reaction time. When viewing two counter-rotating concentric rings (0.8 and 8 deg diameter) that step together (< 8 deg), subjects make saccades at shorter latencies (158 vs. 314 ms) if they attend to the inner ring, whether the targets are stationary or being pursued. Other experiments revealed that neither eccentricity nor divided attention nor ring size alone can explain the observed changes in saccade latency. When we systematically varied the size of the ring and the step-size, we found that saccade latencies decreased as a function of the ratio of step-size to ring-diameter until the position error was larger than the size of the attended object. We propose that this latency effect arises from a tendency to inhibit saccades when the object of scrutiny moves but remains within the field of attention, to avoid unnecessary interruptions of vision.

Thematic Sessions

TB-84**Monday 10:10**

Squeezing impression from compression: Eliminating response uncertainty as an explanation for pre-saccadic compression.

A. Hunt (University of British Columbia, Psychology Department, 2136 West Mall, V6T 1Z4 Vancouver, Canada. E-Mail: AmeliaHunt@imag.net), C. Chapman, A. Kingstone (University of British Columbia)

Immediately before a saccade is executed, observers underestimate the number of items that appear near a saccade goal. This effect, known as presaccadic compression, is thought to reflect processes involved in maintaining perceptual continuity during saccades. However, observers tend to be uncertain about many events just before a saccade, so it is possible that the compression effect instead reflects this general uncertainty. We explored the role of uncertainty, orientation, and stimulus size in the compression effect, and found significant presaccadic compression even when observers were certain about their responses. Moreover, the effect is largest for horizontally-oriented visual stimuli, and varying the size of the items presented during the saccade has no effect on the extent of compression. Our findings confirm that compression is a perceptual, rather than a response-related uncertainty effect, and it is limited to the direction of the saccade.

TB-85**Thursday 12:10**

Does perception use the intended or actual eye movement signal? Evidence from the adaptation of reactive and voluntary saccades.

T. Collins (Laboratoire de Psychologie Expérimentale, Université René Descartes, 71 avenue Edouard Vaillant, 92774 Boulogne-Billancourt, France. E-Mail: therese.collins@univ-paris5.fr), K. Doré-Mazars

Visual attention is directed toward the location the eyes are aiming for, but the question of whether perception uses the intended or actual eye movement (EM) signal is still under debate. To examine this question, we dissociated these positions by saccadic adaptation and tested perceptual capacities at both positions. A first experiment showed a presaccadic attentional locus shift concurrent to adaptive landing position shifts, suggesting that perception relied on actual EM signals. The second and third experiments examined whether the use of actual EM signals depended on the intentionality of the saccade. Results suggested that saccades elicit attentional orientation at different times according to their intentionality, but that this difference does not persist to the final phases of saccade programming. Whatever the type of saccade, the perceptive system has access to actual EM signals, originating downstream from adaptation, which drive the presaccadic attentional focus.

TB-86**Monday 10:50**

Change detection in possible and impossible perceptual events: An implementation of a gaze contingent paradigm with video clips.

E.M. Reingold (University of Toronto, Department of Psychology, 3359 Mississauga Road North, L5L 1C6 Mississauga, Ontario, Canada. E-Mail: reingold@psych.toronto.edu), A. Elahipanah, J. Shen (University of Toronto)

Participants in a series of experiments viewed 2 sec. video clips while their eye movements were monitored. The clips depicted collisions between 2 hockey players. The clips were either played in the normal forward direction or in reverse. Reverse clips are closely matched to forward clips in terms of low-level perceptual characteristics but they depict events that violate the laws of physics (e.g., gravity) and consequently they are experienced as difficult to comprehend. Participants' task involved detection of discontinuities in the clips created by skipping or immediately repeating one or more video frames. A gaze contingent display paradigm was used to introduce these discontinuities in real time either during a fixation or during a saccade. The type of clip (forward vs. reverse) had a strong effect on the detection of discontinuities but had no influence on participants' ability to identify which of the 2 possible types of discontinuities was presented.

TB-87**Monday 11:10**

Exogenous and endogenous attention shifts during smooth pursuit eye movements.

D. Kerzel (Université de Genève, FPSE, 40 Boulevard du Pont Arve, 1205 Genève, Switzerland. E-Mail: dirk.kerzel@pse.unige.ch), N. E. Ziegler (University of Giessen)

Previous studies have argued in favor of an obligatory coupling of saccade goal and focus of visual attention (e.g., Deubel & Schneider, 1996). In a similar fashion, Khurana and Kowler (1987) proposed a coupling of visual attention and the target of smooth pursuit eye movements. The current study investigated whether exogenous and endogenous attention shifts are possible during smooth pursuit eye movements. Subjects foveated a stationary (fixation) or moving (smooth pursuit) fixation cross. An exogenous or endogenous cue indicated the location of the upcoming discrimination target with a probability of 80%. The difference in discrimination performance between valid and invalid cue conditions was taken as a measure of visual attention. Cueing effects did not depend on eye movement or retinal motion of the discrimination target. The results suggest that the coupling of visual attention to the target of a smooth pursuit eye movement is not as strong as has been proposed.

Thematic Sessions

TC-88

Monday 17:00

Information sampling strategies in face perception.

C. Lansing (University of Illinois at Urbana-Champaign, Speech and Hearing Science, 901 S. Sixth Street, 61820 Champaign, USA. E-Mail: crl@uiuc.edu), P. De Graef, G. van Belle (University of Leuven)

What is the diagnostic information for face perception? Previous research suggested that it is task-dependent. Different facial features appear to be relevant to identify a person's face than their gender, or emotional state. So far, this conclusion is based on discrete responses to partially occluded faces (Schyns & Oliva, 1999) or on facial locations fixated during continuous scanpaths (Pearson et al., 2003). Neither technique offers an insight in the extent to which foveated and peripheral facial features contribute to task performance. In the present study, we used a gaze-contingent display change paradigm. Viewers scanned faces in three different viewing conditions: full-view, foveal window, and foveal mask. These conditions were orthogonally varied with two tasks: face identification and emotion identification. The results show simultaneous use of foveal and peripheral facial information with weights that change as a function of the task and the viewer's experience with the task.

TC-89

Monday 17:20

Eye movements of an artist during sketching and drawing a portrait.

M.F. Land (University of Sussex, Dept. of Biology and Environmental Science, Falmer, BN1 9QG Brighton, United Kingdom. E-Mail: m.f.land@sussex.ac.uk), G. Baker (University of Sussex)

We studied the eye movements of an artist while he made two sorts of portrait drawings: a quick sketch (40s), and a more measured drawing (4 min). In both cases he alternated between sitter and drawing (mean cycle time 1.7s). During the sketch he made several fixations on the sitter in view, finishing near the end point of the line he was about to draw. He transferred his gaze to the corresponding point on the drawing, and drew to that point. He never appeared to fixate the starting point of each line, either on the sitter or the sketch, suggesting that this was derived from his internal plan of the sketch. He never repeated a line. Thus the role of his fixations in the progress of the sketch was very clear. The measured drawing was different. In addition to starting new lines, he frequently returned to the same point either to check the last line or to alter it. This more complicated strategy made it much more difficult to work out the exact role of individual fixations.

TC-90**Monday 17:40**

Eye gaze in face-to-face interaction with a talking head.

S. Raidt (INP Grenoble, Institut de la Communication Parlée, 46, avenue Félix Viallet, 38031 Grenoble, France. E-Mail: Stephan.Raidt@icp.inpg.fr), G. Bailly

We aim at implementing realistic eye movement in an animated 3D clone with the long-term goal of an embodied conversational agent (ECA) able to maintain realistic face-to-face communication. In a conversation, gaze direction is important in determining the object of interest as well as in coordinating turn taking and in signaling mutual attention. In order to realize a credible ECA, such interactions must be well understood and properly implemented. A first experiment, designed as a card game, in which users were asked to find the correct location for a displayed card on a computer screen, showed that the head and eye movements of the ECA influence the users time of performance. The ECA either was not visible or gave helpful or incorrect hints by means of coordinated head and eye movements. During our presentation, we will discuss the results of this experiment and present a video sequence showing the current implementation of eye movement in the ECA to demonstrate the effect.

TC-91**Monday 18:00**

Asymmetrical face processing by gaze behavior during audiovisual speech perception.

M. Paré (Queen's University, Departments of Physiology, Botterell Hall, ON K7L 3N6 Kingston, Canada. E-Mail: pare@biomed.queensu.ca), H. Shelley, M. Yurick, K.G. Munhall (Queen's University)

The human face communicates visual information of particular significance for social interactions. To understand better the process of gathering facial information, we examined the spatial distribution of gaze fixations displayed by subjects performing an audiovisual speech perception task, in which single sentences were presented with either the dynamic face matching the speech sound, a static face, or a static face-like object. Gaze fixations were found to be significantly asymmetrical: subjects looked most frequently at the right side more than the left side of the faces, even when horizontally mirrored faces were viewed. This asymmetry was also more pronounced for dynamic stimuli than for static stimuli. Our results show that the process of gathering facial information is structured because of the observer's strategy rather than the stimulus itself. They also emphasize the importance of studying face processing with dynamic stimuli to simulate naturalistic communication conditions.

Thematic Sessions

TC-92

Monday 18:20

Contextually enhanced transsaccadic object perception in realistic scenes.

P. De Graef (University of Leuven, Laboratory of Experimental Psychology, Tiensestraat 102, B-3000 Leuven, Belgium. E-Mail: Peter.DeGraef@psy.kuleuven.ac.be),

Object recognition in realistic scenes is facilitated when the object is semantically consistent with the scene. Theoretically, scene context can affect foveal object processing once the object is fixated, and/or it can affect extrafoveal object preprocessing before the object is fixated. The present study examines whether object recognition in realistic scenes is based on an integration of presaccadic extrafoveal information and postsaccadic foveal information. Analysis of transsaccadic preview benefits on object fixation parameters reveals that this is indeed the case. Moreover, when transsaccadic preview benefits were examined as a function of the saccade target's semantic consistency with the surrounding scene context, preview benefits proved to be contextually enhanced. These findings support a model in which rapid scene identification leads to the activation of low-spatial frequency object templates that streamline the transsaccadic processing of context-consistent objects.

TC-93

Monday 18:40

Differences in picture processing and its relation with reading performance for Chinese and English readers.

X. Li (University of Massachusetts Amherst, Psychology, 135 Hicks Way, 1003 Amherst, MA, USA. E-Mail: lixs@psych.umass.edu), K. Rayner, C.C. Williams, K.R. Cave (University of Massachusetts Amherst)

The eye movements of native English and Chinese readers were tracked as they performed a variety of tasks: English reading, face and scene memorization, visual search for colored shapes, and visual search for the occurrences of a Chinese character in text and random displays. For Chinese speakers, we also examined reading of Chinese sentences. There were group differences in fixation duration and number of fixations for picture processing tasks with Chinese readers having more fixations of shorter duration. Additionally, we found that reading was uncorrelated with most other tasks for English readers, whereas both reading tasks were correlated with picture processing for Chinese readers. This difference suggests that Chinese readers rely on a different representational system that takes advantage of the pictorial information present in the Chinese writing system. English readers, in contrast, use more abstract coding of characters that does not correspond to picture processing.

TD-94**Tuesday 11:30**

Reanalysis and competition during syntactic ambiguity resolution: Automatic or strategic processes?

R.P.G. Van Gompel (University of Dundee, Department of Psychology, Nethergate, DD1 4HN Dundee, United Kingdom. E-Mail: r.p.g.vangompel@dundee.ac.uk), J. Pearson, M.J. Pickering, M. Arai

Recent studies (Van Gompel et al., 2001, 2005) have shown that without preceding question, ambiguous sentences are easier to read than disambiguated sentences, suggesting that difficulty is not due to competition between syntactic analyses, but occurs when the processor has to reanalyse. Two new eye-movement reading experiments investigated whether competition occurs when ambiguous sentences (The landlord of the actor who had trained himself for the fun-run was not working) are preceded by a question (Who had trained?) that encourages the construction of all analyses. First fixation and first-pass times for himself in ambiguous sentences were shorter than in sentences disambiguated by gender (e.g., himself is incongruent with landlady). However, later measures (e.g., total times) showed the opposite pattern. We conclude that reanalysis is an early, automatic process that occurs regardless of the preceding question. In contrast, competition is a late, conscious process.

TD-95**Monday 17:20**

The role of syntactic category information in phonological ambiguity resolution.

R. Morris (University of South Carolina, Psychology, Barnwell College, 29208 Columbia, United States. E-Mail: morris@gwm.sc.edu), J. Folk, A. Jones (Kent State University)

We investigated whether phonological activation precedes syntactic category resolution during reading. In two eyetracking experiments sentences contained biased phonologically and semantically ambiguous words: noun-verb semantically ambiguous (DUCK), noun-verb phonologically ambiguous (SOW), noun-noun semantically ambiguous (CALF) and noun-noun phonologically ambiguous (SEWER). Prior context contained syntactic structure information consistent with the subordinate interpretation. Gaze durations were inflated on noun-verb phonologically ambiguous but not noun-verb semantically ambiguous words. Furthermore, prior syntactic information did not make resolving phonological ambiguity easier for noun-verb versus noun-noun phonologically ambiguous words. An oral reading study revealed that readers often produced the dominant pronunciation of phonologically ambiguous words initially. These data suggest that phonological activation occurs prior to syntactic category or semantic resolution.

Thematic Sessions

TD-96**Tuesday 14:00****Effects of syntactic category predictability on eye movements during reading.**

A. Staub (University of Massachusetts, Amherst, Psychology, 436 Tobin Hall, 1003 Amherst, MA, USA. E-Mail: astaub@psych.umass.edu), C. Clifton (University of Massachusetts)

In two eyetracking experiments, we investigated whether the predictability of a word's syntactic category has an effect on reading time, independent of the predictability of the word itself. Experiment 1 compared reading times on adjectives and nouns in a context in which a noun was predictable, but an adjective was not. The adjectives and nouns did not differ in length, frequency, or lexical predictability. Gaze duration was significantly shorter on nouns than on adjectives. Experiment 2 asked whether the presence of a degree adverb (e.g., very, totally), which renders an adjective highly predictable, would speed reading of a subsequent adjective. The degree adverb had a facilitatory effect that appeared relatively late, in the form of shorter first fixation and gaze durations on the noun following the adjective. The implications of these findings for theories of syntactic parsing and models of eye movements in reading will be discussed.

TD-97**Monday 18:00****Eye movements and processing at the point of sentence wrap-up.**

R. Hill (University of Dundee, Department of Psychology, Scrymgeour Building, University of Dundee, DD1 4HN Dundee, Scotland, UK. E-Mail: r.l.hill@dundee.ac.uk), R. van Gompel (University of Dundee)

The phenomena of sentence wrap-up effects, characterised by disproportionately long reading times at the end of sentences, has been well-documented in reading research; however, uncertainty remains over which processes occur during sentence wrap-up as well as how these are reflected in eye-movement behaviour. Additionally, it is unclear whether readers complete all the necessary processing at the end of a sentence or whether some spills over into any ensuing sentence. Two experiments were conducted to address these questions. The first focused on syntactic processing and reanalysis by exploiting syntactic ambiguities in pairs of sentences while the second investigated lexical access by manipulating lexical frequency. Our results suggest both forms of processing are engaged during sentence wrap-up. However, low-level processes (e.g. lexical access) are completed at the end of a sentence, whereas high-level processes (e.g. syntactic processing) can permeate beyond the full stop.

TD-98**Tuesday 14:00**

Distance effects on the resolution of inconsistent anaphors in discourse processing.

K. Chace (University of Massachusetts-Amherst, Psychology, Tobin Hall, 1003 Amherst, USA. E-Mail: kmars@psych.umass.edu), J. Myers, K. Rayner (University of Massachusetts)

Previous research (Cook, 2003) has explored distance effects on anaphoric resolution across passages with consistent and inconsistent antecedents. In a self-paced reading task, Cook found no effects of distance on how long it took to read the line containing the anaphor or the spillover line. We used eye-tracking methodology to further examine these effects. Thirty-six passages were used in a 3 (distance: close vs. intermediate vs. far) X 2 (anaphoric congruency) repeated measures design. Consistent with Cook's results, there were no main effects or interactions in first pass measures of the anaphor and spillover region. However, when total time and regressions into the antecedent region were examined there was both a main effect of congruency, and an interaction such that more time was spent reading the incongruent close antecedent than all the other conditions. These results suggest that eye tracking data are necessary to get a complete picture when studying anaphoric resolution.

TD-99**Monday 18:40**

Structural priming in comprehension: Evidence from visual-world eye-movement experiments.

M. Arai (University of Dundee, Department of Psychology, Department of Psychology, University of Dundee, DD1 4HN Dundee, United Kingdom. E-Mail: m.arai@dundee.ac.uk), R.P.G. Van Gompel, C. Scheepers (University of Dundee)

We investigated whether structural priming observed in production (Bock, 1986) also occurs during sentence comprehension. We used prepositional object (PO, the pirate sent the necklace to the princess) and double object structures (DO, the pirate sent the princess the necklace). Participants read a PO or DO prime, followed by an auditorily presented PO or DO target and pictures of the target nouns. In Experiment 1, the verb in prime and target was repeated. During the presentation of the verb (sent), the number of looks to the theme picture (necklace) was higher after PO than DO primes, whereas the the number of looks to recipient picture (princess) was higher after DO primes. Thus, people's anticipatory eye-movements were affected by the prime structure, indicating that structural priming occurs in comprehension. Experiment 2 showed no evidence for structural priming when the verb was not repeated, indicating that lexical factors play a crucial role in structural priming.

Thematic Sessions

TE-100

Tuesday 10:30

Eye rotations after body rotations.

N.J. Wade (University of Dundee, Psychology, Perth Road, DD1 4HN Dundee, UK. E-Mail: n.j.wade@dundee.ac.uk), **B. W. Tatler** (University of Dundee)

Eye movements during and after body rotations have been investigated mainly in a medical context. They are accompanied by apparent visual motion (vertigo) and postural imbalance. Studies of post-rotational nystagmus represented the first clear indication of discontinuous eye movements. Wells (1792) described the fast and slow phases of nystagmus by comparing the motion of an afterimage (formed before rotation) with a real image viewed after rotation. Crum Brown (1878) provided the first diagrams of nystagmus, noting its reduced amplitude with continued rotation. Post-rotational nystagmus was adopted as a test of vestibular function by Bárány, who was awarded the Nobel Prize in 1914. Dodge (1923) measured nystagmus both during and after body rotation, and applied it to tests of vestibular habituation in aircraft pilots. Post-rotational eye movements have been instrumental in the understanding of vestibular function, and they continue to be employed in aerospace medicine.

TE-101

Monday 14:00

Eye-head coordination: What when the eyes do not move.

J. Van der Steen (Erasmus MC, Neuroscience, PO Box 1738, 301GE Rotterdam, The Netherlands. E-Mail: j.vandersteen@erasmusmc.nl), **J.N. van der Geest**, **J.J. van den Dobbelsteen**, **H. Simonsz**

Changes in the direction of gaze are brought about by the concerted action of saccades and head movements. Voluntary eye head movements are planned by cortical structures and executed by brainstem. This results in a pattern of gaze saccades initially leading the head movement and counterrotation of the eye in the head when gaze is on target. Here we present a case of a 8 year old boy with a rare condition of acquired oculomotor apraxia where the ability to generate voluntary saccades is interrupted. Head movements were recorded with an optotrack and binocular eye movements with and IR video system. Normal activities requiring changes in gaze (reading) are brought about only by head movements. Optokinetic responses are also absent. In contrast, VOR is present, in which case saccades and slow phases occur. This study demonstrates the role of cortical pathways in eye-head coordination and the strategies developed to overcome the dysfunction of this route from cortex to brainstem.

TE-102**Tuesday 11:10**

The collinearity of Listing's plane and the vestibulo-oculomotor response in microgravity.

A. Clarke (Charité Medical School, Vestibular Research Lab, Hindenburgdamm 30, 12200 Berlin, Germany. E-Mail: andrew.clarke@charite.de), T. Haslwanter

The working hypothesis is that in microgravity – due to the absence of the otolith-mediated gravity vector - the orientation of Listing's Plane diverges from that of the VOR co-ordinate frame. The 3D-VOR coordinates are determined from measurements of eye and head movements during active head roll, pitch and yaw. Listing's plane is calculated from measurements of random saccades. 3D eye and head movements were sampled at 200 Hz using the DLR Eye Tracking Device. Currently, experiments are being conducted onboard the ISS, with control experiments in the lab and during parabolic flight. The first results indicate that not only the orientation of the 3D-VOR, but also that of the individual's Listing's Plane is altered in microgravity to an extent greater than observed on Earth. This indicates that the otolith-mediated gravity vector represents a common spatial reference to the central nervous system, the loss of which may lead to a dissociation of otherwise closely coupled sensory-motor systems.

TE-103**Tuesday 11:30**

Ocular motor abnormalities in neurodegenerative disorders of the brainstem and cerebellum.

L. Bour (Academic Medical Centre, University of Amsterdam, Neurology and Clinical Neurophysiology, Meibergdreef 9, 1105 AZ Amsterdam, Netherlands. E-Mail: bour@amc.uva.nl), A. Van Rootselaar, J. Koelman, M. Tijssen (University of Amsterdam)

Ocular motor disorders were recorded in three patient groups with neurodegenerative diseases of brainstem and cerebellum, including progressive nuclear palsy (PSP), spinocerebellar ataxia (SCA6) and familial cortical myoclonic tremor (FCMTE). In PSP patients decreased saccade velocity, saccade hypometry, square-wave jerks and reduced smooth pursuit was found caused by brainstem pathology. In SCA6 patient decreased saccade velocity, vertical saccade hypometry, downbeat nystagmus, square-wave jerks, reduced smooth pursuit and horizontal oscillopsia were recorded, indicating brainstem and cerebellar involvement. FCMTE patients demonstrated square-wave jerks, downbeat nystagmus, reduced smooth and oscillopsia, compatible with cerebellar pathology. Interestingly, in patients with SCA6 and FCMTE downbeat nystagmus increased with hyperventilation. The spectrum of ocular motor disorders observed in PSP, SCA6 and FCMTE are discussed and specifically related to the neurodegenerative changes.

Thematic Sessions

TE-104

Tuesday 11:50

Kinematics of saccades during Bielschowsky head-tilt testing in patients with trochlear nerve palsy and healthy subjects.

K.P. Weber (Zurich University Hospital, Department of Neurology, Frauenklinikstrasse 26, CH-8091 Zürich, Switzerland. E-Mail: konrad.weber@bluewin.ch), O. Bergamin, K. Landau (Department of Ophthalmology), D. Straumann (Department of Neurology)

In 10 patients with unilateral trochlear nerve palsy (uTNP) and 10 healthy subjects we analyzed upward (US) and downward (DS) 10 deg saccades. Subjects were seated in upright (UP) and 45 deg ear-down (EDP) whole-body roll positions. Eye movements were recorded at 200 Hz with 3D video oculography. In UP, US and DS of healthy subjects showed idiosyncratic, but consistent curvature to the right or left in both eyes independently. In EDP, DS curved increasingly to the upper ear and US to the lower ear. In uTNP, DS of the covered affected eye curved to the healthy side and US to the affected side. Ocular counterroll in EDP modulates tonic innervation of vertical and oblique eye muscles. The resulting imbalance of synergistic vertical and oblique eye muscles leads to curved vertical saccade trajectories during head roll. uTNP induces a muscle imbalance similar to ocular counterroll towards the healthy side. Supp. by SNF and Koetser Found.

TE-105

Tuesday 12:10

Dissociated hysteresis of static ocular counterroll in humans.

A. Palla (Zurich University Hospital, Department of Neurology, Frauenklinikstrasse 26, CH-8032 Zürich, Switzerland. E-Mail: antpalla@access.unizh.ch), C.J. Bockisch, O. Bergamin, D. Straumann (Zurich University Hospital)

Eyes cyclodiverge during static head roll. Using a motorized turntable, 8 healthy human subjects were rotated quasi-statically (2 deg/s) about the naso-occipital axis. Subjects fixed upon a blinking laser dot straight ahead in otherwise complete darkness while we recorded 3D eye movements with modified dual search-coils. A sinusoidal function with a first and second harmonic was fitted to torsional eye position as a function of torsional head position. The amplitude (A) and position lag (ph) of the first harmonic differed significantly between the eye ipsilateral to head roll (EI) and the eye contralateral to head roll (EC). On average, A was larger for EI (8.1 deg v. 6.6 deg) and ph was larger for EC (12.5 v. 5.1 deg). We conclude that cyclodivergence observed during head roll is the result of dissociated static hysteresis between EI and EC, which, in part, might result from an asymmetric backlash within the otolith pathways. Supp. by SNF.

TF-106**Tuesday 10:30**

First come, first serve - a simple rule for landmark-based localisation.

C. Koch (Dipl. AO; PhD student, Ludwig-Maximilians-Universität München, Leopoldstr. 13, 80802 München, Germany. E-Mail: ckoch@psy.uni-muenchen.de), H. Deubel (LMU München)

We recently demonstrated that objects found at the end of the saccade serve as spatial landmarks (Deubel, 2004). Here we study in detail the temporal characteristics of this landmark effect. Subjects saccaded to two target stimuli which were blanked with saccade onset. We systematically varied the delay with which one or both stimuli reappeared after the saccade. The results reveal a strong -first come, first serve- rule: the target that reappears first is always perceived as stable and serves as a landmark for postsaccadic relocalisation. Further experiments studied localisation in a fixation condition. To our surprise, the data demonstrate that the landmark effect exists even during fixation: the first of two stimuli tends to be perceived as stable, leading to an induced motion percept for the second. It seems that continuously present landmarks assist localisation whenever attention shifts require a remapping of visual space.

TF-107**Thursday 11:10**

The relative roles of high and low level factors in saccade control: An information theoretic analysis.

B.W. Tatler (University of Dundee, Psychology, Perth Road, DD1 4HN Dundee, UK. E-Mail: b.w.tatler@dundee.ac.uk), R.J. Baddeley (University of Bristol)

While it has been long known that both high level task-dependent (Yarbus 1967) and low level task-independent factors (Parkhurst et al 2002) influence the choice of where to fixate, what has not been known is the relative contribution of these two in naturalistic viewing conditions. By estimating the spatial distribution of fixation locations when participants view natural scenes, we show how information theory can be used to quantify the relative contributions of these two factors. This can be done without any potentially arbitrary decisions about which low level features are used to determine low level salience. Using our method, we show that task-dependent factors accounted for 39% (0.37 bits) of the eye movement fixation information, whereas task-independent factors accounted for 61% (0.59 bits). Over the course of several seconds of viewing, we found that the contribution of task-independent factors was time invariant, whereas the contribution of task-dependent factors increased.

Thematic Sessions

TF-108

Tuesday 11:10

Attentional deployment before sequences of goal-directed eye and hand movements.

H. Deubel (Ludwig-Maximilians-Universität, Department of Psychology, Leopoldstrasse 13, 80802 München, Germany. E-Mail: deubel@psy.uni-muenchen.de), D. Baldauf (Ludwig-Maximilians-Universität)

We here study attentional allocation before the execution of sequences of two or three sequential hand or eye movements in a dual-task paradigm combining movement preparation with a perceptual discrimination task. For the manual movements, results demonstrate that attention is focussed to all movement-relevant target positions. Performance at the intermediate locations between the movement targets is at chance, evidence for a division of attention among non-contiguous locations. Also, the results reveal that premotor attentional deployment is parallel rather than serial. In contrast to the findings for manual movements, there is no indication of attentional deployment to a second or third movement target before the onset of a sequence of saccades. We suggest that manual movement sequences are prepared as a whole, establishing a motor program. Saccades, however, always require attention to be focussed at the target of the next saccade.

TF-109

Tuesday 10:50

Our eyes move away from things we expect: on the role of expectancy in the programming of eye movements.

S. Van der Stigchel (Vrije Universiteit, Department of Cognitive Psychology, Van der Boechorststraat 1, 1081 BT Amsterdam, The Netherlands. E-Mail: s.van.der.stigchel@psy.vu.nl), J. Theeuwes (Vrije Universiteit)

Previous research has shown that in order to make an accurate saccade to a target object, nearby distractor objects need to be inhibited. The extent to which saccades deviate away from a distractor is often considered to be an index of the strength of inhibition. The present study shows that mere expectation that a distractor will appear at a specific location is enough to generate saccade deviations away from this location. This suggests that higher order cognitive processes such as top-down expectancy interact with low level structures involved in eye movement control. These results have important implications for current theories of target selection and provide insights in the interactions between the neural structures involved in eye movement control.

TF-110**Tuesday 11:50**

Cognitive control during antisaccade performance.

S.B. Hutton (University of Sussex, Department of Psychology, University of Sussex, BN1 9QH Brighton, UK. E-Mail: s.hutton@sussex.ac.uk), B.W. Tatler (University of Dundee)

Complex behaviour requires monitoring of ongoing action and behavioural adjustment in order to prevent, detect and correct erroneous responses. The antisaccade task allows these processes to be investigated in the lab. We report a contingency analysis of a large sample of antisaccade trials in which we determined the effect of target location and outcome (correct or incorrect) of the previous trial on current trial performance. Antisaccade errors were nearly twice as likely to occur after an error than after a correct antisaccade on the previous trial. Repetition priming effects were observed- following a correct antisaccade errors were less likely to occur if the target appeared in the same hemifield. Current trial performance was modulated by the speed with which errors on the previous trial were corrected- slowly corrected errors led to post-error slowing, rapidly corrected errors did not. Results are discussed with reference to the role of conscious awareness in cognitive control.

TF-111**Tuesday 12:10**

Keeping your eye on the ball? The magic of representational motion.

G. Kuhn (University of Durham, Department of Psychology, Science Site, South Road, DH1 3LE Durham, UK. E-Mail: G.Kuhn@sussex.ac.uk), M.F. Land (University of Sussex)

Many techniques used by magicians to create illusions rely on psychological principles. Participants were asked to watch video clips of a magic trick, in which a man threw a ball up in the air three times. On the final throw, the ball was palmed in his hand, whilst his eyes and head followed an imaginary ball travelling upwards. This created an illusion of the ball vanishing in mid air. 72% of the participants erroneously claimed to have seen the ball move up in the air, thus providing a powerful example of representational motion. Rather than merely tracking the ball, most people looked at the face prior to tracking the ball, thus utilising social attention cues to guide their eye movements. On the first two throws people tracked the ball. However, on the final throw, they did not look at the area at which they claimed to have seen the ball disappear, thus suggesting that although social attention is important in guiding eye movements, the eyes will only fixate on real objects.

Thematic Sessions

TG-112

Tuesday 15:30

Saccadic velocity and duration as psychological variables I. Standardization procedure.

R. Schleicher (University of Cologne, Institute of clinical psychology, Hönninger Weg 115, 50969 Cologne, Germany. E-Mail: r.schleicher@uni-koeln.de), N. Galley

Both parameters depend on their amplitudes: a larger amplitude allows for higher velocities, but also increases duration. Although indicative these parameters are seldom used as psychological variables. When doing so one has to eliminate the influence of varying amplitudes. According formula were proposed by (Becker, 1989) and (Collewijn et al, 1988) and based on small data sets. We now propose new expectancy values obtained from a large data set. In various experiments the EOG of 661 subjects performing different tasks was recorded with 1000Hz. Saccades were identified automatically offline. For computation of expected values we used horizontal saccades in the tasks Picture inspection and Raven matrices with altogether 734 saccades pro person. Expectancy values were computed in the range between 0.5 and 40 degrees. The obtained functions are: 1.) $380 * (1 - \exp(-0.064 * \text{amp} - 0.10))$ for velocity 2.) $549 * (1 - \exp(-0.088 * \text{amp} - 0.15))$ for max.velocity 3.) 22.7 2.45 * amp for duration.

TG-113

Tuesday 15:50

Saccadic velocity and duration as psychological variables II. Some results.

N. Galley (University of Cologne, Institute of clinical psychology, Hönninger Weg 115, 50969 Köln, Germany. E-Mail: nielsgalley@t-online.de), R. Schleicher

Standardized values of saccadic velocities of 661 probands were analyzed along with fixation durations during the first minute of several tasks: Picture inspection, Raven matrices, two tracking tasks, an accelerated moving light point Sinus, a similar accelerated Square wave task, and a free Interview, continued with Eyes closed. In the two tracking tasks the course of the mean fixation duration was similar, whereas the course of the saccadic velocity differed: velocity in the Sinus task increased initially, then decreased, while in the Square wave the reverse can be observed. In the tasks Picture inspection (which includes memorizing for later reproduction) and Raven matrices the course of fixation durations differed in the first 60 sec-onds, but saccadic velocities were similar. We looked at saccadic velocities in different age groups (6 – 95 years). We found clear age effects: young adults showed the smallest values, while the older and younger people reached higher velocities.

TG-114**Tuesday 16:10**

Gaussian representations of multiple viewers interest.

K. Holmqvist (Lund University, SoL, Box 201, S-22100 Lund, Sweden. E-Mail: kenneth@lucs.lu.se), M. Nyström, M. Novak

This talk discusses how replacing gaze points by Gaussian probability mass functions can generate a structured representation of multiple viewers' interest. In particular, we develop a method for identifying major clusters and removing gaze points (viewers) outside of them. We let the dispersion of gaze points, as estimated by the symmetric Kullback-Leibler distance, control the variance of the Gaussians. The question at issue arose in a project on eye-tracking based video compression, and we therefore have a slightly different method compared to earlier Gaussian representations (e.g. Velichkovsky et. al 1995, Wooding 2002) and eye-data clustering methods (Santella, DeCarlo 2004). A major difference is that each viewer contributes with only one gaze point. We present data from our video compression project to exemplify the usefulness of these methods.

Thematic Sessions

TH-115

Tuesday 15:30

Driver eye scan patterns and legibility of highway signs at night: Effects of sign luminance, driver age and environmental complexity.

F. Schieber (University of South Dakota, Heimstra Human Factors Laboratories, 414 E. Clark Street, 57069 Vermillion, SD, USA. E-Mail: schieber@usd.edu), D. Burns (3M Company), J. Myers, N. Willan, J. Gilland (University of South Dakota)

The purpose of this study was to quantify real-world highway sign reading behavior while driving at night. Good agreement was found between ASL ETS-PC eye movement data (last-look distance) and verbal report measures of sign legibility distance ($r = 0.9$). Significant reductions in legibility distance were observed as sign reflectivity was reduced from “newly installed” levels down to a level representing proposed FHWA minimum retroreflectivity values. The magnitude of this effect varied as a function of the driving environment. Mean duration of the last fixation made while reading exceeded 3 seconds. Total eyes-on-the-sign time exceeded 6 seconds given unrestricted sight distance. Taken together, the eye fixation data suggests that reading a mission-critical highway sign requires more visual effort than expected. These results have important implications for the optimal design of retroreflective sheeting materials.

TH-116

Tuesday 15:50

Pilot gaze and aircraft performance with respect to situation awareness

M. Biella (DLR (German Aerospace Center), Institute of Flight Guidance, Human Factors Dep., Lilienthalplatz 7, 38108 Braunschweig, Germany. E-Mail: Marcus.Biella@dlr.de),

German Aerospace Center (DLR) conducted a project named MOSES (More Operational Flight Safety by Enhanced Situation Awareness). 40 student pilots as well as 10 experienced airline pilots performed up to 8 different scenarios consisting of initial, intermediate and final approach, and a taxi segment by means of a generic cockpit simulator. The flight scenarios differed regarding - level of automation (i.e. manual vs. automatic landing; airport surface map vs. taxi guidance display) - sophisticated wind and visual conditions, and - traffic/obstacle events on the airport surface. Simulator performance, pilot gaze and physiological data, completed by pilots self assessments were recorded during the trials. A first analysis of the data shows some interrelations between the different data sources.

TH-117**Tuesday 16:10**

The school transportation vehicle's icon – doing any good?

T. Falkmer (Senior lecturer, Rehabilitation Medicine,, Department of Neuroscience and Locomotion, INR, Linköping University, Faculty of Health Sciences, SE-581 83 Linköping, Sweden. E-Mail: torbjorn.falkmer@inr.liu.se), A. Anund,(Swedish National Road and Transport Research Institute VTI), T. Dukic (Chalmers University of Technology)

The issue on how to mark school transportation vehicles has been highlighted due to multiple fatal crashes involving children. The aim of the project was to decide whether or not the current school bus-icon increase traffic safety, in terms of road user behaviour. The term school bus-icon refers to the icon itself and the additionally blinking orange/yellow lights when the bus is stopping to pick-up or drop pupils. A total of 32 drivers drove a track of 5-6 kilometres, in two types of traffic environments, i.e. city (50 km/h) and countryside (70 km/h) with three experimental conditions; no mark at all, school bus-icon alone, and school bus-icon provided with blinking lights. The experimental car recorded the speed and the lateral position. Drivers' eye movements were recorded with a head mounted system. After the drive, subjects answered a questionnaire concerning their understanding of the icon, their reaction to the six buses and their attitudes towards safety and speed.

Thematic Sessions

TI-118

Tuesday 15:30

The binocular co-ordination of eye movements during reading in adults and children

H. Blythe (University of Durham, Department of Psychology, Science Laboratories, South Road, DH7 8TL Durham, UK. E-Mail: h.i.blythe@durham.ac.uk), H. Joseph, S. White, S. Liversedge (University of Durham)

We measured binocular co-ordination in adults and children, as they read sentences containing a length and a frequency manipulation. While it is generally assumed that eye movements are conjugate, it has recently been demonstrated that this is actually not the case. We found fixation disparity at the end of fixations for all participants, with greater disparity magnitudes in the fixations made by children than in those by adults. These disparities were significantly greater than one character space. Adults made significantly fewer crossed than aligned or uncrossed fixations. However, children showed a higher proportion of crossed fixations than adults. These data suggest that binocular co-ordination during reading is poorer in children than adults. Finally, we found no influence of either word length or frequency on binocular co-ordination in adults or children.

TI-119

Tuesday 15:50

The reader's conception of space.

W. Murray (University of Dundee, Department of Psychology, Park Place, DD1 4HN Dundee, Scotland. E-Mail: w.s.murray@dundee.ac.uk),

Kenedy and Murray (1987) demonstrated that the accuracy of reader's regressive eye movements is unaffected by the size of the required saccade. They concluded that re inspections are therefore not based upon either current visual input or a conceptual representation of text. But rather, that readers maintain a spatial code. This paper reports the results of two studies which investigate whether these accurate large regressive saccades are really driven by a spatial representation or whether 'space' may in fact be recovered from a conceptual representation. The first experiment examined the effects of spatialization of text, as it is being read, on the frequency and accuracy of regressions. The second manipulated 'conceptual distance' with the reactivation of either a short or long antecedent words using a pronominal anaphor. The results overall demonstrate a clear role for a purely spatial representation derived during reading, but do show evidence of conceptual effects.

TI-120**Tuesday 16:10**

Ophthalmokinesis (Pavlidis Test) objectively prognose-diagnose preschoolers at high-risk for ADHD.

G.Th. Pavlidis (University of Macedonia, 54060 Thessaloniki, Greece. E-Mail: Pavlidis@uom.gr), P. Samaras (Kavala)

ADHD is a mainly hereditary, neurological disorder, estimated to affect approximately 3% to 7% of school-age children. The diagnosis of ADHD is difficult in preschool ages and is done, as in the present study, via questionnaires (DSM-IV-R.) and clinical evaluation. It is well established that many neurological conditions, including ADHD and dyslexia, are reflected in ophthalmokinesis. Thirty two preschool children (4 to 6year-olds) at high-risk for ADHD and their normal controls were tested with the fully automated biological test of ophthalmokinesis (Pavlidis Test). Discriminant analysis showed that 93.1% of the children were accurately classified into their respective two categories on the basis of their ophthalmokinesis. The easy to use, quick and biological test is non-verbal, and once further validated and standardised, it could be used internationally, irrespective of language, for the accurate screening of preschoolers for ADHD.

Thematic Sessions

TJ-121

Tuesday 15:30

Using ERP to examine the "eye-mind" link during reading.

E.D. Reichle (University of Pittsburgh, Department of Psychology, 635 LRDC, 3939 O'Hara St., PA 15260 Pittsburgh, USA. E-Mail: reichle@pitt.edu), N. Tokowicz, Y. Liu, C.A. Perfetti (University of Pittsburgh)

Cognitive theories of eye-movement control during reading (e.g., E-Z Reader; Reichle et al., 2003) posit that lexical processing causes the oculomotor system to move the eyes from one word to the next. This hypothesis was tested in two event-related brain potential (ERP) experiments in which participants moved their eyes from centrally- to peripherally-displayed letter strings to make lexical decisions about both stimuli as quickly as possible. Experiment 1 showed that saccade onset latencies, directions, and magnitudes could be accurately measured using ERP. Experiment 2 replicated these results and identified ERP components that: (1) varied as a function of word frequency; (2) predicted saccade onset latencies; and (3) could be localized to cortical areas implicated in lexical processing. These results are consistent with predictions of the E-Z Reader model and support the hypothesis that the decisions about when to move the eyes during reading are linked to lexical processing.

TJ-122

Tuesday 15:50

Examining the stages of the E-Z Reader model.

E.M. Reingold (University of Toronto, Department of Psychology, 3359 Mississauga Road North, L5L 1C6 Mississauga, Ontario, Canada. E-Mail: reingold@psych.toronto.edu), K. Rayner (University of Massachusetts)

A critical prediction of the E-Z Reader model of eye movement control in reading is that experimental manipulations that disrupt early encoding of visual and orthographic features of the fixated word without affecting subsequent lexical processing should influence the processing difficulty of the fixated word (word N) without producing any processing effect on the next word (word N+1). We tested this prediction by monitoring participants' eye movements while they read sentences in which a target word was either presented normally or altered. One modification to the appearance of target words involved a substantial reduction of contrast between the word and the background. Reduced stimulus quality is typically assumed to have an impact that is confined to an early stage of word recognition. Consistent with the E-Z Reader model this faint presentation methodology produced a robust influence on the duration of fixations on word N without substantially altering the processing of word N+1.

TJ-123**Tuesday 16:10**

Using reinforcement learning to understand the emergence of "intelligent" eye-movement control during reading.

E.D. Reichle (University of Pittsburgh, Department of Psychology, 635 LRDC, 3939 O'Hara St., PA 15260 Pittsburgh, USA. E-Mail: reichle@pitt.edu), P.A. Laurent (University of Pittsburgh)

The eye movements of skilled readers exhibit considerable regularity (Rayner, 1998). One hypothesis is that this regularity reflects the perceptual, cognitive, and motor limitations of the reader (e.g., limited visual acuity), and the inherent constraints of the task (e.g., rapidly identifying words in their correct order). To examine this hypothesis, an artificial agent that was capable to learning to move its eyes via reinforcement learning was given the task of learning to read as efficiently as possible. The agent's eye-movement behavior resembled that of human readers, suggesting that important aspects of eye-movement control emerge as a consequence of satisfying constraints that are imposed on readers. These simulations also suggest new accounts of some contentious empirical results (e.g., fixation duration costs associated with word skipping) and theoretical assumptions (e.g., the familiarity check in the E-Z Reader model of eye-movement control; Reichle et al., 2003).

Thematic Sessions

TK-124

Tuesday 17:00

Primate prefrontal cortex sends rule-related information to the superior colliculus.

K. Johnston (University of Western Ontario, Physiology and Pharmacology, London, ON, CANADA, N6A 5C1 London, Canada. E-Mail: kjohnst9@uwo.ca), S. Everling (University of Western Ontario)

Rule selective activity is a well established property of prefrontal (PFC) neurons. Anatomical studies have demonstrated that the PFC sends direct projections to the superior colliculus (SC), however, the functional role of these projections remains unknown. Here, we identified PFC neurons projecting to the SC using antidromic identification, and recorded the activity of these neurons while monkeys performed a task in which they were required to make pro-saccades or anti-saccades in alternating blocks. In this task, the animals were not explicitly cued as to which behaviour would be rewarded, rather the task contingency switched from one behaviour to the other after a given number of correct trials were performed. Thus, they were required to determine which behavioural rule was currently in effect. Many corticotectal PFC neurons exhibited rule selective modulations in activity. This finding provides direct evidence that PFC neurons send rule-related activity to oculomotor structures.

TK-125

Tuesday 17:20

Prefrontal corticotectal projections to the rostral pole of the superior colliculus in the macaque.

C. Field (The University of Western Ontario, Physiology and Pharmacology, Medical Sciences Building Room M216, N6A 5C1 London, Canada. E-Mail: cbfield@uwo.ca), K. Johnston, T. Babic, J. Ciriello, S. Everling (University of Western Ontario)

The caudal superior colliculus (SC) in primates is involved in saccade generation whereas the rostral SC is involved in fixation. The SC receives direct inputs from many prefrontal cortical (PFC) areas. However, the precise termination of these inputs remains unknown. We used retrograde tract-tracing techniques combined with immunohistochemistry to identify corticotectal PFC neurons and determine if they project specifically to the rostral or caudal pole of the SC. Cholera toxin B subunit (CTB) or fluorogold (FG) were pressure injected into the rostral or caudal SC at sites previously shown to inhibit or elicit saccades, respectively. CTB labelled neurons were clustered in Brodmann's area 9, anterior cingulate, ventral bank of the principal sulcus and supplementary eye fields. FG labelling was observed throughout the entire PFC. These findings demonstrate that areas in the PFC project directly to the rostral pole of the SC and suggest that these areas are involved in fixation.

TK-126**Tuesday 17:40**

Stimulation at the supplementary eye field modulates the initiation of directionally selective anticipatory saccades.

S. Yang (Smith-Kettlewell Eye Research Institute, Visuomotor Physiology Laboratory, 117d2318 fillmore street, 94115 San Francisco, USA. E-Mail: syang3@ski.org),

Saccade latencies are often shortened by a temporal gap preceding target onset, which is thought to result from the general disinhibition of the oculomotor system. Carpenter (2000) reported that those effected saccades occurred only when preceded by saccades of the same direction, suggesting that anticipation mediates the gap effect. Here we examined the nature of gap effect by stimulating the SEF while primates were executing visually guided saccades, with the frequency of target direction and the presence of temporal gap varied across trials. The results show that the gap effect was contingent with the predictability of target direction. An asymmetry in target frequency leads to shortened saccade latency regardless the target direction in the preceding trial. Stimulation at sites of the SEF modulated the effect of target frequency but have little effect on the effect of temporal gap, showing that the SEF is involved in regulating directionally selective saccade in a gap condition.

TK-127**Tuesday 18:00**

Anti-saccades in patients with right parietal lesions.

S.H. Butler (University of Glasgow, Department of Psychology, G12 8QB Glasgow, UK. E-Mail: s.butler@psy.gla.ac.uk), C.J.H. Ludwig, I.D. Gilchrist (University of Bristol), K. Muir, M. Harvey (Southern General Hospital)

We have previously reported that patients with right parietal lesions can be impaired on both stimulus driven and goal driven oculomotor capture indicating that it is not just the frontal lobe that inhibits task irrelevant responses, but that both frontal and parietal regions may form a network that select targets for goal related action. To further substantiate this argument we tested the same patients on an anti-saccade task which requires participants to inhibit the stimulus driven orienting responses to the target and instead generate a voluntary orienting response in the opposite direction. Results collected so far indicate that some parietal patients show a significant increase in error rates but others do not. So at present these data do not lend additional support to an integrated model of saccade control in which information from different stages in the processing hierarchy feeds into a common functional salience map. More parietal patients are currently being tested.

Thematic Sessions

TK-128

Tuesday 11:30

Fast event-related fMRI of prosaccades, antisaccades, and nogo trials.

M. Brown (University of Western Ontario, Neuroscience, Physiology, Psychology, M216, Medical Sciences Bldg, UWO, N6A5C1 London, Ontario, Canada. E-Mail: mbrown23@uwo.ca), H. Goltz, T. Vilis, K. Ford, S. Everling (University of Western Ontario)

We compared prosaccades, antisaccades, and nogo trials using fast event-related fMRI in humans to investigate inhibition processes in the antisaccade task. Every trial consisted of a cue and a response interval, each lasting 2 to 7 sec (3 sec mean, exponential distribution). During the cue interval, subjects fixated on a central dot, whose colour cued the trial type. During the response interval, a peripheral white dot appeared 200 ms after fixation offset. For the prosaccade, antisaccade, and nogo tasks, subjects had, respectively, to look at the peripheral stimulus, to look away from it, and to maintain central fixation. Behaviour was monitored with visual eye tracking to exclude error trials. We extracted activation time courses with linear deconvolution. The cortical saccade system (FEF, SEF, IPS) and caudate exhibited task-related activation. The pattern of relative activation for the cue and response components of the three task types differed depending on the brain region.

TK-129

Tuesday 18:40

Cognitive influences on the vector and latency of express saccades.

J. Edelman (The City College of New York, Biology, J526, Marshak Science Bldg., Convent Ave. at 138th, 10031 New York, United States. E-Mail: jedelman@sci.ccnycunyu.edu), D. Shiu (The City College of New York)

The programming of saccades (sacs) to complex visual stimuli is influenced not only by perception, but also by cognition (He and Kowler, 1989). Can object-centered neural coding (reviewed in Olson, 2003) affect express sacs? EMs of 3 subjects were measured using a video eyetracker (Eyelink II - SR Research). In 2/3 trials a central cue (left or right arrow) appeared for 500-800 ms. After a 150ms gap, two horiz. squares (1x1 deg) appeared separated by 6°. The two squares were located at +4,0, or -4° horiz; +/- 8° vert. Ss were instructed to saccade to the cued square (left or right) as quickly and accurately as possible. For all 3 Ss, saccade endpoint depended on cue, even for express sacs (90-110 ms). There was no difference in latency between cued sacs and 1-target sacs. These results suggest that neural areas encoding movements in object-centered coordinates can rapidly influence visuomotor areas that mediate reflexive responses to suddenly appearing visual stimuli.

TL-130**Wednesday 12:00**

The Effect of withholding parafoveal preview information in processing English compound words.

J. Hyönä (University of Turku, Department of Psychology, Assistentink. 7, FI-20014 Turku, Finland. E-Mail: hyona@utu.fi), A. Pollatsek, B.J. Juhasz, K. Rayner (University of Massachusetts)

Prior research has shown that the advantage of having a normal parafoveal preview of a word over a condition in which none of the letter information is preserved is usually about 20-40 ms. Recently, Hyönä et al. (2004) and Pollatsek and Hyönä (2005) observed a much bigger preview effect (about 100 ms in gaze duration) involving Finnish compound words. The present study investigated whether this striking difference is due to the fact that Finnish compounds are written without a space. Both spaced and unspaced English compounds were placed in sentence frames and there were two preview conditions: (a) full preview and (b) only the first two letters of the second constituent preserved. Again, we observed preview effects of at least 90 ms for both types of compounds, with the effect being somewhat bigger for the unspaced compounds. It thus appears that there is something special about compound words independent of the orthography that makes them more unitized than other two lexeme units.

TL-131**Wednesday 12:20**

Further investigations into the use of parafoveal word length information in reading.

B.J. Juhasz (University of Massachusetts, Amherst, Psychology Department, Tobin Hall, 1003 Amherst, MA, USA. E-Mail: bjjuhasz@psych.umass.edu), K. Rayner (University of Massachusetts), S.J. White, S.P. Liversedge (University of Durham)

This study examined the role of parafoveal word length information in reading. In two eye tracking experiments compound words were used where the deletion of one letter results in two words (shorthand, short and). Prior to fixating the compound word or the two short words, their length could be accurately or inaccurately specified in the parafovea. In Experiment 1 targets were embedded in neutral sentences. The accuracy of parafoveal length information affected landing positions and fixation durations on the words. In Experiment 2, predictability of the target words by prior sentence context was also manipulated. A similar pattern of results to Experiment 1 was obtained in neutral contexts. In addition, sentence predictability and accuracy of parafoveal length information interacted in first fixation duration, such that there was a larger effect of parafoveal length accuracy when the target was predictable. Implications for models of eye movement control in reading will be discussed.

Thematic Sessions

TL-132

Wednesday 12:40

Processing of parafoveal letter information by children: Evidence from the moving window paradigm.

T. Häikiö (University of Turku, Dept. of Psychology, Tennbyntie 48 A 19, 21600 Parainen, Finland. E-Mail: tuomo.haikio@utu.fi), J. Hyönä, R. Bertram, P. Niemi (University of Turku)

Processing of parafoveal letter information in reading was examined with a moving window paradigm. Adults and 2nd, 4th and 6th grade children read stories while their eye movements were recorded. The amount of letter information available around the fixation point was manipulated (7, 11, 15, 19 characters, and whole line) alongside the level of text difficulty. As expected, the more difficult text slowed down the youngest readers more than the more experienced readers. However, contrary to our expectations, the smallest window distracted the youngest readers more than the older readers, as indexed by longer gaze durations on words. Thus, it seems as if beginning readers are more disturbed by the garbage letters outside the window. Alternatively, as a result of inadequate foveal processing, young readers may require more letter information from the surrounding text, which is prevented when the window is at its smallest. We will present analyses to tease apart these alternative accounts.

TL-133

Wednesday 13:00

Determinants of the optimal viewing position in visual word recognition.

R. Shillcock (University of Edinburgh, Psychology and Informatics, 2 Buccleuch Place, EH8 9LW Edinburgh, United Kingdom. E-Mail: rcs@inf.ed.ac.uk),

Word recognition in the reading of text takes place on the basis of visual information accrued during static fixations during reading. Paradoxically in individual readers the preferred viewing location (PVL) in the reading of text has been reported not to predict the position of the observed viewing location (OVP) in isolated visual word recognition (Radach Reilly and Vorstius 2004). We review accounts of the OVP and present a connectionist model of the mapping of feature-based orthographic representations of words of length 1–9 letters onto a large lexicon. The more peripheral part of the processing architecture is divided to represent the precise vertical division of the human fovea and its initial contralateral hemispheric projection. We describe a number of determinants of the OVP and explore the effects of incorporating information about the PVL derived from an eye-tracking corpus.

TL-134**Wednesday 13:20**

Mislocated fixations during reading and the inverted optimal viewing position effect.

A. Nuthmann (University of Potsdam, Department of Psychology, PF 60 15 53, 14415 Potsdam, Germany. E-Mail: nuthmann@rz.uni-potsdam.de), R. Engbert, R. Kliegl (University of Potsdam)

Refixation probability during reading is lowest near the word center, suggestive of an optimal viewing position (OVP). Counterintuitively, fixation durations are largest at the OVP, a result called the Inverted Optimal Viewing Position (IOVP) effect (Vitu, McConkie, Kerr, and O'Regan, 2001). Current models of eye-movement control in reading fail to reproduce the IOVP effect. We propose a simple mechanism for generating this effect based on error-correction of mislocated fixations due to saccadic errors (Nuthmann, Engbert, and Kliegl, in press). First, we propose an algorithm for estimating proportions of mislocated fixations from experimental data yielding a higher probability for mislocated fixations near word boundaries. Second, we assume that mislocated fixations trigger an immediate start of a new saccade program causing a decrease of associated durations. Thus, the IOVP effect could emerge as a result of a coupling between cognitive and oculomotor processes.

TL-135**Wednesday 13:40**

The relative importance of language factors in word skipping during reading.

D. Drieghe (Ghent University, Experimental Psychology, Henri Dunantlaan 2, 9000 Ghent, Belgium. E-Mail: denis.drieghe@ugent.be), T. Desmet (Ghent University), M. Brysbaert (Royal Holloway)

The skipping probability of a word is influenced by its processing ease (e.g. a predictable word is skipped more often than an unpredictable). A meta-analysis of studies examining this influence (Brysbaert, Drieghe, Vitu, in press) reported effect sizes across studies ranging from 0% to 13%, with an average of 8%. One study does not fit this picture: Vonk (1984) reported 23% more skipping of the pronoun (she) in sentence (1), in which the pronoun had no disambiguating value, than in sentence (2) where it did. 1)Mary was envious of Helen because she never looked so good. 2)Mary was envious of Albert because she never looked so good. We re-examined this ambiguity in Dutch and observed only an 8% difference in skipping the pronoun. Our results also show that when the pronoun was masculine (hij [he]), it was skipped 10% more often than the feminine pronoun (zij [she]), probably due to the fact that in Dutch the feminine pronoun can also be plural (they), making it potentially ambiguous.

Thematic Sessions

TM-136

Wednesday 12:00

Eye movement analysis as an evaluation tool in the field of human-computer interaction.

D. Zambarbieri (University of Pavia, Department of Informatics and System Science, via Ferrara 1, 27100 Pavia, Italy. E-Mail: dani@unipv.it), S. Crespi, C. Robino, L. Calvi (University of Pavia)

Eye movements analysis represents a powerful tool in all studies dealing with visual attention and exploration, as in the case of a subject interacting with a computer display. It can integrate the classical evaluation tests by providing quantitative and objective information. A quantitative methodology has been defined for the evaluation of e-learning systems. A SW records eye movements, and any interaction of the subject with the computer (mouse, keyboard and scrolling). Data are then analysed first by making use of all the recorded signals to reconstruct scanpath on each page. Then the operator identifies the Region of Interests on the screen. For each page and for each RoI temporal and spatial quantitative parameters and the sequence of accesses among RoIs are computed. This methodology developed for the evaluation of e-learning systems can be transferred to any situation that implies interaction of a subject with the computer such as Internet navigation.

TM-137

Wednesday 12:20

Scanpath analysis during navigation through an hypertext: Sequence of accesses.

D. Zambarbieri (University of Pavia, Department of Informatics and System Science, via Ferrara 1, 27100 Pavia, Italy. E-Mail: dani@unipv.it), S. Crespi, C. Robino, L. Calvi (University of Pavia)

A Region of Interest (RoI) is a part of the page that contains visual or content related information particularly salient and interesting for the comprehension of the presented material. From the eye movements recorded during subjects' exploration of an hypertext the sequence of accesses can be analysed in order to study the allocation of subject's attention during navigation from a behavioural point of view. This analysis considers the first RoI accessed by subjects for each page giving evidence of the RoI that mostly attract subject's attention. First access could be driven by perceptual indexes and by the position of the RoI itself more than by a conscious choose. Our experimental results indicate that the initial position of subject's gaze facing a new page could be both driven by perceptual indexes and automatically allocated in two different positions: the centre of the new page or the last position of the previous page.

TM-138**Wednesday 12:40**

Making sense of content: Eye-tracking older, novice users to evaluate an alternative web browser design.

A. Dickinson (University of Dundee, Division of Applied Computing, Jam Factory, University of Dundee, DD1 4HN Dundee, Scotland, UK. E-Mail: adickinson@computing.dundee.ac.uk), R. Hill, P. Gregor, L. McIver, S. Milne (University of Dundee)

Despite the potential benefits and an often underestimated desire to use computers and the Internet, older adults are considerably less likely to use them than any other age group. Inappropriate software design is a major contributing factor to this phenomenon. By taking into account their specific needs and accommodating some of the ways that older adults differ from typical computer users, we developed a web application specifically for this demographic. This was evaluated by examining the eye movements of twelve older (70 years and over) users while they looked at webpages using our software and contrasting this with webpages displayed using Internet Explorer. Contrary to expectations, we did not find that older users spent less time looking at our simplified interface rather than I.E.'s default and cluttered interface of menus and toolbars. However, the design of the interface did radically alter viewing behaviour of the contents of the webpages and the type of information fixated.

TM-139**Wednesday 13:00**

Visual processing and eye movements in a virtual shopping environment.

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Virtual shelf tests via internet are a newly emerging instrument in consumer research, offering an excellent way to study visual processing in a well controlled applied setting. In the present study images of fruit juice packages were arranged in 256 different shelf-like arrays, each including 16 triplets. To examine effects of bottom up features, the form of the packages was varied (boxes vs. bottles). As a variation of top down features, brands were either familiar or unfamiliar. Conditions similar to a classic visual search (Neisser, 1993) and a classic memory search task (Sternberg, 1996) were designed to induce specific types of scanning behavior. In both tasks, item position was systematically varied. Global and local scanpaths and fixation patterns will be discussed and theoretical implications considered.

Thematic Sessions

TM-140

Wednesday 13:20

The effect of photos and information graphics on newspaper reading.

K. Holmqvist (Lund University, SoL, Box 201, S-22100 Lund, Sweden. E-Mail: kenneth@lucs.lu.se), J. Holsanova, N. Holmberg (Lund University)

We report the results of two newspaper reading experiments. We examine how readers' eye movements are affected by graphical elements such as photos and information graphics. Control variables in these experiments include size and content of photos, and spatial structure of information graphics. We hypothesized that large photo size and animate photo content would be associated with a local increase in textual processing and earlier pictorial attention. We also hypothesized that the presence of information graphics would generate a local increase in reading time, and that a sequential structure would facilitate decoding. Our results show that photos have a strong effect on newspaper scanning, whereas these elements have no effect on reading interest. This finding indicates that reading and scanning are separate processes. We also found that information graphics lead to an increase in reading time, and that a sequential layout facilitated decoding. Consequently, photos and information graphics have different effects on newspaper reading patterns.

TM-141

Wednesday 13:40

The attention-guiding function of color-codes in processing illustrated text.

S. Folker (University of Bielefeld, Faculty of Technology, Neuroinformatics Group, P.O.-Box 100131, 33501 Bielefeld, Germany. E-Mail: sonja.folker@uni-bielefeld.de), L. Sichelschmidt, H. Ritter (University of Bielefeld)

While reading and scene perception are well-established fields in eye movement research, few studies deal with text and pictures in combination – despite the fact that this presentation format is extremely common. An experiment was conducted to study how the processing and integration of these different representational modalities is achieved and might be improved by using color-codes that increase the contiguity of the material. While the results replicate the established differences in the ways text and pictures are processed, the use of color-codes seems to render the processing more effective. An increased number of switches/sec. between text and pictures indicates a more integrated processing. In guiding the reader's attention, color-codes reduce cognitive load and foster coherence-formation processes. At least for readers with low prior knowledge, the real difficulty of processing illustrated text therefore seems to lie in the integration of the different sources of information.

TN-142**Thursday 10:30**

The role of memory and eye movements in static and dynamic visual search.

A. von Mühlenen (Ludwig-Maximilians-University, Department Psychology, Leopoldstrasse 13, 80802 München, Germany. E-Mail: avm@lmu.de), T. Geyer (Ludwig-Maximilians-University)

The role of memory in visual search has lately become a controversial issue. Horowitz and Wolfe (1998) asked observers to search displays for a letter T among letters L in two experimental conditions: In the static condition, the displays remained unchanged, whereas in the dynamic condition, all letters were randomly re-located every 100 ms. If search involves a memory-based mechanism that keeps track of the previously examined locations, observers would be expected to have great difficulties searching the dynamic display. Surprisingly, search performance did not differ in the two conditions, from which they concluded that memory is not involved in the static condition. Another explanation is that observers adopted in the dynamic condition a sit-and-wait strategy (i.e., attending to a region of the display and waiting for the target to appear). This hypothesis is supported in an eye movement study, showing that observers make fewer fixations in the dynamic than in the static condition.

TN-143**Thursday 10:50**

Searching again: a saccade based task to investigate memory in visual search.

C. Körner (University of Graz, Department of Psychology, Universitaetsplatz 2/III, 8010 Graz, Austria. E-Mail: christof.koerner@uni-graz.at), I.D. Gilchrist (University of Bristol)

Real visual search often involves searching the same environment, consecutively, for a number of different targets. Here we show that when participants search the same letter display twice for different target letters the search for the second letter benefits from previous exposure to the display. The time necessary to find the second target letter depended on when that letter was last fixated in the previous search. The benefit extends up to about the last four fixations(maximally 1200 ms). In a further experiment we have manipulated the time interval between first and second search by masking the search display for 0 ms, 600 ms, or 1200 ms, respectively in order to investigate whether these effects reflect the limited capacity or the decay rate of the memory system involved.

Thematic Sessions

TN-144

Thursday 11:50

Can increasing memory workload decrease reaction times? Sternbergs law inverted in saccadic reaction times.

A. Tarnowski (University of Warsaw, Psychology, Stawki 5/7, 00-183 Warsaw, Poland. E-Mail: adam.t@plusnet.pl),

Visual attention may be oriented either by stimulus-oriented bottom-up mechanisms or by voluntarily controlled top-down system. This project is devoted to incorporating working memory into models of top-down attention orienting. In the present research four experiments were conducted to explain, how particular structures of working memory influence visual attention. The most spectacular finding is that the increase in working memory load effects in decreasing saccadic eye movement reaction times. Under some conditions, this outcome inverts the Sternberg's effect, and may, therefore, provide and inspiration to reformulate the attention resources allocation theory. In brief, when one mental task becomes difficult, other tasks are supported by less attention resources. This, however, may not always impair the performance on these secondary tasks as they may be performed in an automated mode.

TN-145

Thursday 11:30

The effect of the Müller-Lyer (ML) illusion on reflexive and memory guided saccades.

P. Knox (University of Liverpool, Orthoptics, Brownlow Hill, L69 3GB Liverpool, UK. E-Mail: pcknox@liv.ac.uk), **N. Bruno** (University of Trieste)

Debate continues about the implications of perception/action dissociations for our understanding visuomotor processing. In conditions in which there is little effect on pointing, the ML illusion affects both perception and reflexive saccades (Bernadis et al, Ex. Brain Res. in press). We have now investigated the effect of ML stimuli in a memory guided saccade paradigm (stimulus display time: 1s; memory delay: 2s) in six adult subjects with "in" (><) and "out" configurations (< >) and three amplitudes (separations between the vertices: 4°, 6° or 8°). Eye movements were recorded with infrared oculography and the amplitude of primary saccades measured offline. Saccade amplitude was significantly smaller with "out" compared to "in" configurations ($F_{1,5}=39.1$; $p=0.002$). Across subjects and conditions the size of the effect was $13\% \pm 7\%$, smaller than previously observed on reflexive saccades ($24.8\% \pm 3.8\%$). Thus both types of saccade are affected by the ML illusion, although to differing degrees.

TN-146**Tuesday 18:00**

Pre-attentive representations in transsaccadic object perception.

K. Verfaillie (University of leuven, Department of psychology, Tiensestraat 102, B-3000 Leuven, Belgium. E-Mail: karl.verfaillie@psy.kuleuven.ac.be), F. Germeys

When a viewer explores a natural scene, the eyes typically hop from one object to another. Some studies have suggested that transsaccadic memory may be limited to pre-saccadically attended objects. However, it is possible that these studies mainly tap into attentive levels of representation. Evidence from different experimental paradigms indeed indicates that observers store a quite detailed representation of the contents of the pre-saccadic fixation, and that there is an important role for a pre-attentive component in transsaccadic memory. The paradigms include studies of transsaccadic preview benefits, of change detection in combination with blanking and cueing, and of object substitution masking. I will present new data supporting the hypothesis that both pre-attentive and attentive levels of representation are involved in transsaccadic object perception.

TN-147**Thursday 10:50**

Using saccadic gain adaptation to study double-step saccades.

M. Collett (Michigan State University, Zoology, 203 Natural Sciences, 48824 East Lansing, USA. E-Mail: collettm@msu.edu), H. Deubel (Ludwig-Maximilians Universität)

One technique for analysing the various pathways involved in producing saccades in humans is by behaviourally altering the saccadic gain of a specific saccadic type and then testing how the resulting gain adaptation transfers to other types of saccades. This technique has been used to produce a preliminary taxonomy of single-step saccades: reactive saccades to novel features, scanning saccades to already perceived features and memory saccades to the position of no longer visible features (Deubel 1999). We present results that expand the taxonomy to include double-step saccades which use an efference copy from the first saccade to guide a second saccade to a no-longer-visible target. We also present data indicating that the efference copy used to update eye-position before second step is affected by gain adaptation. This result implies that the efference copy originates from a late processing stage in the brainstem, as is the case for monkeys (Tanaka 2003).

Thematic Sessions

TO-148**Thursday 10:30****Incremental picture-sentence integration: Tracking eye-movements in scenes and sentences.**

P. Knoeferle (Saarland University, Computational Linguistics, FR 4.7 Building 17.1 Room 1.19, 66041 Saarbruecken, Germany. E-Mail: knoeferle@coli.uni-sb.de), M.W. Crocker

The Carpenter and Just model (1975) predicts that for picture-sentence integration corresponding parts of sentence and picture are serially compared with one another. Underwood et al. (2004) fail to find a mismatch effect in total sentence reading times for serial picture-sentence presentation - a result that contradicts the Carpenter and Just predictions. In two experiments (eye-tracking reading in serial scene-sentence presentation and eye-tracking in scenes during utterance comprehension) fine-grained word region analyses revealed an incremental integration of scene and sentence both during reading and spoken comprehension - emphasizing the importance of eye-movements in investigating the incremental integration of scene and sentence. We suggest the absence of a mismatch effect in Underwood et al. is due to the grain size of their analyses (total sentence reading times only).

TO-149**Tuesday 10:30****How to make sad people happy: Emotional inferences in text processing.**

L. Sichelschmidt (University of Bielefeld, Linguistics, POB 100131, 33619 Bielefeld, Germany. E-Mail: max.sichelschmidt@uni-bielefeld.de), A. Walberer

Against the background of current psycholinguistic theories, we have investigated the question to what extent readers of short narratives infer the protagonists' emotions (cf. Gygax, Garnham, & Oakhill, 2004). In extension of earlier research on elaborative inference, we have employed eye movement measurement to compare three text conditions: Consistent (context suggesting a particular emotion such as happiness, followed by target sentence stating that the protagonist is happy) Inconsistent (context suggesting happiness, target stating sad). Introduced (context suggesting happiness, target stating sad, introduced by a disjunction such as yet). Inconsistency led to an increase in the number of fixations of the critical word. Closer inspection showed that this was due to the polarity of emotions: A switch from positive to negative was processed in a different way than the opposite. Implications for theories of inference in text processing are discussed.

TO-150**Thursday 10:50**

Predictability within a word: Evidence from Finnish compounds.

R. Bertram (University of Turku, Finland, Psychology, Assistentinkatu 7, 20014 Turku, Finland. E-Mail: rayber@utu.fi), J. Hyönä (University of Turku), A. Pollatsek (University of Massachusetts)

The 2nd constituent of bimorphemic compounds is more or less predictable depending on the number of compounds that can be formed with the 1st constituent. In Finnish, the word *alttari* (altar) is the left constituent of *alttaritaulu* (altarpiece) and 40 other compounds. In contrast, a word like *aktivisti* is the left constituent of only 3 compounds other than *aktivistiliike* (activist movement). Thus *aktivistiliike* should be much more predictable than *alttaritaulu* given the 1st constituent. We tested whether this kind of within-word predictability affects within-word processing in normal sentence reading. The main result was that the 2nd constituent was read faster when the compound family is small. There was no difference in gaze duration, but the number of regressions to the 1st constituent was significantly larger when family size was smaller. This indicates that the constraint has both costs and benefits.

TO-151**Tuesday 11:10**

How are vowels processed during silent reading?

J. Ashby (University of Massachusetts at Amherst, Psychology, 431 Tobin Hall, 1003 Amherst, MA, USA. E-Mail: ashby@psych.umass.edu), R. Treiman, B. Kessler (Washington University in St. Louis), K. Rayner (University of Massachusetts)

Eye movement studies using a fast-priming paradigm have found that consonant information is used earlier in word recognition than vowel information (Lee, Rayner, and Pollatsek, 2001). The present experiments investigate how vowel information is processed in silent reading. Experiment 1 examined whether parafoveal processing of ambiguous vowels is affected by surrounding consonant context. Targets (e.g., rack) were preceded by vowel-similar (raff) or vowel-dissimilar (rall) nonword previews. Experiment 2 tested whether phonological vowel information is processed parafoveally when the orthographic vowel differed from the target. Targets (e.g., chirp) were preceded by vowel-similar (cherg) or vowel-dissimilar (chorg) nonword previews. Phonologically appropriate vowel information facilitated word reading in both experiments. Implications of these results for models of word recognition and phonological representation in reading will be discussed.

Thematic Sessions

TO-152

Thursday 11:30

Understanding sentences in dynamic scenes: Assessing the locus of the interaction between visual and linguistic representations.

R.G. de Almeida (Concordia University, Department of Psychology, 7141 Sherbrooke St. West, H4B 1R6 Montreal, Canada. E-Mail: almeida@alcor.concordia.ca), J. Di Nardo, M. W. von Grunau (Concordia University)

Eye movements were recorded as participants were shown a series of movies of events and listened to sentences related to those events. The main verbs in the sentences were either causative (spill) or perception (see). In addition, the agents in the scenes moved either toward the visual referent of the grammatical object of the main verb in the sentence, away from it, or remained neutral. We measured (a) the time taken to initiate a saccade to the target object after the onset of the main verb and (b) the proportion of fixations to that object as a function of the three motion contexts and two verb types. Results show main effects of both verb type and motion direction: saccades onsets were faster (and more fixations to the object were obtained) when the verb was a causative and when the agent moved towards the target object. We suggest that the interaction between visual-contextual and verb-conceptual information occurs rapidly within conceptual short-term memory.

TO-153

Thursday 12:10

Integrating language and vision: the time-course of the mapping of lexical representations onto concurrent visual objects.

F. Huettig (Ghent University, Department of Experimental Psychology, Henri Dunantlaan 2, 9000 Gent, Belgium. E-Mail: falk.huettig@ugent.be), J. McQueen (Max Planck Institute for Psycholinguistics)

A visual-world study is reported investigating the time-course of how phonological, visual-shape and semantic information accessed from spoken words is used to direct gaze towards objects in a concurrent visual environment. During the acoustic unfolding of Dutch words (e.g. bean-boon), eye movements were monitored to pictures of phonological, shape and semantic competitors (e.g. a bow-boog, a sword-zwaard, and a lettuce-sla), and to pictures of objects unrelated on all three dimensions. Time-course differences were observed with attentional shifts to phonological competitors preceding shifts to shape competitors which in turn preceded shifts to semantic competitors. The data suggest that during language-mediated visual search, attention is directed to the item with the current highest priority ranking, as co-determined by the type of lexical information that becomes available as the spoken word unfolds and by featural information in the visual display.

Poster Sessions

Poster Sessions

PA-154

Monday 14:00

Eye movements in relation to the two visual systems approach.

M. Joos (Technische Universität Dresden, Applied Cognitive Research / Psychology III, Mommsenstrasse 13, 1062 Dresden, Germany. E-Mail: joos@applied-cognition.org), S. Pannasch, J. R. Helmert, B. M. Velichkovsky

Models of perception often propose two streams of visual processing, variously named as dorsal/ambient and ventral/focal (e.g. Norman, 2001). However, this distinction was never associated with eye movements. Therefore, after free picture exploration patches of the previously fixated image regions were generated for a recognition task. In a first study, we found evidence that fixation durations and the amplitude of following saccades well distinguished visual processing in the two systems. In a follow-up study we expanded this approach by classifying each fixation on-line as belonging to either of the two visual systems and tested these assumptions again. The results confirmed the idea that eye movement parameters are strongly related to the dominance of either of the two visual systems. Norman, J. (2001). Two visual systems and two theories of perception: An attempt to reconcile the constructivist and ecological approaches. *Behav Brain Sci*, 24(6).

PA-156

Monday 14:00

What perception and eye movements predict about our spatial orientation without interference of vision.

E. Lorincz (University of Zurich, Neurology Department, Vestibulo-Oculo-Motor Lab., Frauenklinikstrasse 26, 8091 Zurich, Switzerland. E-Mail: erika.lorincz@usz.ch), B. Hess (University of Zurich)

To identify the coordinate systems that correlate with head orientation in space, we measured 1) the 3D slow phase of post-rotatory eye velocity induced by off vertical roll rotations in normal humans, 2) the setting of a luminous line to the subjective visual vertical (SVV). Subjects seated up-right in a 3D turntable were rotated at $\pm 60^\circ/s$ (acceleration: $150^\circ/s^2$) before being stopped in one of 7 orientations ranging from 0 to $\pm 90^\circ$. The latter orientation was then maintained for about 60s. 1) The desaccaded post-rotatory angular eye velocity was fitted following a 3D generalisation of Robinson's velocity storage model, in which we introduced a gravity dependent projection operator to obtain an estimation of the head spatial orientation. 2) A line appearing after stop rotation was set to the SVV. The data showed that 3D residual eye velocity reflects the actual spatial head orientation, displaying an error profile that overestimates small tilt and underestimate larger tilt angles.

PA-157**Monday 14:00**

Verification of Panum's Area by a new visual space in using an "active" gazing eye.

Y. Kitamura (Kansai University, Institute of Foreign Language Education, 3-3-35 Yamate-cho, 564-8680 Suita, Japan. E-Mail: kitamura@ipcku.kansai-u.ac.jp), K. Horii, K. Kotani, T. Usui (Kansai University), G. d'Ydewalle (Katholieke Universiteit Leuven)

The world we humans perceive is called visual space which is geometrically distorted. Luneburg, R. K., therefore, formulated a Riemann space with a negative constant of curvature to describe this. In this current paper, we propose a new model in light of information processing of perception in which a straight visual line from the cyclopean eye is assumed. Unlike traditional models, our model treats an initial fixation point and a following fixation point in the same continuous visual space. Kinetic momentum from an initial point to the following point is calculated from the angle of the initial fixation point to the following fixation point gazed through the cyclopean eye. At the same time, four types of dominating eyes are introduced into the model resulting in high verification of our theoretical calculation of Panum's fusional area by comparing experimental data by Ogle, K. N.(1962).

PA-158**Monday 14:00**

Investigation of capture of visual direction in dynamic vergence with continuous and flashing monocular lines.

S. Jainta (Institut für Arbeitsphysiologie, Individual Visual Performance, Ardeystr. 67, D-44139 Dortmund, Germany. E-Mail: jainta@ifado.de), W. Jaschinski (Institut für Arbeitsphysiologie), H. Jungnickel (Fachhochschule Jena)

Visual directions of continuously presented monocular objects are captured by those of nearby binocular objects, which questions the reliability of nonius lines for measuring eye position (Erkelens & van Ee, 1997). Like these authors, we presented two square random-dot patterns (one to each eye) oscillating in counter phase as a dynamic vergence stimulus. A smaller central blank rectangle (of variable width) contained a vertical monocular line oscillating in phase with the random-dot pattern of the respective eye. Subjects adjusted the motion-amplitude of the line until it was perceived as stationary. With a continuously presented monocular line, we confirmed Erkelens & van Ee: the adjusted motion-amplitude of the line was equal to the motion-amplitude of the random-dot pattern, provided the blank square was narrow (which indicates capture of visual direction). However, when the line was flashed at the moments of maximal and minimal vergence stimulus, the adjusted motion-amplitude of the line was smaller and less affected by the width of the blank rectangle; the capture effect appeared to be reduced with flashing nonius lines. The colour of the line had a minor effect.

Poster Sessions

PA-159

Monday 14:00

Individual dark vergence and dynamic changes in vergence, estimated by psychophysical tests using flashed dichoptic nonius lines.

W. Jaschinski (Institut für Arbeitsphysiologie, Individual Visual Performance, Ardeystr. 67, D-44139 Dortmund, Germany. E-Mail: jaschinski@ifado.de), W.B. Kloke (Institut für Arbeitsphysiologie), C. John (Fachhochschule Aalen)

We tested dynamic vergence with step disparity stimuli of 52 minarc in the convergent and divergent direction, relative to an initial vergence corresponding to viewing distances of 100, 60, 30, & 40 cm. Responses were measured psychophysically in a series of trials with repeated vergence changes by flashing dichoptic nonius lines at a fixed delay t after the step: the amount of nonius offset was varied by an adaptive procedure. Vergence velocity was estimated by the change in vergence response from $t=0$ to $t=400$ ms. In 27 subjects, we also measured the dark vergence position (resting vergence in a dark surround without fusion stimulus) that varied between a viewing distance of 30 cm and infinity among individuals. Vergence changes were predominantly performed towards the individual dark vergence position: when the dark vergence position was closer (or more distant) than the initial vergence position, vergence changes were larger in the convergent (or divergent) direction, respectively.

PA-160

Monday 14:00

Habituation of the distractor effect: Evidences in eye movements and ERPs.

S.T. Graupner (Dresden University of Technology, Applied Cognitive Research / Psychology III, Mommsenstrasse 13, 01062 Dresden, Germany. E-Mail: graupner@applied-cognition.org), J. Marx, S. Pannasch, B.M. Velichkovsky (Dresden University of Technology)

The presentation of irrelevant distractors together with a target leads to a significant increase in saccadic latency. This phenomenon has been labelled remote distractor effect. Due to the intermodality of the effect an explanation within the framework of the orienting reaction (OR) has been proposed (Pannasch et al.). An essential feature of the OR is the habituation for repeated presentations. During free visual exploration of paintings eye movements and event related potentials (ERPs) were recorded in parallel. Visual and acoustic distractors were presented to investigate possible effects of habituation. Evidence was obtained within (fast) and across (slow) pictures: in fixation duration primarily for visual distractors and in components of the ERPs mainly for acoustic distractors. Pannasch et al. (2001). The omnipresent prolongation of visual fixations: saccades are inhibited by changes in situation and in subject's activity. *Vision Res*, 41(25-26), 3345-3351.

PA-161**Monday 14:00**

Three dimensional Hess screen test before and after botulinum toxin injection in horizontal strabismus.

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Background: Botulinum toxin injections (BTI) in extraocular muscles are being performed to reduce a squint in gaze straight ahead. Material and Methods: 2 patients with right abducens nerve palsy and 1 patient with decompensated left microesotropia were measured 3-dimensionally (torsional, vertical, horizontal) with the search coil method immediately before and 2 to 3 times within 1 week following an EMG-guided BTI into a medial rectus muscle. Results: In all patients mean horizontal gaze deviation decreased and horizontal incomitance increased beginning from day one. Mean vertical deviation remained constant. Torsional incomitance remained unchanged. Conclusions: BTI created a strong paresis. Patients benefited from a reduced mean horizontal deviation at the cost of more diplopia in eccentric gaze positions. The three dimensional Hess Screen Test is an excellent method to analyze the effects of BTI over time.

PA-162**Monday 14:00**

Congenital nystagmus as non-linear adaptive oscillations.

D. Berry (Universidade de Évora, Departamento de Física e Centro de Geofísica de Évora, Rua Romão Ramalho, 59, 7002-554 Évora, Portugal. E-Mail: dberry@uevora.pt), C.M. Harris (University of Plymouth)

Congenital Nystagmus (CN) is a pathological involuntary oscillation of the eyes with an onset within the first few months of life, with an incidence of about 1:3000. It is a life-long oculomotor disorder that cannot be explained by any underlying neurological abnormality which might compromise adaptive mechanisms. There is no cure, and CN has so far defied explanation in spite of numerous attempts to model the disorder. In this theoretical study we show that these eye oscillations could develop as an adaptive response to maximise visual contrast with poor foveal function in the infant visuomotor system, at a time of peak neural plasticity. We propose that CN is a normal developmental adaptive response to an abnormal congenital sensory input. This can explain why CN does not emerge later in life and why CN is so refractory to treatment. It also implies that any therapeutic intervention would need to be very early in life.

Poster Sessions

PA-163**Monday 14:00**

The origin of downbeat nystagmus: an asymmetry in the distribution of on-directions of vertical gaze-velocity Purkinje cells.

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To propose a new hypothesis on cerebellar Downbeat nystagmus: The slow upward drift in DBN consists of (1) a vertical centripetal gaze-evoked drift, and (2) an upward bias drift already present with gaze straight ahead (= spontaneous drift). While the gaze-evoked drift can be explained by a shortening of the time constant of the vertical velocity-to-position integrator caused by a disorder of the FL, the mechanism of the spontaneous upward drift remains unclear.

PA-164**Monday 14:00**

Verification of empirical horopters by a new visual-space model by using an "active" gazing eye.

K. Horii (Kansai University, Department of Systems Management Engineering, 3-3-35 Yamate-cho, 564-8680 Suita, Japan. E-Mail: khorii@iecs.kansai-u.ac.jp), Y. Kitamura, K. Kotani, K. Akahoshi (Kansai University), G. d'Ydewalle (Katholieke Universiteit Leuven)

How accurately do we humans perceive the outside world? When the mid-point between the two eyes is added to the visual target and the dominant eye, these three points satisfy mathematically to form an iso-vergence circle (IVC). This visual space handles asymmetrical vision by the introduction of an active gazing eye. An equal distance horopter (EDH) and an apparent fronto-parallel plane (AFPP) are used in our experiments. The experimental results and theoretical computation were overlaid on the charts. The experimental results show that 1) when the target was far, angle of convergence took the dominating position; 2) when the target was near, the visual distance took the dominating position in gazing; and 3) alternative dominant eye occasionally shifted into the midst of the dominant eye.

PA-165**Monday 14:00**

Gaze distractors influence the curvature of task-instructed saccades: Evidence for the role of the superior colliculus in gaze-cued orienting.

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We examined the oculomotor responses triggered by perception of an averted gaze and the role of superior colliculus (SC) in gaze-triggered orienting. In Experiment 1, participants (n=10) performed voluntary and reflexive vertical saccades from a central fixation point to designated target areas while their eye movements were recorded. Schematic faces with averted gaze were presented before or simultaneously (SOAs of -75ms / 0ms) with the imperative signal. The gaze distractors caused both voluntary and reflexive saccades to curve away from the gaze direction at the SOA of -75 ms. In Experiment 2, participants (n=11) performed reflexive vertical saccades, and gaze or peripheral distractors were presented with -100ms / 0ms SOAs. Both gaze and peripheral distractors caused the saccades to curve away from the distractor at both SOAs. The results imply that an averted gaze is prone to trigger an imitative gaze response and that the SC is involved in this type of orienting.

PA-166**Monday 14:00**

Measurement of the active gazing eye by an improved Rosenbach method: Tracing from the dominant eye to the "active" gazing eye.

K. Horii (Kansai University, Department of Systems Management Engineering, 3-3-35 Yamate-cho, 564-8680 Suita, Japan. E-Mail: khorii@iecs.kansai-u.ac.jp), Y. Kitamura, K. Kotani (Kansai University), F. Okuyama (Suzuka University of Medical Science), G. d'Ydewalle (Katholieke Universiteit Leuven)

Is the dominant eye really stable in its side of the eye? Four different dominant eyes characterized by their side of dominance were introduced together with the stability of dominance. Rosenbach's method was applied to determine the dominant eye. In this current report, procedural improvements were made to this method to cope with changes in distance and direction of the visual target and to obtain whether the occurrence of diplopia was noticed or not by the subject. Two types of material (with or without the noise pattern) were shown to check if the occurrence of diplopia was noticed less frequently with the noise pattern than without it. The result showed that eye-dominance shifted from the right eye to the left eye or vice versa far more frequently than supposed.

Poster Sessions

PA-167

Wednesday 13:00

Vestibular contribution to updating orientation in space following whole body rotations.

T. Tchelidze (University Hospital Zurich, Neurology, Frauenklinikstr. 26, 8091 Zurich, Switzerland. E-Mail: tamara.tchelidze@usz.ch), B. Hess

To investigate whether 3D eye positions comply to the non-commutative rotatory kinematics, a monkey was trained to fixate eccentric targets that flashed for 1000 ms in one of the four quadrants of the visual field in otherwise complete darkness. After the target disappeared the animal had to maintain fixation on the memorized target during about 2s while it was sequentially rotated in pitch (25°), roll (15°) and yaw (25°), or in the reversed order, using steps of velocity of 60°/s (200°/s²). Similarly, sequential rotations were applied only in pitch and yaw in two different orders. We found that final 3D eye positions in the 3-step paradigms differed on average by 9.2°, which is close to the predicted value (9°), whereas in the 2-step paradigms (without roll) there was almost no difference. Our data suggest that the brain does indeed integrate vestibular information to keep eye position on a memorized space-fixed target, using information on both head position and velocity.

PA-168

Monday 14:00

The asymmetry of pitch VOR to steps of acceleration.

S. Ramat (University of Pavia, Computer and Systems Science, Via Ferrata, 1, 27100 PAVIA, Italy. E-Mail: steram@linus2.unipv.it), C.J. Bockisch, K.P. Weber, A. Tarnutzer, D. Straumann (University of Zurich)

Vertical VOR (VVOR) generates eye movements compensatory for pitch head rotations. VVOR studies in humans are not conclusive regarding the existence of a directional asymmetry, and the contribution of otolith organs to the VVOR. We studied the early (0-300ms) VVOR in 6 normal subjects in response to steps of angular acceleration in pitch about an earth-horizontal axis. Trials started with subjects upright, prone, upside-down or supine and rotated them 90 deg with 1 s constant acceleration at 90 deg/s² and 1 s of constant deceleration. We recorded 8 trials for every subject with each starting position and in each direction. Our results suggest responses are symmetric for about 100 ms. Thereafter responses to backward pitch had a generally lower gain than those to forward pitch (between 200 and 250ms mean forward gains across subjects and conditions ranged from 0.61 and 0.70, backward gains ranged from 0.39 to 0.48). Such difference may be due to an asymmetric gain of vestibular signals.

PA-169**Monday 14:00**

Contributions of visual areas V2 and V3 to the analysis of depth and motion signals guiding smooth eye movements.

C.R. Ponce (Harvard Medical School, Department of Neurobiology, 220 Longwood Avenue, WAB 218, 2115 Boston, MA, U.S.A. E-Mail: carlos_ponce@student.hms.harvard.edu), S.G. Lomber (University of Texas at Dallas), R.T. Born (Harvard Medical School)

The middle temporal (MT) visual area is a critical source of motion and disparity signals used to guide smooth eye movements. It receives major cortical inputs from visual areas V1, V2 and V3. To explore the contributions of these inputs, we reversibly inactivated parts of V2 and V3 while measuring smooth eye movements in awake behaving macaques. We found that inactivation of these regions caused a retinotopic deficit in the initiation of smooth pursuit and optokinetic responses, which was most significant for high stimulus velocities (>30 deg/s, corresponding to spatial displacements above 0.5 deg). Vergence was similarly impaired: the only significant changes in horizontal vergence velocity were for eye movements elicited by large binocular disparity steps (>0.8 deg). Our results suggest that V2 and V3 are important in the processing of visual information used to generate eye movements, contributing most to the analysis of motion signals involving large spatial steps.

PA-170**Monday 14:00**

Color-defined motion perception during saccades.

H. Ito (Kyushu University, Department of Visual Communication Design, 4-9-1, Shiobaru, Minamiku, 815-8540 Fukuoka, Japan. E-Mail: ito@design.kyushu-u.ac.jp),

During saccades, moving retinal images usually do not cause motion perception. However, color-defined objects are seen to move during saccades. Stationary red/green discs on a green background were displayed. When the luminance was similar for the red discs and the green background, strong motion perception arose. No motion of the green disc was seen across the tested luminance range. A green circular contour was attached to each of the red discs and varied in luminance. Only when the luminance of the contour was similar to that of the background, strong motion perception arose. When black lines or sparse random dots were overlaid, perceived motion was still strong. The results show 1) that saccadic suppression has little effect on motion perception of color-defined objects, 2) that the stability of the visual world is accomplished only by luminance information processing, 3) and that luminance edges stabilize color during saccades when both edges are common in retinal positions.

Poster Sessions

PA-171

Monday 14:00

The influence of microsaccades on visually and memory guided saccades.

M. Rolf (University of Potsdam, Department of Psychology, PO Box 601553, 14415 Potsdam, Germany. E-Mail: rolfs@rz.uni-potsdam.de), J. Laubrock, R. Kliegl (University of Potsdam)

During fixation, microsaccades (small fast eye movements) slightly shift the image on the retina, thereby refreshing the visual input and counteracting retinal fatigue. Here, we studied influences of microsaccades on visually and memory guided saccades. That is, saccade targets were presented during fixation, but removed again in memory trials. First, across both conditions, we find a strong drop of microsaccade rate prior to saccades. Second, if microsaccades occur shortly before a saccade is commanded, saccadic reaction times in visual and memory trials are increased by about 25% (or 60 ms). Third and most interestingly, saccadic response latencies to remembered target locations (memory trials) are significantly shorter if microsaccades occurred just before target disappearance as compared to when no microsaccade in that time window. We speculate that in the case of target disappearance, its visual perception may be sustained by microsaccades leading to faster reaction times.

PA-172

Monday 18:00

Human recognition of symbols and words having the same meanings: An EEG and eye movement study.

H. Toyoshima (Information Science Research Center Co., Ltd., IT Group, 1-14, W-3, N-21, Kita-ku, 001-0021 Sapporo, Japan. E-Mail: toyosima@isrc.co.jp), T. Yamanoi (Hokkai-Gakuen University), T. Yamazaki (NEC Bio-IT), S. Ohnishi (Hokkai-Gakuen University)

To investigate human brain activity during recognition of symbols or words with identical meaning, the authors recorded electroencephalograms (EEGs) and eye movements from subjects, four women aged from 20 to 21, in viewing arrows or Chinese characters presented on the CRT and directing to the directions (meaning either the direction up, down, left or right) that they mean. Reaction times of gaze for the presentation of arrows were almost equal for all directions. However, comparison between the presentation of arrows and characters with identical meaning showed delayed reactions to characters for all directions. Presentation of the characters meaning up and down, which are very similar in shape, elicited slightly earlier reactions than other characters. Furthermore, for both of arrows and characters, the peak latencies of event-related potentials (ERPs) for the opposite meaning (e.g., up and down) were almost the same peak latency time, while their polarities were in reverse.

PA-173**Monday 14:00**

Long-term retention of reflexive saccades adaptation in human subjects.

D. Pelisson (INSERM/Univ. Lyon I, Espace et Action U534, 16 avenue du doyen Lepine, 69676 Bron, France. E-Mail: pelisson@lyon.inserm.fr), N. Alahyane (Espace et Action)

Motor adaptation allows us to keep our motor performance despite challenging variations in sensori-motor conditions. The long-term effects of adaptation demonstrated for limb reaching movements and for the VOR have not yet been studied for saccadic eye movements. In this study, we measured in 5 human subjects the retention of reflexive saccades adaptation induced by the backward double-step target protocol. We found that the 22 % decrease of saccade gain observed immediately after the adaptation session (day 0) was partially but significantly maintained on days 1 and 5 (average retention rates: 36% and 19%) and then decreased further to non significant values (days 11 and 19). No change in dynamics or latency could be related to the adaptation and, unexpectedly, adaptation was more effective and enduring for leftward than for rightward saccades. We conclude that the quickly developing neural changes related to saccade adaptation can last for a much longer period of time.

PA-174**Tuesday 14:00**

Transsaccadic memory for the position of stationary and translating pointlight walkers.

G. Van Belle (University of Leuven, Psychology, Tiensestraat 102, 3000 Leuven, Belgium. E-Mail: goedele.vanbelle@psy.kuleuven.ac.be), J. Vanrie, K. Verfaillie

The present study investigated transsaccadic memory for the position of stationary and translating pointlight walkers. In a display with a stationary and a translating pointlight walker, subjects saccaded towards one of the pointlight walkers and had to detect intrasaccadic changes in the position of either the saccade target or the saccade flanker. Intrasaccadic displacements of the translating walker were easier to detect than displacements of the stationary walker. The saccadic status of the displaced walker also proved an important factor for displacement detection. Displacements of the saccade target walker were better detected than displacements of the flanking walker. However, this saccade target benefit only proved reliable for translating walkers.

Poster Sessions

PA-175

Monday 14:00

The effect of nicotine on antisaccade performance.

N. Rycroft (University of Sussex, Psychology, University of Sussex, BN1 9QH Brighton,
UK. E-Mail: n.rycroft@sussex.ac.uk), S.B. Hutton, J.M. Rusted

The antisaccade task provides a laboratory analogue of situations in which execution of the correct behavioural response requires the suppression of a more prepotent or habitual response. Recent models of antisaccade performance suggest that errors are more likely to occur when the intention to initiate an antisaccade is insufficiently activated within working memory. Nicotine is known to enhance specific working memory processes in healthy adults. Using a within-subjects design, we explored the effect of nicotine on antisaccade performance in a large sample of smokers. Nicotine reduced antisaccade errors and correct antisaccade latencies, but only if smoked in the first experimental session. Nicotine also reduced the latency to correct errors at a trend level. The results of this research have implications for current theoretical accounts of antisaccade performance, and for interpreting the increased rate of antisaccade errors found in some psychiatric patient groups.

PA-176

Monday 14:00

Eye movements and memory for location of a transient target.

M.K. Uddin (Kyushu University, Department of Behavioral and Health Sciences, 6-19-1,
Hakozaki, 812-8581 Fukuoka, Japan. E-Mail: kamaluddin67@hotmail.com), N. Yuri
(Fukuoka University of Education), S. Nakamizo (Kyushu University)

We compared following three conditions with respect to accuracy and precision of location memory: (i) no saccade $\frac{3}{4}$ observers had to maintain gaze on a central fixation point while target presented for 1000 ms, (ii) saccade to briefly exposed target $\frac{3}{4}$ they had to quickly saccade to target presented for 150 ms, and (iii) saccade to long exposed target $\frac{3}{4}$ they had to quickly saccade to target presented for 1000 ms. The observers' task was to point to the remembered location of the target with the mouse cursor available after a retention interval of 150 ms following target offset. The results showed highest accuracy in 'saccade to long exposed target' followed by 'saccade to briefly exposed target' and lowest in 'no saccade' conditions. Further, precision was greater with 'saccade to long exposed target' condition than either of the other two conditions. These results can be explained with the findings that memory guided saccades are usually less accurate than those in visually guided saccades (i.e., saccades in the saccade to long duration target) due to both systematic and variable errors (Vergilino and Beauvillain, 2001).

PA-177**Monday 14:00**

Influence of target orientation and target from on postsaccadic correction movements of the eyes.

H. Tegetmeyer (University of Leipzig, University Eye Hospital, Liebigstr. 10-14, D-04103 Leipzig, Germany. E-Mail: tegeth@medizin.uni-leipzig.de), A. Wenger

The aim of this study was to investigate the influence of target orientation on postsaccadic correction movements. Video recordings of eye movements were obtained from 35 healthy volunteers. Mueller-Lyer targets of 15° angular magnitude were presented in horizontal and vertical orientations. For both horizontal and vertical target orientations, saccades between inward-pointing arrowheads were significantly greater than saccades between outward pointing arrowheads. This effect was reversed when the target length was adjusted to equal length perception. Postsaccadic correction movements, however, were not influenced by target length: significant correction movements were observed only in the direction of outward pointing arrowheads for horizontal target orientation and in the direction of inward pointing arrowheads for vertical target orientation, respectively. These results correspond to a prevalence of horizontal saccadic hypometria and of vertical saccadic hypermetria, respectively.

PA-178**Monday 14:00**

Spatio-temporal dipole modeling of EEGs during perception of straight movements.

T. Yamanoi (Hokkai-Gakuen University, Dep. Eng., Div. Electronics and Information Eng., 1-1, W-11, S-26, Chuou-ku, 064-0926 Sapporo, Japan. E-Mail: yamanoi@eli.hokkai-s-u.ac.jp), H. Toyoshima (Information Science Research Center), T. Yamazaki (NEC Bio-IT)

Electroencephalograms (EEGs) were recorded when healthy subjects, four men aged from 22 to 23, observed the straight down, up, right, left or random (reference stimulus) movement of a white-filled circle displayed on a cathode-ray tube (CRT). Thirty data from EEGs (19 channels) were summed for each movement, and the equivalent current dipole localization (ECDL) method was applied to the averaged data. Results indicated that dipoles were localized to the middle temporal gyrus at 80 - 120 ms latency, to the intraparietal sulcus at 140 - 180 ms latency, to the precentral gyrus at 210 - 250 ms latency and to the frontal eye field at 210 - 260 ms latency. This spatio-temporal transition was common to all subjects. The directions of the estimated dipoles were found to be opposite corresponding to those of eye movements. Moreover, dipoles were located at the superior colliculus, which is thought to be related with the eye movement.

Poster Sessions

PA-179

Monday 14:00

Eye movement revealed the aging effect in the involvement of frontal lobe function in performance of visuospatial memory task.

M. Furuya (Sapporo Medical University, Health Science, South 1 West 17 Chuo-ku, 060-8556 Sapporo, Japan. E-Mail: fmisato@sapmed.ac.jp), S. Murakami, N. Ikeda (Sapporo Medical University), T. Yamanoi, H. Toyoshima, Yuhta Fujiwara (Hokkai Gakuen University)

We experimented a new developed computer tool for visuospatial sequential memory to 154 healthy adults and studied the involvement of frontal lobe function in performance by recording eye movements. In a new tool, the stimuli were presented with any order at each cell on the touch-panel display which was divided into 3-6, and subject was requested to recall the location and sequence order of those stimuli and to touch the cell according to his recall. In results the elder performance was worse in the task which was apparently random, even though in the systematically stimuli task. The age related performance might be due to the decreasing not only of memory capacity but of certain frontal lobe functions. On this hypothesis, we recorded 4 subject's eye movements during task performance by EMR-8(NAC) and found delayed reaction time which indicated the difficulty of detecting regularity of the stimuli in the elder, while the young adults anticipated and began to move their eyes before stimuli.

PA-180

Monday 14:00

Feed-forward associative learning for saccadic eye movement control.

M. Fujita (Hosei University, Faculty of Engineering, 3-7-2 Kajino-cho, Koganei-shi, 184-8584 Tokyo, Japan. E-Mail: fujita@k.hosei.ac.jp),

I have presented the oculomotor vermis (OMV) hypothesis on the adaptive control of saccades. It has four basic components: (1) the fastigial oculomotor region has a place-coding equivalent to the motor map of the superior colliculus (SC). (2) each Purkinje cell (PC) in the OMV receives parallel fiber signals from every part of the SC. (3) the tectolivo-cerebellar projection has a specific topography. (4) the most effective timing for the LTD of granule-to-PC connection is 100-300 ms by which a parallel fiber signal precedes a climbing fiber signal. The theory regards this time delay as a reaction time of corrective saccades and explains behavioral data observed during adaptation, particularly in terms of the spatial (Deubel 1987) and temporal aspects (Kojima et al. 2002, 2003). Furthermore, here I predict that memory transfer from the cortex to the nuclei should keep a wide dynamic range of PC response capability and explain the characteristics of long-term adaptation of saccades.

PA-181**Monday 14:00**

Three-dimensional constancy and under-constancy during saccades.

M. Wexler (Collège de France, Laboratoire de Physiologie de la Perception et de l'Action [LPPA], 11, pl. Marcelin Berthelot, 75005 Paris, France. E-Mail: wexler@ccr.jussieu.fr),

I have recently described a neglected form of spatial constancy during saccades, three-dimensional spatial constancy (Wexler, PNAS 102, 1446-51, 2005). One consequence of saccades is that the directions of all visible points shift uniformly; directional or 2D constancy. The problems raised by 3D consequences of saccades, on the other hand, have been neglected. When the eye rotates in space, 3D orientations of all stationary surfaces undergo an equal-and-opposite rotation with respect to the eye. When presented with an optic simulation of a saccade but with the eyes still, observers readily perceive this depth rotation of surfaces; when simultaneously performing the corresponding saccade, the 3D orientations of surfaces are perceived as stable, and it is this phenomenon I propose calling 3D spatial constancy. In the experiments, observers viewed ambiguous 3D rotations immediately before, during, or after a saccade. The results showed that before the eyes begin to move the brain anticipates the 3D consequences of saccades, preferring to perceive the rotation opposite to the impending eye movement. Further, the anticipation is absent when observers fixate while experiencing optically simulated saccades, and therefore must be evoked by extraretinal signals. Such anticipation could provide a mechanism for 3D spatial constancy and transsaccadic integration of depth information.

Poster Sessions

PB-182**Tuesday 18:00**

Fixation patterns in an abstract reasoning task.

G. Wesiak (University of Graz, Department of Psychology, Universitätsplatz 2, 8010 Graz, Austria. E-Mail: gudrun.wesiak@uni-graz.at), W. Krenn (University of Graz)

Abstract reasoning tasks are widely employed to measure individual differences in intelligence. Earlier research with geometric matrices showed that the three problem components type (easy vs. difficult), number (1, 2, or 3), and ambiguity (high vs. low) of the necessary operations influence fixation frequency, whereas only the latter two effect the solution frequency of items. We also found, that the more systematic participants proceed in solving the problems, the higher their solution frequencies. To find out which components and which steps in the solution process distinguish best between higher and lower scoring participants, a set of 24 geometric matrices with varying components was constructed. Fixation frequency and fixation duration are analysed to investigate the differential effects of the components. Fixation paths are analysed to uncover in which phase of the solution process higher scoring participants differ most from lower scoring participants.

PB-183**Monday 14:00**

A cerebellar saccade controller implemented in Simulink.

F.A. Rodriguez Campos (University of Connecticut, Biomedical Engineering, 260 Glenbrook Road, 06269-2247 Storrs, USA. E-Mail: Francisc.Rodriguez_Campos@huskymail.uconn.edu), J.D. Enderle

A cerebellar model implemented in Simulink is presented for the control of horizontal saccades. Neurons in the model are fully simulated (dendrite, soma, axon and presynaptic terminal). Eye position input is processed by the cerebral cortex, propagated to structures in cerebellum that process the input signal to generate an output that ends the neural stimulus to the rectus eye muscles. The model is implemented using the Simulink toolbox of MATLAB. Implementation in Simulink allows portability among different operative systems and provides a visual layout of the neural network (since the Simulink environment is block diagram based). The behavior at any site in the network is accessible and can be compared with experimental data. In addition to that the MATLAB platform allows the connection via ActiveX controls with other systems (for instance mechanical simulation software).

PB-184**Monday 14:00**

Controlling computers by eyes while reducing Midas touch-problems.

A. Huckauf (Bauhaus-University Weimar, Faculty of Media, Bauhausstr. 11, 99423 Weimar, Germany. E-Mail: anke.huckauf@medien.uni-weimar.de),

Computers can be effectively controlled by gaze. However, one problem is object selection: In current implementations, selections are elicited after a critical dwell time. But, fixations serving for investigation cause unintended selections (Midas Touch). To minimize this problem, long dwell times are to be used; to the disadvantage of the speed of control. Our alternative approach uses anti-saccades for selection. In anti-saccade control, highlighted objects produce a copy to one side of the object. The object is selected when fixating to the side opposed to that copy. Selection performances were studied using anti-saccades, individually adapted dwell times, and by a standard computer mouse. Although with anti-saccades, more errors were observed than with dwell times, users were much faster; even faster than with the highly trained mouse. The study shows that anti-saccades are easy to learn, fast to fulfil, and can become an alternative selection mechanism for gaze controlled systems.

PB-185**Monday 14:00**

Flexible contingent CRT display for saccadic adaptive control.

W. Payne (University of Plymouth, SensoriMotor Laboratory, Neuroscience, Portland Sq, University of Plymouth, Drake Circus, PL4 8AA Plymouth, UK. E-Mail: william.payne@crrsLtd.com), P. West (Cambridge Research Systems), C. Harris (University of Plymouth)

Understanding saccade adaptive control requires intra-saccadic stimulus shifts in real time to be triggered during the ongoing saccade. Technically this is non-trivial, and the availability of saccade contingent displays has limited research in this area. We explore a CRT method in which the whole visual display can be arbitrarily updated during a saccade using a modified Visage Visual Stimulus Generator (Cambridge Research Systems, Ltd.). Preliminary data indicates a variable frame update latency of approximately 15-30 ms from trigger onset when using an IRIS infra-red limbus tracker sampled at 1kHz and displaying the stimulus with a conventional CRT (167Hz). Thus, this novel technique allows an arbitrary change in the visual display during saccades of modest amplitudes. This study suggests that it will be possible to investigate saccade adaptive control using readily available technology, and to have unprecedented flexibility in the control of the contingent image properties.

Poster Sessions

PB-186**Monday 14:00****A prototype video-based finger tracker for braille and tactile pictures.**

K. Holmqvist (Lund University, SoL, Box 201, S-22100 Lund, Sweden. E-Mail: kenneth@lucs.lu.se), B. Breidegaard, S. Strömqvist, K. Fellenius, Y. Eriksson

One half of the poster will discuss the technical solutions used in the finger tracking system. How to calibrate, how to extract the positions of Braille text, how to translate the Braille text into plain text, how to recognise the index fingers, and how not to mix them up with other fingers? The other half of the poster presents a few pilot recordings we have made of tactile reading. In particular, we suggest that tactile perception shares many properties with visual perception, both for text and for pictures, despite some obvious differences. Concern uptake, visual fixations appear to correspond to plateaus in a finger speed curve.

PB-187**Monday 14:00****On-line saccade adaptation in a real-world scenario.**

T. Rodemann (Honda Research Institute, Europe, Carl-Legien-Strasse 30, 63073 Offenbach, Germany. E-Mail: Tobias.Rodemann@honda-ri.de), F. Joubin, C. Goerick (HRI-EU)

Every system that wants to fovealize a previously seen visual target needs to compute the mapping between image and (head/eye) motor coordinates. Standard approaches use either an analytical solution or a specific offline calibration procedure. For a continuous (maybe even life-long) operation of a visuomotor system these approaches are not well suited, as the mapping has to be adapted to changes in the hardware or software of the system. Here we present a technical system that can continuously adapt the visuomotor mapping for a 2 DoF camera head in a real-world environment in real time. The system monitors its performance in targeting saccades and, on demand, activates a visual-feedback based adaptation. The system can operate reliably in a variety of visual environments. We show how this approach can learn the correct mapping from a random initialization and even a prism inversion within a few 10 saccades.

PB-188**Monday 14:00**

Mathematical analyses and expository visualizations of gaze sequences.

J. West (Rochester Institute of Technology, Information Technology, 102 Lomb Memorial Drive, 14623 Rochester, NY, USA. E-Mail: jmw9523@it.rit.edu), A. Haake, E. Rozanski (Rochester Institute of Technology), K. Karn (Xerox Corporation)

Eye tracking analysis techniques, such as determining gaze durations for areas of interest, can provide insight into the cognitive processes that occur when a subject views a stimulus. More complex gaze sequence investigations, including consistency, transition probabilities, string-edit distance, and Markov analysis, not only discover patterns of eye movements but also provide a mathematical framework for comparing gaze sequences. While these approaches can be invaluable when determining shared viewing behaviors within and across groups of subjects, they are not included in existing eye movement analysis packages. To solve this problem, we developed eyePatterns, a cross-platform tool for discovering, identifying, and comparing patterns and idiosyncrasies in eye path sequences. eyePatterns uses user-created taxonomies and outputs expository visualizations representing mathematical analyses, making patterns and deviations in gaze sequences highly visible.

PB-189**Monday 14:00**

Eye movement driven head-mounted camera.

S. Bardins (Ludwig-Maximilians-University Munich, Departement of Neurology, Klinikum Grosshadern, Marcioninstr.23, 81377 Munich, Germany. E-Mail: SBardins@nefo.med.uni-muenchen.de), E. Schneider, K. Bartl, T. Dera, G. Boening, T. Brandt

A head mounted video camera was developed that is continuously aligned by the user's orientation of gaze. Eye movements are tracked by video-oculography and used to drive servo motors that rotate the camera. This artificial eye is therefore moved by the sensorimotor output of a biological system that evolved over millions of years. It mimics the natural exploration of a visual scene and acquires video sequences from the perspective of a mobile user while the vestibulo-ocular reflex stabilizes the gaze of the camera during head movements and locomotion. A new calibration procedure was developed that eliminates the need for an exact knowledge of the nonlinear function that maps motor commands to camera orientation, allowing to position the camera with an accuracy of 0.54 deg. Mobility was achieved by the development of a lightweight headmount together with miniturized cameras and a custom made mobile computer. Various applications in health care, industry, and research are conceivable.

Poster Sessions

PB-190**Monday 14:00**

Mobile 3D video-oculography.

G. Boening (Ludwig-Maximilians-University Munich, Department of Neurology, Klinikum Grosshadern, Marcionistr.23, 81377 Munich, Germany. E-Mail: GBoening@nefo.med.uni-muenchen.de), E. Schneider, K. Bartl, S. Bardins, T. Dera, T. Brandt

A lightweight mobile video-oculography (VOG) system was developed to allow realtime and mobile measurement of eye movements in 3D. Small infrared(IR) sensitive analog or digital cameras operated at up to 100 Hz were attached laterally to a comfortable head mount. Placing the cameras laterally and using transparent IR mirrors guaranteed an undisturbed view together with high contrast eye-imaging. A principal component analysis was applied to thresholded pupil pixels to identify blinks and other artifacts. The pupil margin was extracted by a contour finding algorithm to robustly determine 2D eye movements. Pigment markers painted on to the sclera were analyzed to detect ocular torsion with an accuracy better than 0.1 deg. The open source software for online VOG image processing was tested on different operating systems. Cheap production of the system is feasible due to low cost components and various price and performance configurations can be realized by choosing different camera models.

PB-191**Tuesday 11:30**

Factors of gaze tracking errors in remote videooculography.

G. Daunys (Siauliai University, Department of Electronics, Vilnius 141, LT-76353 Siauliai, Lithuania. E-Mail: g.daunys@tf.su.lt), N. Ramanauskas, V. Laurutis, D. Dervinis (Siauliai University)

The most comfortable for user are remote video-based eye tracking systems. The method to detect a pupil centre co-ordinates with big accuracy was proposed and tested with synthetical images. The same is not valid for detection of corneal reflection co-ordinates, because its diameter is small. The practical implementation of some video-based head tracking algorithms was carried out in our study. The cross-correlation method was applied to detect small shifts of little areas of subject face. The head translation and rotation movements were detected. The slow head movements are easily separable from eye movements. Most problematically is to remove fast head movements, which arise from subject body tremor. In the most pupil centre tracking data the oscillations of approximately 6 Hertz frequency were obtained. The evaluation of head movements influence to gaze detection was done. The ways to build reliable gaze tracking system are discussed.

PB-192**Monday 14:00**

Scanpaths.org: a central online archive of scanpath data.

S. Nikolov (University of Bristol, Dept of Electrical and Electronic Engineering, Merchant Venturers Building, Woodland Road, BS8 1UB Bristol, UK. E-Mail: stavri.nikolov@bristol.ac.uk), J. Pelz (Rochester Institute of Technology)

We describe the recently created Online Archive of Scanpath Data (Scanpaths.org) located at www.scanpaths.org. Its mission is to provide the research community with a central online repository of scanpath data gathered by different laboratories and companies around the world in various experiments and applications. This data, especially when well documented and available in a common eye-tracker independent format, could be used by researchers to develop new gaze-tracking and visual information analysis algorithms and systems, without having to recreate the experiments carried out to collect the original data. The data in the Scanpaths.org archive will come primarily from experiments dealing with the visual analysis of natural images, video and computer-generated scenes. A complete example data set (Cattaneo, Pelz, et al.) collected during an experiment probing the picture superiority effect is provided on the web site to help prospective contributors structure their data.

PB-193**Monday 14:00**

EyeDataAnalyser - A general and flexible visualisation and analysis tool for eyetracking data files.

K. Essig (Neuroinformatics Group, Faculty of Technology, Bielefeld University, P.O.-Box 100131, 33501 Bielefeld, Germany. E-Mail: kessig@techfak.uni-bielefeld.de), S. Pohl, H. Ritter (Bielefeld University)

The EyeDataAnalyser is a new approach to visualise, analyse and interpret eyetracking data, developed by eyetracking researchers, which provides the same functionality as professional programs. It is designed as an intuitive tool that is optimised to the requirements arising in day-by-day eye-data analysis. A distinguishing feature of the EyeDataAnalyser is its enhanced flexibility, i.e. it can not only handle data files recorded by eyetrackers of different vendors, but it can also be configured to interpret different user-defined messages. It is designed for professional data exploration, but also as a tool that can be used by novices. The program is platform independent. Eye movements can be saved as a real-time or slow motion video that can be integrated into presentation software. Furthermore the recorded eye movements can be overlaid on a video recording of the experiment. Trial related data is stored as text files which can be easily imported into statistics software.

Poster Sessions

PC-194

Tuesday 14:00

Oculomotor responses to moving targets in dyslexia.

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We examined the latency of the first catch-up saccade in age- and IQ-matched adults with and without dyslexia in a step-ramp smooth pursuit (SP) task (amplitude 3°; speed 14°/s). On 50% of trials, a stationary distractor appeared synchronously with, and at the mirror image position to, the SP target. Eye movements were recorded using infrared oculography and analysed offline. In both groups, the percentage of trials in which the first oculomotor response was a saccade in the direction of target motion (as opposed to SP) was greater in distractor trials (combined median 41% vs 6%). The latency of the first catch-up saccade was significantly lower in the dyslexic group (e.g. leftward: 339±80ms vs 376±29ms). In the presence of a distractor, saccade latency was reduced. This reduction was less marked in the dyslexic group (leftward: 53ms; rightward: 41ms) compared to controls (leftward: 74ms; rightward: 98ms). These results are consistent with poorer SP performance in the dyslexic group.

PC-195

Tuesday 14:00

Adaptation of eye saccades in dyslexic children: test of a cerebellar impairment.

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Developmental dyslexia is a learning disability of reading arising despite normal intelligence and suitable environment. Among the different neurobiological hypotheses, a cerebellar dysfunction has been suggested. Our work was aimed at testing this cerebellar hypothesis by studying the adaptation of reflexive saccades triggered by the sudden appearance of a visual target. Indeed, saccadic adaptation, which maintains our eye movements accurate throughout life, represents a sensitive cue of the integrity of the oculomotor cerebellum. By using the double-step target protocol, we induced an adaptive decrease of 17.5° horizontal reflexive saccades. We compared the results obtained in dyslexic children (3 subtypes of dyslexia) with those produced by normal age-matched children. Our study revealed a large variability of abilities of saccade adaptation in the dyslexic group relative to the normal group, suggesting a heterogeneous impairment of the cerebellum in this developmental disorder.

PC-196**Tuesday 14:00**

Top-down and bottom-up effects in pure alexia.

R. Johnson (University of Massachusetts Amherst, Department of Psychology, Tobin Hall, 1003 Amherst, USA. E-Mail: becca@psych.umass.edu), K. Rayner (University of Massachusetts)

Pure Alexia (letter-by-letter reading) is a type of acquired dyslexia in which premorbidly literate individuals have difficulty reading. The primary characteristic of LBL reading is a large increase in naming latency as a function of the number of letters in a word (the word length effect). LBL reading is assumed to be the result of damage to the mechanisms responsible for parallel processing of letters, thus leading to the serial encoding of the component letters in a word. In accord with this assumption, the eye-movement data from GJ (a pure alexic with left occipito-temporal brain damage and right homonymous hemianopia) demonstrates a pattern strikingly similar to normal readers given a one-letter moving window. GJ also exhibits a word-length effect in reading sentences and a sensitivity to word frequency and predictability. These data support an interactive account of reading in pure alexics in which the degraded bottom-up input relies strongly on intact top-down influences.

PC-197**Tuesday 14:00**

Pre- and post-operative search coil recordings in patients with unilateral trochlear nerve palsy.

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Background: So far, the effect of strabismus surgery in patients with trochlear nerve palsy (TNP) has been investigated using subjective methods. Material and Methods: 10 patients with unilateral TNP were measured before, at 1.5 months (5 patients), and at 3 months after strabismus surgery (7 anteropositions IO, 2 SO tucks and 1 IR recession). To evaluate the mean deviation angle and the degree of incomitance 9 different gaze positions were recorded binocularly and 3-dimensionally (torsional, vertical, horizontal) with search coils. Results: Three months post-operatively mean vertical deviation (8.6° to 4.7° ; $p=0.006$; dependent t-test) and vertical incomitance (3.7° to 2.8° ; $p=0.04$) were reduced significantly. Mean horizontal deviation and torsional incomitance also decreased. Horizontal incomitance was unchanged. Conclusions: In patients with trochlear nerve palsy the search coil technique proved that strabismus surgery, despite adding a “new paresis”, reduces vertical incomitance while decreasing mean vertical deviation.

Poster Sessions

PC-198

Tuesday 14:00

Mild head injury: a close relationship between motor function at one week post-injury and overall recovery during the first six months.

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Based on findings that instrumented motor testing after mild closed head injury (CHI) can provide sensitive markers of cerebral dysfunction, this study examined if early motor assessment can provide an indication of outcome after mild CHI. At 1 week post-injury, we assessed oculomotor performance, upper-limb visuomotor function and psychometric status in 37 mild CHI patients. We then examined the relationship between early motor function and outcome at 3 and 6 months (i.e., postconcussional symptoms and performance of everyday tasks) using linear regression. Motor-based regression models were able to explain a considerable proportion of the variance in outcome, with motor function at 1 week relating much closer to outcome at 3 and 6 months than early psychometric assessment, symptom status, or clinical measures of trauma severity. Early motor assessment may considerably improve outcome prediction after mild CHI and help decrease head-trauma-related morbidity and rehabilitation costs.

PC-199

Monday 18:20

Do predictive mechanisms improve angular vestibulo-ocular reflex in vestibular neuritis?

A. Sprenger (University of Luebeck, Dept. of Neurology, Ratzeburger Allee 160, 23538 Luebeck, Germany. E-Mail: Andreas.Sprenger@neuro.uni-luebeck.de), E. Zils, G. Stritzke, A. Krueger, H. Rambold, C. Helmchen (University of Luebeck)

Recovery from vestibular neuritis is often incomplete which leads to persistent vestibular imbalance during rapid head movements. Patients with unilateral vestibular lesions have a larger gain of the horizontal vestibulo-ocular reflex during active compared to passive head movements. To test whether this gain increase is related to predictive mechanisms we studied fifteen patients with vestibular neuritis and fourteen control subjects during predictable and unpredictable passive horizontal head impulses in the light and darkness. The vestibulo-ocular reflex showed a significantly shorter latency and higher gain in the light for predictive head impulses towards the ipsilesional side. However, this effect is small and might contribute but cannot exclusively account for the gain increase during active head movements.

PC-200**Tuesday 14:00**

Impaired visual scan paths in schizophrenia while free regarding daily living scenes.

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Using high-resolution infra-red oculography, we investigated visual scan paths while free regarding photographs of daily living scenes and reflexive saccades in 14 schizophrenic patients and 14 controls. Patients exhibited less fixations but the mean fixation time (FT) was longer than in controls. Furthermore, mean saccade amplitude (SA) was also smaller in the patient group resulting in a shorter total scan path length. In contrast, saccadic accuracy and latency were in the same range in both groups. Prolonged FT in patients may indicate a higher percentage of semantic fixations. As saccadic accuracy and latency were in the normal range the prolonged FT and shorter SA in the patient group are not due to impaired saccade generation or general motor retardation. With fewer fixations and a shorter scan path length these findings may reflect deficient visual information gathering contributing to a misinterpretation of the environment and delusional symptoms in schizophrenic patients.

PC-201**Tuesday 14:00**

Inhibition of Return in left unilateral Neglect: Comparing eye movements and keypress data.

P. Wurtz (University of Bern, Departments of Clinical Research and Neurology, Pavillon 52A, University Hospital Bern, 3010 Bern, Switzerland. E-Mail: pascal.wurtz@dkf.unibe.ch), R. Ptak (University of Geneva), T. Pflugshaupt, R. von Wartburg, Th. Nyffeler, C.W. Hess, R.M. Müri (University of Bern)

Inhibition of return (IOR) denotes the phenomenon that reaction time to visual targets at previously attended locations is slowed, compared to targets appearing at new locations. IOR has been shown to affect both saccadic and manual responses and is thought to enhance the efficacy of visual search by facilitating the orientation towards novel locations. Present research suggests impaired IOR in patients suffering from visuo-spatial neglect after brain injuries. This may partly account for their ineffective visual exploration behavior. This study investigated the time course of IOR in manual and oculomotor responses of neglect patients. The results suggest that neglect patients do - similar to healthy controls - show IOR, which develops more quickly for saccadic responses than for manual responses. Thus saccadic responses can be inhibited while manual responses are still facilitated. However, neglect patients have a more pronounced facilitation at short stimulus onset asynchronies.

Poster Sessions

PC-202

Tuesday 14:00

Hypervigilance–avoidance pattern in spider phobia.

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Cognitive-motivational theories of phobias propose that patients' behavior is characterized by a hypervigilance–avoidance pattern. This implies that phobics initially direct their attention towards fear-relevant stimuli, followed by avoidance that is thought to prevent objective evaluation and habituation. However, previous experiments with highly anxious individuals confirmed initial hypervigilance and yet failed to show subsequent avoidance. In the present study, we administered a visual task in spider phobics and controls, requiring participants to search for spiders. Analyzing eye movements during visual exploration allowed the examination of spatial as well as temporal aspects of phobic behavior. Confirming the hypervigilance–avoidance hypothesis as a whole, our results showed that, relative to controls, phobics detected spiders faster, fixated closer to spiders during the initial search phase and further from spiders subsequently.

PC-203

Tuesday 14:00

Dynamic visual acuity and eye movements.

A.I. Kubarko (Belarus State Medical University, Human Physiology Department, Derzhinsky ave.83, 220798 Minsk, Belarus. E-Mail: kubarko@bsmu.by), Y. Kubarko (Minsk City Hospital ?9)

Dynamic visual acuity (DVA) for moving Landolt rings (MLR) tracked by eye movement and DVAF for MLR during gaze fixation was evaluated. Sensory vision and oculomotor functions were tested also. The control of direction, velocity, size and other parameters of MLR optotypes movement, as well as the synchronization of the oculo-grafic eye movement recording with MLR, was carried out with the original computer software. The study was performed in 83 healthy subjects and in 179 patients with different neurological diseases. The resolution threshold was in the range of 62-67 deg/s for DVA and 24-28 deg/s for DVAF in healthy subjects. DVA reduction was often found in the study patients compared to healthy subjects. Our results indicate that DVA has diagnostic value for screening patients with deterioration of brain function. The possible reasons for decreases in DVA are perceptual and sensor sensitivity impairment, as well as different types of eye movement disorders revealed by oculo-graphy.

PC-204**Tuesday 14:00**

Esotropia related to idiopathic intracranial hypertension. Is an intervention needed?

J. Bandyopadhyay (senior house officer, University Hospitals Coventry, Stoney Stanton Road Coventry, cv14fh coventry, united Kingdom. E-Mail: jayasis@aol.com), V. Hegde (Aberdeen Royal Infirmary), F. Dean (University Hospitals Coventry)

Methodology: Observational case series of 3 patients presenting at a paediatric ophthalmology clinic in a year diagnosed with idiopathic intracranial hypertension (IIH) and esotropia. Patients selected from an existing database of IIH of at a tertiary teaching hospital in UK. Ophthalmology, orthoptic and paediatric assessment was done. Diagnostic and therapeutic lumbar puncture was carried out in all. Radiological imaging of the brain and orbits was carried out. All patients received oral acetazolamide Results: Patient demographics ranged 3.5 to 14 years .Ophthalmic examination was unremarkable in all except papilloedema. Bilateral LR weakness in one and unilateral LR weakness in 2 patients were seen at presentation. 1 patient had to be fitted with Fresnel prism to overcome AHP and relieve diplopia. Esotropia resolved within 3 months in all although disc oedema/field changes showed a slow improvement. Conclusion: Esotropia caused by IIH in children resolves rapidly after normalising the intracranial pressure and by and large does not require any intervention.

PC-205**Tuesday 14:00**

The association of vestibulo-ocular reflex (VOR) cancellation and smooth pursuit: A study using patients with abnormal smooth pursuit.

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During head rotation, the VOR generates compensatory eye movements to stabilize gaze. At times, it is desired to track an object using combined eye-head tracking and in so doing the VOR mechanism must be overridden (cancelled). It is still unclear whether the VOR can be suppressed or an opposing smooth pursuit eye movement is activated. In order to address this issue, we measured eye movements in patients known to have saccadic smooth pursuit. We evaluated eye movements in Spinocerebellar ataxia type 3 (SCA-3), Episodic ataxia type 2 (EA-2) patients and in normal subjects using the magnetic search coil. During passive whole body rotation subjects were required to track either a stationary target (VOR) or a target which moved along with body rotation (VOR cancellation). Results show that in contrast to the saccadic smooth pursuit, gaze motion during VOR cancellation was relatively smooth. Thus, overriding the VOR mechanism can be carried out not only by activating smooth pursuit.

Poster Sessions

PC-206

Tuesday 14:00

Voluntary monocular smooth pursuit eye movements: A case study.

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We report a case study of a neurologically intact subject who demonstrates an ability to make smooth pursuit eye movements with one eye while keeping the other eye relatively stable. Her binocular coordination is intact, and she does not dissociate the two eyes spontaneously. We presented her with either a horizontally or vertically moving target and asked her to track it with left, right, or both eyes. She was able to follow the horizontally moving target monocularly; the x-coordinates of the moving and stabilized eye position samples differed significantly from each other. However, this was not case for the y-coordinates when the target was moving vertically. We also recorded her voluntary monocular smooth pursuit eye movements in the absence of a moving target. Both the x- and y-coordinates of left and right eye demonstrated a discrepancy. We will also report an fMRI study comparing her neural activity during programming of monocular versus binocular smooth pursuit eye movements.

PC-207

Tuesday 14:00

Anti-saccade performance in patients with schizophrenia: A model.

O. de Wilde (Academic Medical Center Amsterdam, Psychiatry, Tafelbergweg 25, 1105 BC Amsterdam, Holland. E-Mail: o.dewilde@amc.uva.nl), L. Bour, P. Dingemans, T. Boeree, D. Linszen (Academic Medical Center Amsterdam)

Anti-saccade performance is impaired in patients with schizophrenia compared to healthy controls. In the present study we investigated whether anti-saccadic performance can be used as an endophenotype for schizophrenia by studying unaffected siblings. We also studied the relationship of anti-saccadic performance with other cognitive functions. We confirmed that anti-saccade performance of schizophrenic patients is impaired. However, the difference between unaffected siblings and healthy controls was not significant. In siblings and patients, anti-saccadic performance was correlated with processing speed. Only in patients anti-saccadic performance was correlated with working memory function. The latter finding suggests a possible degenerative process in patients with schizophrenia after disease onset. Finally, a neuro-biological model will be presented to understand the findings of anti-saccadic performance in patients with schizophrenia and their siblings.

Characteristic eye movement and gaze in Alzheimer disease during visuospatial sequential working memory task.

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In Alzheimer's Disease(AD), working memory deficit is observed at early stage, and in this study visuospatial sequential working memory of AD is tested by our new developed computer soft using touch-panel display. We studied how to get visual information and use it for doing performance by recoding eye movement. It helps us to understand AD working memory deficit and the point of therapy for AD patients. We used EMR-8(NAC image Technology Inc.) to record the eye movement and gaze of them and age-matched controls when they performed the touch-panel computer task which was to touch the colored cell(3-6 divided) in the same order as it colored on the touch-panel screen. AD patient's eye movements were less during cells colored and his gaze was fixed on the screen point. When he touched the cell, his gaze located out of the right cell, and his gaze time prolonged more and his eye movements were less than the control. It suggested that AD patient working memory deficit was influenced not only his memory loss but also his disorganized gaze control.

Poster Sessions

PD-209**Tuesday 14:00**

Fixating the inside edge: How amateurs benefit from visual strategies found among professional racers.

Ph. Sury (University of Bern, Department of Psychology, Muesmattstr. 45, 3012 Bern, Switzerland. E-Mail: philipp.sury@gmx.ch),

Land (2001) described the visual strategy of a Formula 3 racing driver and how he fixated the tangent points on the inside edges of the curves to verify and modify his racing line. In this experiment simulating a mountain pass road it was investigated if naïve amateur drivers employ the same visual strategy when being initially left with no specific visual strategy. In a second and third drive subjects were specifically instructed to fixate the tangent points of either the inside or the outside edges to investigate the connection between fixated tangent points and crash rates in various types of curves. The results of this study are to be presented at ECEM13.

PD-210**Tuesday 14:00**

Eye movements in virtual environment navigation: An approach to landmark recognition.

Y. Jin (University Tübingen, Dept. of Cognitive Neuroscience, Auf der Morgenstelle 28, Tübingen, 72076 Tübingen, Germany. E-Mail: yu.jin@uni-tuebingen.de), S. Gillner, H. A. Mallot (University Tübingen)

By studying eye movements, we have the opportunity to come closer to covert cognitive processes via objective, overt measurement. Eye movements were recorded when subjects performed a navigation task in a desktop VR environment. Landmarks and distractors have matched visual properties. But unlike landmarks, distractors contain no spatial information. The purpose of this study is to compare eye movement patterns towards landmarks and distractors. Data clearly showed that subjects directed gaze more often to landmarks and duration was longer. Additionally in different experiment conditions, an object gained more gaze-fixation and had longer duration when it was used as a landmark. Subjects selectively directed gaze towards important information (landmarks), rather than viewing the scene randomly. Different eye movement patterns can not be accounted for by the object visual appearance, but are due to its function either as landmark or as distractor in the navigation task.

PD-211**Monday 10:30**

Attentional effectiveness of iconic warning labels in tobacco advertising analyzed by eye-tracking techniques.

A. Crespo (National Distance University of Spain, Eye Movements and Pupillometry Laboratory, C/ Juan del Rosal, 10, 28040 MADRID, SPAIN. E-Mail: acrespo@psi.uned.es), R. Cabestrero, A. Barrio (National Distance University of Spain)

Although research on eye movements may help us to objectively test whether warning labels in tobacco advertisements are visually attended, an experimental eye-tracking approach has remained unusual in the field of tobacco control. A new strategy to dissuade people from this addictive behaviour involves the use of iconic images along with impacting messages. The experimental study here reported offers evidence about the effectiveness of the use of the new full-colour vivid images used as warning labels to capture viewers' attention using an eye-tracking technique. Results offer new evidence about the effectiveness of these new warning labels as visual cues to capture viewers' attention, using an eye-tracking technique. In addition, attentional differences between smokers and non-smokers during visual exploration of warnings are also discussed. Results obtained are encouraging and offer new empirical evidences that do not fully agree with previous research in this field.

PD-212**Monday 14:00**

Interview-based eye movement analysis in consumer behavior research.

S. Unno (University of Keio, Faculty of Environmental Information, 2-27-21, Nogata, Nakano-ku, 165-0027 Tokyo, Japan. E-Mail: t04141su@sfc.keio.ac.jp), Y. Kato, D. Yamaguchi, M. Nakagawa, A. Kawakita, K. Esashi, C. Kaneko, M. Shiosawa, R. Takahashi, K. Isoda, S. Takeuchi, M. Nishida, R. Fukuda, T. Fukuda (University of Keio), M. Moriguchi (Coca-Cola Japan)

Interviews and eye tracking studies are both used in the analysis of consumer behavior. However, they have rarely been used in conjunction. We combine these methods to produce a comprehensive analysis of consumer behavior. Subjects' eye movements were monitored with a head-mounted camera while selecting a bottled drink from a convenience store drink section reproduced in our laboratory. Subjects were subsequently shown their eye movement video and interviewed about their visual search strategies. The data revealed four phases in the purchase decision process: (1) observation of products, (2) search for a certain product, (3) comparison with other products, and (4) deciding on a product. The eye tracking data showed a distinct visual search pattern corresponding to each phase. We propose more effective marketing strategies, such as new display arrangements in stores, which are tailored to the observed selection process.

Poster Sessions

PD-213

Tuesday 14:00

Research on effective arrangement of beverages in convenience store through eye movement analysis.

Y. Kato (University of Keio, Faculty of Environmental Information, Endoh 5322, 252-8520 Fujisawa, Japan. E-Mail: t01521yk@sfc.keio.ac.jp), S. Takeuchi, R. Fukuda, T. Fukuda (University of Keio), M. Moriguchi (Coca-Cola Japan)

The arrangement of how the beverages are placed in a Japanese convenience store does not have any particular rule. To propose an effective way to arrange the inside of a refrigerator, we acquired an eye-movement data of a consumer through an experiment and analyzed the data with new approach. Eye movement of a subject was recorded by head mounted device while selecting a drink from a convenience store drink section reproduced in our laboratory. After that, the subject was shown their eye movement video and was interviewed about their eye movement. We analyzed the data by calculating the eye movement data, by drawing the path of the eye movement with an illustrating program, and by recording the fixation data of each subject. The eye movement data revealed that the center of each row, and third and fourth row of all refrigerators had high rate. Furthermore, the fixation data showed an interesting relevance with the eye movement data.

PD-214

Tuesday 14:00

Eye movements during purchasing from a vending machine.

J. Miyakawa (Keio University, Faculty of Environmental Information, 5322 Endoh, 252-8520 Fujisawa-Shi, Japan. E-Mail: t02879jm@sfc.keio.ac.jp), N. Takahara, R. Fukuda and T. Fukuda (Keio University), M. Moriguchi (Coca-Cola Japan)

The aim of this study was to investigate eye movements during drink selection from a vending machine. Specifically, the relationship between attention to product and purchase choice was studied. According to AIDMA theory (Attention, Interest, Desire, Memory, and Action), getting consumers' attention is the first step in a purchase. However, displays on vending machines typically lack coherent organization, with little thought given to the placement of the product. In this study, eye movements were recorded while subjects were looking at a soft drink vending machine. Subjects were told to begin by fixing their gaze at the middle of the stimulus, and then search for the product they wanted to buy. Analyses of eye movement showed that the subjects' eyes tended to move either right or left rather than up or down. These results suggest that positioning products horizontally will have the greatest impact on purchasing behavior.

PD-215**Tuesday 14:00**

Visual behaviour during manual assembly tasks.

T. Dukic (National Institute for Working Life - West, West, P.O. Box 8850, SE-402 72 Gothenburg, Sweden. E-Mail: tania.dukic@arbetslivsinstitutet.se), T. Falkmer (Linköping University)

In manufacturing industries, where most of the tasks are still manual, visual demands are important factors in order to achieve working in good body postures and performing the work with a high quality. In order to design workplaces in accordance with workers' visual behaviour and capabilities, there is a need to actually identify these visually demanding tasks. The aim of this study was to identify assembly workers' gazing during the performance of their manual work, in order to improve workplace design taking workers' visual needs into account. Five visually demanding assembly tasks were selected. Workers' eye movements were recorded with a head mounted system, SMI iView, using infrared cameras to capture the positions of pupil and the corneal reflex sampled at 50Hz. The analysis focused on fixations data and on the time span between action of the different limbs (head, hands) and eye movements.

PD-216**Monday 10:10**

Visual search and behavioral characteristics during purchasing.

N. Takahara (Keio University, Graduate School of Media and Governance, 5322 Endoh, 252-8520 Fujisawa-Shi Kanagawa, Japan. E-Mail: naocot@sfc.keio.ac.jp), K. Miyazaki, Y. Kato, M. Niikura, M. Nakagawa, S. Unno, F. Kaihara, T. Fukuda (Keio University), N. Itoh (National Institute of Advanced Industrial Science and Technology)

Despite the importance of having an in-depth understanding of consumer psychology, there are few experimental studies on how human perception and physical movements relate to purchasing behavior. The aim of this study is to reveal the association of visual search and behavioral characteristics during purchasing. Seven female subjects wore a cap-mounted eye camera and were asked to browse and then buy magazine at a bookstore. The subjects were given instructions to act as they usually would. Their sequences of movements were recorded by stationary and following (chasing) video cameras. Afterwards, the subjects were shown videos of their purchasing behavior and interviewed about their thoughts during different actions. Data analyses revealed several associations of eye movements to head and body movements, some of which are patterns unique to purchasing behavior. From these results, the relationship between visual search and body movement during purchasing are discussed.

Poster Sessions

PD-217

Tuesday 14:00

Visual search behaviour in fracture detection and localisation in plain radiographs.

J. Leong (Imperial College London, Department of Surgical Oncology and Technology, 10th Floor QEQM, St Marys Hospital, W2 1NY London, United Kingdom. E-Mail: j.leong@imperial.ac.uk), M. Nicolaou, R. Emery, X-P. Hu, A. Darzi, G-Z. Yang (Imperial College London)

Error in interpreting radiographs is estimated as 1.5%. This study aims to correlate visual search pattern with performance by using eye tracking for fracture detection. The Tobii 1750 Eye Tracker was used for obtaining scan-path data. 31 digital skeletal radiographs were displayed. Five groups of radiologists and orthopaedic surgeons with differing experience were asked to identify the fracture(s). We found no significant difference between times; but Consultants were superior, with higher number of True Positive and lower False Positives and False Negative. The median dwell time for identified fracture was lower in Consultants. Two distinctive stages of search were found when the distance of fixation from fracture is plotted against time. This pattern appears less frequently in the Junior Resident groups and in missed fractures. Higher performance was reflected by increased dwell time away from fractures, and a distinctive two phased search pattern.

PD-218

Tuesday 14:00

Inferring processing styles from eye movements in information search task.

J. Simola (Helsinki School of Economics, Center for Knowledge and Innovation Research, P.O.Box 1210, FIN-00101 Helsinki, Finland. E-Mail: simola@hkkk.fi), J. Salojärvi, K. Puolamäki (Helsinki University of Technology), I. Kojo (Helsinki School of Economics)

We recorded participants' (N=11) eye movements in an information search task. First, they saw a question, and then a list of 10 online newspaper titles. From the set of ten titles, one was the correct answer (C), five were irrelevant (I), and four were known to be relevant (R) to the topic of the question. Analysis of eye movement data with hidden Markov models revealed different reading styles characterizing the processing of the relevance classes (C, I or R). When irrelevant (I) titles were read, the processing time (sum of fixation durations) of words was short, and there was a high probability to jump to an unread line. When the correct answer (C) was read, the processing time was longer, and typically there were more than one fixation per word. There was also a high probability that participants ended the trial when they had encountered the correct answer. Our results indicate that more careful processing strategy was adopted when the correct line was processed.

PD-219**Tuesday 14:00**

Understanding banner blindness: Using eye tracking to improve web site design.

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Banners, as a main form of advertising on the web, are important for businesses, who want to improve their site's usability for sales, productivity and proficiency. Conversely customers want to navigate the site without being distracted by irrelevant or annoying ads. Design and placement of banners is not well understood and their ineffective use can lead to "banner blindness" which occurs when users overlook the banner entirely. Our study used eye tracking to investigate the elements of banner content and task relevance that may counter banner blindness. Banner content variables included background complexity and color, animation, and presence or absence of elements such as a human face and price tag. Eye movements were gathered for users performing several tasks and viewing banners in a task-free context. Different banners were counterbalanced with task order. Findings on viewing behavior and user preference based on both questionnaires and eye tracking analysis will be presented.

PD-220**Wednesday 10:30**

Differences of qualitative and quantitative load on pupil size using a word memory task.

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The role of resources activation during different phases of processing has been broadly analysed using pupil dilations. A great amount of evidences have been added to the theoretical corpus relating pupil size with the cognitive load. Not many works have been carried out addressing the response of pupillary system before two different types of load: Qualitative (difficulty) and Quantitative (amount). Pupil size of 18 participants was recorded during an auditory word span task. Two different factors were manipulated: number of words to be remembered (4 or 8) and its difficulty (high and low word frequency). A big effect of the quantitative load is observed. In addition the qualitative load effect was also observed but in a smaller amount. That indicates that the pupillary response is sensible mainly to the demands of the task but in a lower extent react as a consequence of the difficulty. The qualitative effect seems to appear only when the demands of the task are not overwhelming.

Poster Sessions

PD-221

Tuesday 14:00

Visual strategy over time to explore a work of art.

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Visual trajectory in 3 paintings (Goya, Matisse, and Mathey) was studied over 5, 30 and 60 sec., on 15 subjects. Eye movements (Tobii 1750), emotion, first glance, and details were analyzed. There is dissociation between: first fixation and subject's notion of first vision (the shorter the discovering time, the better is the evaluation - correct evaluation 37.77%). Subjects confuse first glance with longest fixation, movement, major zone of interest (ZI), and emotional spot. There is no correlation between memory of details and time. 5 subjects did not encode observed details. Number of ZI is not proportional to the time. Emotion is not correlated to the time. First fixation is a landing period (62.23 %), before path decision. Saccades' direction is equally distributed at the 4 cardinal points. Matisse has the lowest fixation time average, confirming that duration increases with task's difficulty.

PD-222

Tuesday 14:00

Gaze tracking using a webcam.

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A system for text entry of a handicapped person was presented earlier, where the person could move a cursor when touching three different buttons when tilting the head. This system needs to be replaced by a gaze recognizer. We present a non-intrusive gaze tracker which detects five different gaze directions. The system uses an ordinary webcam for image capture and an infrared light for illumination. As an infrared filter is mounted in front of the lens, the system runs stable at almost any lighting conditions. The system has been tested on several sequences of the handicapped person and it shows good recognition rates.

PE-223**Tuesday 14:00**

Eye movements during scene viewing: The influence of viewing task and image repetition.

R. von Wartburg (University of Bern, Dept. of Neurology and Dept. of Clinical Research, Inselspital, 3010 Bern, Switzerland. E-Mail: roman.vonwartburg@dkf.unibe.ch), T. Pflugshaupt, P. Wurtz, T. Nyffeler, R.M. Müri (University of Bern)

The influence of the two factors “viewing task” and “stimulus repetition” on various oculomotor measures was assessed. Eye movements were tracked during repeated viewing of scene images under different instructions (free viewing, recognition, memory task). Both factors were found to independently influence fixation durations and saccade amplitudes. The analysis of the spatial fixations patterns yielded the following main results. (1) Comparing the first and second viewing of an image, a significant occurrence of repeated sequences (scanpaths) was found, which was independent of viewing task. (2) However, when disregarding sequence information, the similarity of fixation patterns between first and second viewing was significantly affected by the task. (3) Inter-observer similarity of fixation patterns was also dependent on both task and repetition. These results have theoretical implications regarding subjects’ viewing strategies, but also bear on methodological questions.

PE-224**Tuesday 14:00**

Size matters: Saccades during image viewing.

R. von Wartburg (University of Bern, Dept. of Neurology and Dept. of Clinical Research, Inselspital, 3010 Bern, Switzerland. E-Mail: roman.vonwartburg@dkf.unibe.ch), T. Pflugshaupt, P. Wurtz, T. Nyffeler, R.M. Müri (University of Bern)

Over a wide range, it is not more difficult for the oculomotor system to program and execute long saccades rather than shorter ones, so that it is more economical to move the eye by a single long saccade instead of several small ones. It seems thus plausible to hypothesise that their amplitudes depend on object spacing in a stimulus display; if an image is scaled to different sizes, amplitudes can be expected to vary proportionally. Nevertheless, it has been argued by prominent researchers in the field that mean amplitudes range between 2 and 4° independently of scene size. To our knowledge, how saccade amplitudes are influenced by scaling scene images to different sizes has not been investigated yet. Based on a large data set, we show that mean amplitudes indeed vary with image size, as well as median amplitude and std. deviation. However, the mode invariably remains at 1°. We argue that solely documenting mean values insufficiently describes the distribution of saccade amplitudes.

Poster Sessions

PE-225

Tuesday 14:00

Eye movements in episodic scene memory.

L. Holm (Umeå University, Psychology, Beteendevetarhuset, Umeå universitet, 901 87 Umeå, Sweden. E-Mail: linus.holm@psy.umu.se), T. Mäntylä (Umeå University)

Previous research has been inconclusive as to the role of eye movements in episodic scene recognition. We investigated the role of eye movements in scene recognition by focusing on perceptual reinstatement. In two scene recognition experiments, eye movements were registered during study and test. We obtained experimental control over number of fixations during study and test by means of a gaze contingent paradigm. In experiment 1, participants indicated their recollective experience at test as based on explicit recollection and familiarity respectively. In Experiment 2, participants made old / new decisions and confidence judgments at test. Eye movement consistency across study and test differentiated recollective experience and confidence ratings. Specifically, explicit recollection and high confidence responses were characterized by a higher consistency than familiarity-based and low confidence responses.

PE-226

Tuesday 14:00

First saccades land close to the animal in the scene.

H. Kirchner (CNRS, Centre de Recherche Cerveau et Cognition, 133 route de Narbonne, 31062 Toulouse, France. E-Mail: holle.kirchner@cercu.ups-tlse.fr), D. Kerzel (Université de Genève), S.J. Thorpe (CNRS)

Ultra-rapid categorisation studies have analysed human responses to briefly flashed, static natural scenes in order to determine the time needed to process different kinds of visual objects. In the present study two photographs were simultaneously presented for 600 ms on either side of fixation, only one of which contained an animal. When five experienced subjects were asked to precisely look at the animal, they showed remarkably good performance (90%) with a sharp latency distribution (mean = 185, SD = 38 ms). For about half of the images we used, the animals occurred slightly off the centre of the images ($> 1^\circ$), but this induced more variability in the landing positions of the first saccade than when the animal was centred. This suggests that at the time of animal detection information about its precise location may be rather vague. Further experiments will be needed to determine whether localisation accuracy depends on the scene layout and how it develops over time.

PE-227**Tuesday 14:00**

Eye-tracking while processing written words and images: Interaction and competition between types of representation.

I. Hub Faria (Faculdade de Letras da Universidade de Lisboa, Laboratório de Psicolinguística, Alameda da Universidade, 1600-214 Lisboa, Portugal. E-Mail: ihfaria@fl.ul.pt), A. Baptista, P. Luegi, C. Taborda (University of Lisbon)

Does the processing of written material interact with the visual processing of a scene? If so, what counts as prominent, to be kept in memory? We presented 3 sets of pictures (with and without captions) as eye movements were monitored. Participants were instructed to carefully observe the images, and, at the end of each set, recall and provide written descriptions of what they had seen. We obtained four primary results: written material, acting as an intrinsic property of a scene, interacts with the visual processing of the scene; better recall descriptions of images without captions correlated with a larger number of fixations and higher mean fixation durations; descriptive captions compete with the information contained in the image; when the caption refers to the visual focus of the image, participants produced a higher number of fixations in the image than in the caption. With a caption focusing a sub-part of the image, they made more fixations on the caption than on the image.

PE-228**Tuesday 14:00**

The daily look in the mirror: Preference ratings and eye movements on self and others' portraits.

M. Loertscher (University of Bern, Department of Psychology, Muesmattstr. 45, 3000 Bern 9, Switzerland. E-Mail: miloe@bluewin.ch), N. Hofer, F. Notter (University of Bern)

People often dislike pictures of themselves, while others consider the same portrait as good. This might be due to a mere-exposure effect, as people are more familiar with their mirror image than with their own non-reversed picture. No such difference should be found for unfamiliar faces. Previous research on prosopagnosia patients as well as neuroimaging studies have shown that the brain regions involved in face recognition are dominantly located in the right brain hemisphere. This leads to the assumption, that subjects pay more attention to the left visual field. The present study tested if the functional asymmetry is reflected in eye movements and if there is a preference for ones own mirrored image. As expected, significantly more fixations were made on the left side of the portraits and a tendency to direct the first saccade to the left was found. Additionally, subjects favoured their own mirror-reversed portrait, while there was no such preference for pictures of others.

Poster Sessions

PE-229

Tuesday 14:00

How designers and consumers view a product during memorizing?

S. Sharmin (University of Tampere, TAUCHI-unit, Department of Computer Sciences, Kanslerinrinne 1, FIN-33014 Tampere, Finland. E-Mail: Selina.Sharmin@cs.uta.fi), H. Rantala, K. Koivunen, K.-J. Rähkä (University of Tampere)

Gaze paths are affected by several factors, such as motivation, target, and characteristics of viewers. An eye movement study was carried out to evaluate perception of different design products presented as pictures to 20 participants (10 designers, 10 consumers) in five tasks. Participants evaluated aesthetics, usability and durability of the products along with free observation and memorizing. In the memorizing task, participants were instructed to memorize the products displayed for 10 seconds and answer a question regarding the characteristics of the product. Statistical analysis of gaze data showed that fixation count was significantly higher for designers than consumers while perceiving products during memorizing ($t = -2.141$, $df = 18$, $p < 0.05$). Consequently, mean fixation duration for designers was lower than for consumers. Designers might tend to obtain as much information as possible in shorter time with higher fixation count to memorize objects.

PE-230

Tuesday 14:00

Eye movements and EMG while social interaction with virtual anthropomorphic characters.

S. Pannasch (Dresden University of Technology, Applied Cognitive Research / Psychology III, Mommsenstrasse 13, 01062 Dresden, Germany. E-Mail: pannasch@applied-cognition.org), L. Schilbach, J.R. Helmert, S.T. Graupner, B.M. Velichkovsky (Dresden University of Technology), A. Mojzisch (Georg-August-Universität)

In an fMRI study Schilbach et al. presented virtual characters that appeared moving on-screen, turned either towards the subject or towards an invisible person besides him and then exhibited facial expressions that were judged as socially relevant or as arbitrary. A close relation between the activity of different brain regions and the degree of involvement in social interaction was reported. In this replication we used the paradigm to measure eye movements and EMG for a temporally more detailed analysis of ongoing processes. Subjects eye and facial movements showed that the intensity of visual attention is specifically related to the fact of eye-to-eye contact with a virtual other. Results reveal a clear-cut difference in visual attention depending on involvement of first vs. third person perspective on the part of the observer. Schilbach, L. et al. (2004). On Being With Others: Neural Correlates of Social Interaction. 10th Annual Meeting of the Organization for HBM 2004, Budapest.

PE-231**Tuesday 14:00**

Context effects on the visual scanning of social scenes

E. Birmingham (University of British Columbia, Psychology, 2136 West Mall, V6T 1Z4 Vancouver, Canada. E-Mail: ebirmingham2@yahoo.ca), M. Yanko, A. Kingstone (University of British Columbia), W. F. Bischof (University of Alberta)

We have recently suggested that in order to understand how attention operates in the real world, researchers need to study how attentional allocation varies with the situation or context. Instead of attempting to reduce the variance that accompanies changes in context, we chose to observe and describe this variance. Specifically, we asked how task influences where observers direct their attention within pictures of social and asocial scenes. We eye monitored observers while they viewed various scenes (e.g., an empty room, rooms with objects, and rooms with people) and performed different tasks (free-viewing, describing, and inferring attentional states). We found that task had a significant impact on not only on the distribution of fixations across the scenes, but also on the transitions observers made between different regions of the scene. The data are novel with respect to how people process information in scenes under differing task demands, and with different scene types.

PE-232**Tuesday 14:00**

Objects capture perceived gaze direction.

J. Lobmaier (Cognitive Neuroscience, Department of Psychology, Treichlerstrasse 10, 8032 Zürich, Switzerland. E-Mail: j.lobmaier@psychologie.unizh.ch), M. Fischer (University of Dundee), A. Schwaninger (MPI Tuebingen)

The interpretation of another person's eye gaze is a key element of social cognition. Previous research has established that this ability develops early in life and is influenced by the person's head orientation, as well as local features of the person's eyes. Here we show that the presence of objects in the attended space also has an impact on gaze interpretation. Eleven normal adults identified the fixation points of photographed faces with a mouse cursor. Their responses were systematically biased toward the locations of nearby objects. This capture of perceived gaze direction probably reflects the attribution of intentionality and has methodological implications for research on gaze perception.

Poster Sessions

PE-233

Tuesday 14:00

Sentence production in the wild-data from Danish soccer commenting.

P. Diderichsen (Lund University, LUCS (Lund University Cognitive Science), Kungshuset - Lundagard, S-222 22 Lund, Sweden. E-Mail: philip.diderichsen@lucs.lu.se),

Griffin and Bock (2000) suggest that the production of simple descriptions of static pictures proceeds in a cascade with an initial short phase of scene conceptualization followed by overlapping incremental formulation and articulation phases. If there is indeed such a conceptualization phase then agents in passive constructions without a substantial patient/subject should receive more visual attention during this phase when an agent will be uttered in the construction than when an agent-less passive construction is about to be produced. This hypothesis was tested using real life data from a Danish soccer commentator whose eye movements were being recorded while commenting a soccer match on live radio. Even in this setting the results of Griffin and Bock were replicated. There was evidence for both the conceptualization phase and incremental lexical activation. (Griffin Z. M. and Bock K. (2000): What the eyes say about speaking. *Psychological Science* 11 pp. 274-279)

PE-234

Tuesday 14:00

Visual Based Image Retrieval (VBIR) - A new approach for natural and intuitive image retrieval

K. Essig (Neuroinformatics Group, Faculty of Technology , Bielefeld University, P.O.-Box 100131, 33501 Bielefeld, Germany. E-Mail: kessig@techfak.uni-bielefeld.de), H. Ritter (Bielefeld University)

Much research focused on the development of Content-Based Image Retrieval (CBIR) systems which retrieve relevant images from an image database. In a new approach we use an eyetracker as a elegant method for relevance feedback which allows to determine the importance of different image regions for the current retrieval process. This allows a much finer and more natural user feedback process than in common CBIR systems. By increasing the weight of the features in the image regions with many fixations, the retrieval process can be substantially improved. Furthermore the measurement of eye movements give insight into the cognitive processes and applied strategies during image comparison. We call our approach based on eyetracking techniques Visual Based Image Retrieval (VBIR). With the eyetracker, the subject can actively influence the interaction with an image database via the visual behaviour, and therefore the method provides an intuitive navigation technique for huge image repositories.

PF-235**Wednesday 10:30**

Visual search with a limited field of view: influence of scan path and target conspicuity.

M.A. Hogervorst (TNO Human Factors, Vision Group, Kampweg 5, 3769 DE Soesterberg, The Netherlands. E-Mail: hogervorst@tm.tno.nl), P. Bijl, A. Toet

Goal was to develop a human observer model of search with a limited field of view by i) determining the relationship between search performance and scan path (speed, zoom, field size) and target conspicuity, and by ii) characterizing scanning behaviour of trained observers. Subjects (38 trained army scouts) searched (using a joystick) through a large panoramic image of a heath containing a target (a camouflaged person). From trial to trial the target appeared at a different location. The scan path and time to detection were recorded. Four conditions were run differing in sensor type (visual or thermal infrared) and window size (large or small). Detection performance was highly dependent on zoom factor and deteriorated when scan speed increased beyond a threshold maximum. Moreover, the distribution of scan speeds scaled with the threshold speed, indicating that observers are aware of their limitations and choose a (near) optimal search strategy. Search performance (fraction detected, total search time, time in view for detection) was strongly related to target conspicuity. The relationship between the two was found to be the same for visual and thermal targets, indicating that search performance can be predicted by conspicuity regardless of the sensor type.

PF-236**Wednesday 10:30**

Durations of search fixations.

I. Hooge (Helmholtz Instituut Utrecht University, Psychonomics, Heidelberglaan 2, 3584 CS Utrecht, Nederland. E-Mail: i.hooge@fss.uu.nl), B. Vlaskamp, E. Over (Utrecht University), M. Frens (Erasmus University Rotterdam)

Observers usually search by making fixations interleaved by saccades. Search is not effective if fixation times are too short to analyze the fixation area. If fixations last too long, observers spoil time waiting for nothing. How do observers divide their time over the search display? We collected about 400000 fixations in 12 subjects. They took part in a large search experiment (12 conditions) in which target-distracter dissimilarity and separation between the stimulus elements were varied. The main findings are 1) that fixation times are distributed lognormal and 2) that standard deviations of these distributions scale with the mean (slope = 0.4). Our findings are not in agreement with the exponential distributions of Harris et al. (1988). In addition, the LATER model (that predicts recinormal distributions of saccade latencies, [Reddi & Carpenter, 2000]), cannot be generalized to fixation times either.

Poster Sessions

PF-237

Wednesday 10:30

What can patterns of eye movements tell us about the role of memory in visual search?

E.M. Reingold (University of Toronto, Department of Psychology, 3359 Mississauga Road North, L5L 1C6 Mississauga, Ontario, Canada. E-Mail: reingold@psych.utoronto.ca), A. Elahipanah, J. Shen (University of Toronto)

In a series of experiments employing a repeated search of previously fixated displays we investigated the involvement of a memory-based selection mechanism in visual search. . We found a difference in the fixation rate and acquisition time between previously fixated objects and locations and previously unfixated objects and locations. These findings provided strong evidence for a robust effect of memory on search efficiency.

PF-238

Wednesday 10:30

Reporting the penultimate fixation: conscious vs. incidental accessibility.

J.R. Helmert (Technische Universität Dresden, Applied Cognitive Research / Psychology III, Mommsenstrasse 13, 1062 Dresden, Germany. E-Mail: helmert@applied-cognition.org), M. Hofmann, S. Pannasch, B.M. Velichkovsky

Previous studies have shown that when subjects are asked for the content of the last fixation occasionally the content of the penultimate fixation is reported if duration of the last fixation was short (e.g. Tatler). Two studies are presented where participants viewed paintings on a computer screen for about 7 to 10 fixations. At different latencies after onset of the ultimate fixation the picture was removed and a patch generated from one of the last three fixations was presented. In study 1, participants were to decide whether the patch was equal with the last fixation whereas in study 2 the task was related to the penultimate fixation. Results show that conscious access to contents of the penultimate fixation is nearly impossible (study 2) but still incidentally reportable when being asked for the ultimate fixation (study 1). Tatler, B.W. (2001). Characterising the visual buffer: real-world evidence for overwriting early in each fixation. *Perception*, 30(8), 993-1006.

PF-239**Wednesday 10:30**

Switching between pro- and antisaccades: separating switch costs from inhibition of return.

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A substantial body of research has examined the carry-over of inhibition when switching between different tasks. An ideal paradigm for studying this phenomenon in the oculomotor domain is the combination of pro- and antisaccades, as the execution of an antisaccade demands the suppression of the reaction required in the prosaccade task. A disadvantage of the classic experimental setup with targets presented in the horizontal plane is that in most possible sequences there is no neutral position in trial N that has not served as a stimulus or response position in trial N-1. We addressed this issue by using a three factor design with four target positions in trial N-1 as well as two tasks (pro vs. anti) and four target positions in trial N. This yielded 64 different sequences, each of which were repeated 8 times. Results allow us to separate effects of task switching/repetition from inhibition of return effects. These findings may contribute to resolving conflicting evidence in prior work.

PF-240**Wednesday 10:30**

Oculomotor inhibition across the lifespan.

B. Olk (International University Bremen, School of Humanities and Social Sciences, P.O.Box 750561, 28725 Bremen, Germany. E-Mail: b.olk@iu-bremen.de), A. Kingstone (University of British Columbia)

We investigated the effects of inhibition on saccadic latencies and errors in young and elderly participants when performing pro- and antisaccade tasks. The degree to which inhibition was placed on the eye movement system was varied systematically between experimental conditions. In a no inhibition condition, participants were requested to make a prosaccade to a target on every trial. In low-high inhibition conditions, prosaccade trials and trials on which fixation was maintained (10-50% of the trials) were randomised. In low-high inhibition/volitional eye movement conditions, prosaccade trials and antisaccade trials (10-50% of the trials) were randomised. The results show that prosaccade RT and errors are extremely sensitive to changes in oculomotor inhibition – especially for elderly participants – with RT increasing, and errors falling, as inhibition increases.

Poster Sessions

PF-241

Wednesday 10:30

Accuracy of eye movements does not parallel accuracy of attentional movements.

E.M. Fine (Harvard Medical School, SERI, 20 Staniford Street, 2114 Boston, MA, USE. E-Mail: fine@vision.eri.harvard.edu), S. Yurgenson (SY Consulting), C.M. Moore (Penn Sate University)

A tight link between visual attention and eye movements has been posited. It is difficult to move one's attention between closely spaced items, suggesting limited attentional resolution. We tested the limits of saccadic resolution. Observers made one or a series of saccades within homogenous displays of 0.50 deg targets. Saccades spanned n targets or were made sequentially to each of n adjacent targets. Spacing was close (0.75 deg center-to-center) or wide (1.50 deg). A dual-Purkinje-image eye tracker monitored eye position. Final eye position was farther from the correct target location when spacing was wide for all but the single-item saccades. When observers moved only one item away, landing position was on-target in all cases. These findings are inconsistent with our expectations that saccade control would exhibit similar limitations to attentional control, suggesting that the link between discrete movements of attention and eye movements may be looser than previously thought.

PF-242

Wednesday 10:30

Effects of structured backgrounds on saccadic latency.

B. White (Justus Liebig University Giessen, Psychology, Otto Behaghel Str. 10F, 35394 Giessen, Germany. E-Mail: brian.j.white@psychol.uni-giessen.de), K.R. Gegenfurtner (Justus Liebig University), D. Kerzel (University of Geneve)

The remote distractor effect is believed to be caused by stimulation of an extended fixation zone. The superior colliculus is also implicated as the mechanism behind an inhibited saccadic response due to a display change. We examined this further by using a patch of random noise as a distractor while observers made a saccade to a peripheral Gabor-target (4 c/deg), 4, 7 or 10° left or right of fixation. A small (2.3°x2.3°), central patch caused an increase in saccadic latency consistent with typical remote distractors. However a large patch (36°x36°, i.e. background change) did not increase latency despite that it also provided raw stimulation to the fixation region. Latencies also showed a steady decrease as patch size increased from 1.6°x1.6° to 4.5°x4.5°. We conclude that nontarget stimulation of the fixation region is not in itself sufficient to cause an increase in saccadic latency. The results suggest that only a spatially confined element leads to a discharge of fixation neurons.

PF-243**Wednesday 10:30****Effects of switching between leftward and rightward pro- and antisaccades.**

N. Kathmann (Humboldt University at Berlin, Institute of Psychology, Rudower Chaussee 18, D-12489 Berlin, Germany. E-Mail: kathmann@rz.hu-berlin.de), B. Reuter (Humboldt University Berlin), A. Philipp, I. Koch (Max Planck Institute for Human Cognitive and Brain Sciences)

Previous studies suggested that switching between pro- and antisaccade tasks increases errors in both tasks if they are presented in random order. These studies did not control for the effects of switching between leftward and rightward saccades. In the present study subjects switched every second trial (alternating runs procedure) between pro- and antisaccades. In addition, switching between leftward and rightward saccades (response switching) was counterbalanced across tasks and task-switching conditions. Task switching increased errors in both tasks. Response switching increased errors in antisaccade trials that were preceded by antisaccades, but did neither affect prosaccades nor antisaccades that were preceded by prosaccades. The task-shift effects suggest that both pro- and antisaccade trials activate specific production rules that can persist in a subsequent trial. The differential response-shift effects may reflect different modes of response activation in pro- and antisaccades.

PF-244**Tuesday 18:20****The influence of complex distractors in the remote distractor paradigm.**

V. Brown (University of Durham, Psychology, Science Site, South Road, DH1 3LE Durham, UK. E-Mail: Valerie.brown@durham.ac.uk), S.P. Liversedge, J.M. Findlay (University of Durham)

We examined the influence of complex distractors in the Remote Distractor Effect (RDE) Paradigm. Experiment 1 investigated whether linguistic distractors modulated the RDE systematically. Linguistic distractors produced prolonged saccades at central vs peripheral distractor location, but there was no systematic difference between different types of linguistic distractors. Non-linguistic distractors produced equivalent latencies at central and peripheral presentation. This unexpected finding was investigated in Experiment 2, which showed that repeated presentation of a distractor resulted in shorter saccade latencies at central presentation, compared to latencies for distractors that changed on every trial. In Experiment 3 a difference in saccade latencies was obtained between two types of linguistic distractor at an intermediate distractor location. Detailed analysis showed that while saccade onset latencies can be modulated by higher-level cognitive factors, RDE magnitudes are not.

Poster Sessions

PF-246

Wednesday 10:30

Illusory line motion reverses the processing advantage of prosaccades over antisaccades.

T.J. Crawford (Lancaster University, Department of Psychology, Fylde Building, LA1 4YF Lancaster, United Kingdom. E-Mail: t.crawford@lancaster.ac.uk), M. Kean, J. Hamm, R. Klein

The brain requires more time to program an eye movement away from an object (antisaccade) than towards an object (prosaccade). Visual attention has been shown to be critically associated with saccadic eye movements and may be a critical factor in this phenomenon. There is increasing support for the idea that attention can modulate the size of the antisaccade deficit (Kristjansson et al., 2001). Two experiments were conducted using eye movements towards and away from an object. Experiment 1 examined the role of visual attention using illusory line motion, which is known to track an illusory trajectory of a line. On each trial eye movements were either congruent or incongruent with the direction of illusory motion. Experiment 1 demonstrated that the traditional antisaccade deficit was reversed when the saccade was congruent with illusory motion. Experiment 2 demonstrated that the effect cannot be accounted for by any non-specific effects of the paradigm. This demonstrates that an illusory phenomenon can accelerate the processing of an antisaccade and that attention may play a critical role in this process.

PF-247

Wednesday 10:30

Task-irrelevant visual information close to the point of fixation detains the eye.

B. Vlaskamp (Helmholtz Instituut, Universiteit Utrecht, Psychonomics, Heidelberglaan 2, 3584 CS Utrecht, The Netherlands. E-Mail: b.vlaskamp@fss.uu.nl), I. Hooge

In search tasks, fixation duration is found to increase with element density. We examined whether fixation duration depends on the presence of task-irrelevant visual information nearby the search elements. Subjects searched from left to right for a target amongst four horizontally arranged elements. The second (2) and third element (3) appeared either isolated (I) or surrounded by four task-irrelevant elements (S). These 4 conditions (2S/3S, 2S/3I, 2I/3S, 2I/3I) allowed us to examine the dependency of fixation duration on the presence of irrelevant information nearby the foveated element as well as nearby the peripheral saccade target. The irrelevant visual information increased fixation duration drastically (up to 90 ms), but only when it was close to a foveated element. Based on this result and on an additional psychophysical control experiment, we conclude that irrelevant visual information nearby foveated search elements consumes time. Consequently, fixation durations increase.

PF-248**Wednesday 10:30**

Conditions supporting and disrupting the performance of predictive saccades.

M. MacAskill (University of Otago, Van der Veer Institute, PO Box 2682, 8001 Christchurch, New Zealand. E-Mail: michael.macaskill@chmeds.ac.nz), D. Ko, T. Anderson (University of Otago)

When tracking targets stepping between two fixed points at regular intervals, subjects begin to anticipate the target movement. What conditions are required for such prediction to arise? We manipulated the spatial predictability of a target nominally stepping from -10 deg to 10 deg from the midline by applying perturbations from trial to trial. Eight levels of uncertainty (0-8 deg) were crossed with three levels of target duration (750, 1400, 2050 ms) to yield 24 tests of 20 saccades. Eye movements were recorded at 200 Hz in nine healthy subjects. Slower rates of target presentation lead to decreased anticipation of target movement ($F(2,16)=18.1$, $p<0.0001$), as did increased uncertainty ($F(7,56)=5.1$, $p<0.0002$). Small but non-negligible uncertainty (<2 deg) had little effect on latency. Such sub-threshold spatial variability in a temporally predictable target induces saccadic inaccuracy, providing a useful model to test hypotheses of the oculomotor effects of Parkinson's disease.

PF-249**Wednesday 10:30**

Second saccade programming uses actual or intended eye movement signals: Evidence from saccadic adaptation.

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Recent work showed that inter-object saccades are updated according to actual eye position, whereas intra-object saccades are executed as a preplanned motor vector based on object size. In both cases, the on-line control of the next movement could rely on the actual or the intended eye movement signals. Here we distinguish these possibilities by adapting the 1st saccade of a two saccade sequence. We show that the 2nd inter-object saccade programming compensates for the 1st saccade adaptation. Such an updating implies the use of recurrent signals representing either the actual first eye movement or the orbital position. The 2nd intra-object saccade programming relies on the intended eye movement signal, as this saccade does not compensate for the 1st saccade adaptation. Finally, the absence of transfer of the 2nd inter-object saccade adaptation to the 2nd intra-object saccade reinforces the assumption that different signals downstream or upstream from the adaptation site- are used relative to the goal of the next eye movement.

Poster Sessions

PF-250

Wednesday 10:30

Event-related prolongation of fixation duration: Also elicited by acoustic and haptic distractors.

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Presenting two stimuli at the same time one as the target and the other as the distractor, a significant increase of fixation duration is found. This phenomenon is described as distractor effect and most explanations are in relation to changes in the visual modality, e.g. oculomotor reflex. However, we recently suggested an interpretation in terms of the orienting response, since similar results were found with acoustic distractors (Pannasch et al.). In a free viewing picture task, we compared visual, acoustic and haptic distractors. Stimuli of the first two modalities were presented as in the previous study, the haptic stimuli were applied at the index finger as well 100 ms after onset of fixation. Our data indicate not only a prolongation of affected fixations, also a habituation of the effect was found. Pannasch et al. (2001). The omnipresent prolongation of visual fixations: saccades are inhibited by changes in situation and in subject's activity. *Vision Res*, 41(25-26), 3345-3351.

PF-251

Wednesday 10:30

The parallel programming of voluntary and reflexive saccades.

R. Walker (Royal Holloway, University of London, Department of Psychology, Egham, Surrey, TW20 OEX London, UK. E-Mail: robin.walker@rhul.ac.uk), E. McSorley (University of Reading)

This study used a novel two-step saccade paradigm to investigate the parallel programming of consecutive, reflexive (stimulus-elicited) and voluntary (endogenous) saccades. The paradigm required a first reflexive saccade to be made to a peripheral stimulus onset, followed by a second voluntary saccade made to a location specified by a symbolic arrow pre-cue. The paradigm reliably elicited second voluntary saccades after an inter-saccadic interval that was significantly less than the latency of voluntary saccades made in a single-step control condition. The latency of the first reflexive saccades was increased, however, when a second saccade was required in the opposite direction, and decreased when a second voluntary saccade was required in the same direction, as the first step. The results support the view that two saccades (one reflexive stimulus-elicited and one endogenous) can be programmed in parallel (pipelined) in a common motor map.

PF-252**Wednesday 10:30**

The mapping between saccade latency and visual processing time.

C. Ludwig (University of Bristol, Experimental Psychology, 8 Woodland Road, BS8 1TN Bristol, UK. E-Mail: c.ludwig@bristol.ac.uk), I. Gilchrist

We tested whether variability in saccade latency corresponds to variability in time available for visual processing by examining saccadic choice patterns in a contrast discrimination task. Observers indicated which of two Gabor patches was of higher contrast. In Experiment 1 exposure duration was varied to characterise the temporal evolution of the internal contrast response. In Experiment 2 duration was constant, and observers were free to move their eyes. If the latency period corresponds to visual processing time, short latency saccades should be directed to the lower spatial frequency (LSF) patch more frequently than long latency saccades. Saccade latency was varied by manipulating the visibility of the central fixation point (gap versus overlap). The latencies were substantially shorter in the gap condition, but this was not associated with an increased tendency to first look at the LSF. Latency variability does not necessarily map onto variability in visual processing time.

PF-253**Wednesday 10:00**

Target location probability affects saccade accuracy in search: A role for sequential dependencies and implicit learning.

C. Walthew (University of Bristol, Department of Experimental Psychology, 8 Woodland Road, BS8 1TN Bristol, UK. E-Mail: Carol.Walthew@bristol.ac.uk), I. Gilchrist (University of Bristol)

We investigated the effect of manipulating the probability of the target being in a particular location in a search task. In Experiment 1 the target occurred more frequently in either the left or right visual field. The first saccade was directed to the target more often when it occurred in the more frequent locations. This could be a result of sequential dependencies or implicit learning of the spatial probabilities. To investigate whether there were sequential dependencies, in Experiment 2 the target appeared with equal probability at each location. We found strong evidence for sequential dependencies: Performance on the current trial was affected by at least the four preceding trials. In Experiment 3 the target occurred more frequently in either the left or right visual field, but the target location could not repeat within four consecutive trials. The results showed that the advantage for more likely target locations was greatly reduced by this manipulation.

Poster Sessions

PF-254

Wednesday 10:00

Decision-making in computer games: The rubikon model and visual attention.

H. Koesling (National University of Ireland, Maynooth, Department of Computer Science, Maynooth, Co. Kildare, Maynooth, Ireland. E-Mail: hendrik@cs.may.ie), A. Kenny, D. Delaney, S. McLoone, T. Ward (National University of Ireland)

Efficient visual search strategies are important for anticipation and decision-making in complex environments. We investigated if decision-making in First Person Shooter (FPS) games is characterised by the shielding-interruption dilemma: In the pre-decisional phase players process as much information as possible in order to make an accurate decision. According to the Rubikon model they subsequently focus on the implementation of the intended action in the post-decisional phase. Subjects viewed animated sequences of an FPS game. They had to decide which of several opponent game characters to pursue/defend and how to implement their action. Oculomotor data shows a clear distinction between the width of attention in pre- and post-decisional phases (wide and narrow field of view, respectively) and supports the Rubikon model. We also found a considerable lag between goal formation (cognitive Rubikon) and motor response. The lag may be used to improve the anticipatory abilities of FPS games.

PF-255

Wednesday 10:00

Subitizing and slow object counting: Are they the same? Mental chronometry with eye movement.

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Object counting comprises two phases. A relatively fast phase (subitizing), with less than 4 objects, and a slow counting process for greater numerosities, with a higher RT slope when the number of objects is increased. The precise mechanisms underlying this phenomenon are still debated. In the present study the subjects enumerated dots, while the eye movement was registered. First, the detailed eye movement data show that the same fast subitizing mechanism is used in slow counting phase but several times in a trial as the dots are partitioned to smaller (subitizable) subsets. Second, the saccades indicate that the processing of the previous stimuli is over and a new input can be processed. This way the saccades reveal a specific step in the processing stages, enabling us to build a mental chronometry. With these data we propose a detailed temporal model of the subprocesses of slow counting. The model built with eye movement data is highly consistent with some previous ERP results.

PG-256**Wednesday 10:30**

The effect of word frequency and character frequency on the eye movements of Chinese readers.

G.L. Yan (Tianjin Normal University, Research Center of Psychology and Behavior, No.241, Wei Jin Road, He Xi District, 300074 Tianjin, P.R. of China. E-Mail: psyysl@yahoo.com), G.L. Yan, H.J. Tian, X.J. Bai (University of Tianjin Normal University), K. Rayner (University of Massachusetts)

We examined the effect of word frequency and initial and last character frequency on the eye movements of Chinese readers. Thirty native Chinese college students read sentences containing either a high frequency or low frequency word. Each word was 2 characters (which differed in frequency). We found that both word frequency and initial character frequency of the word played important role in the word recognition. Implications for models of eye movements in reading will be discussed.

PG-257**Wednesday 10:30**

Parafoveal word processing in reading chinese sentences.

M.H. Yen (Laboratory for Cognitive Neuropsychology, Institute of Neuroscience, National Yang-Ming Univ, 155, Li-Nong St., Sec.2, Peitou, 112 Taipei, Taiwan. E-Mail: miao@daisy.ym.edu.tw), J.L. Tsai, O.J.L. Tzeng, D. L. Hung (National Yang-Ming University)

Words are viewed as basic units in most models of eye movement control in reading. In written Chinese, there are no boundaries between words, raising the question of how Chinese readers carry out word segmentation. Parafoveal word processing was investigated using the boundary paradigm in an eye movement study in which 25 subjects read sentences for comprehension. A two-character word was embedded in the middle of each sentence as the target. There were three types of preview stimuli, identical word, unrelated real word, or pseudoword. A robust main effect of preview type was observed in all measures. The target was more likely to be skipped with a word preview, even unrelated, compared to a pseudoword preview, suggesting words can be processed parafoveally. The target was fixated longer without identical previews, which may result from difficulty in interfixation integration. We argue that strings of characters can be parsed into words even without direct fixations.

Poster Sessions

PG-258

Wednesday 10:30

The role of word during reading Chinese texts: Evidence from eye movements.

H. Ko (National Central University, Institute of Learning and Instruction, No. 300, Jhonda Road, 32001 Jhongli, Taiwan. E-Mail: hwawei@cc.ncu.edu.tw), M. Chen (National Central University)

Chinese text has no visual indicator of word units. Tsai and McConkie (2003) has suggested that character, rather than word, is the basic unit during reading Chinese text. Yang and McConkie's (1998) study also has found that there is no preferred viewing position of eyes when next word given in reading Chinese. However, on word-superior effect supports that word is the basic unit during reading Chinese text (Cheng, 1981). This study examined whether word or character serves as basic unit of reading Chinese text. Eye movements of readers were recorded as they reading for the purpose of comprehension. Analyses of the first landing position in words were conducted to examine readers' preferred viewing position (PVP). The results show a consistent pattern of readers' PVP on the first character of the two-character words, and the middle position of three- and four-character words. Overall results shows word appears a more critical role when readers comprehend Chinese text.

PG-259

Wednesday 10:30

Optimal landing position in Chinese Idioms reading.

X.J. Bai (Tianjin Normal University, Research Center of Psychology and Behavior, No.241, Wei Jin Road, He Xi District, Tianjin, 300074 Tianjin, P.R. of China. E-Mail: bxuejun@126.com), G.L. Yan, D.L. Shen

The experiment was designed to explore whether the optimal landing position during reading Chinese idioms. Chinese idiom is an unique linguistic type and is composed of four Chinese characters. The subjects who were university students and fixated the first position which was controlled by the experimenter in the first experiment. The subjects were asked to judge the meaning of idioms and their RT was recorded by DMDX system. In the second experiment, the subjects eye movements were recorded by EYELINK when reading sentences that included Chinese idioms. The re-fixation frequency and duration were analysed. The results show there is an optimal landing position that changes with idioms types.

PG-260**Wednesday 10:30**

What orthography does for the eye: Eye movement programming in reading Japanese, Chinese, Korean, and English.

G. Feng (Duke University, Psychology: Social, 206 Kenilworth pl., 27516 Chapel Hill, NC, USA. E-Mail: garyfeng@duke.edu), Y. Lee (UNC Chapel Hill), R. Mazuka, N. Jincho (RIKEN Brain Science Institute)

This study focuses on orthographic influences on the Where and When decisions in reading English, Chinese, Japanese, and Korean. Both E and K are alphabetic and use spaces to mark word boundaries. C and J are non-alphabetical and do not use spaces. While perceptual differences between Kanji and Kana may potentially help to guide eye movements in J, saccade planning in C is still a mystery. Native speakers read engaging novels on a computer. Texts on the screen were shifted left or right at randomly selected saccades during reading (gaze-contingent). If saccades are aimed at specific words, screen shifts should increase corrective eye movements. Distributions fixation duration in 4 languages are remarkably similar. Landing position distributions of E and K suggest both follow a word-based strategy. The C and J data are being analyzed. Current analyses suggest that the WHERE mechanism is more malleable than the WHEN system in adapting to different orthographies.

PG-261**Wednesday 10:30**

The role of eye movements in lateralized word recognition.

J. Hyönä (University of Turku, Department of Psychology, Assistentink. 7, FI-20014 Turku, Finland. E-Mail: hyona@utu.fi), M. Koivisto (University of Turku)

The role of eye movements was examined in lateralized word recognition, where words and pseudowords were presented to the right or left of a fixation point. In the move condition, participants were instructed to launch a saccade toward the target, which was erased from the screen after 100 ms. It was assumed that preparation of an eye movement simultaneously with an attention shift results in attention being more readily allocated to the target. In the fixate condition, participants were asked to fixate on the central fixation point throughout the trial. The data on the lexical decision accuracy showed that word recognition in the LVF benefited from a preparation to make an eye movement, whereas the performance in the RVF was not benefited. The results are consistent with the attentional advantage account (Mondor & Bryden, 1992), according to which the performance deficit of RH for verbal stimuli may be overcome by orienting attention to the LVF prior to stimulus presentation.

Poster Sessions

PG-262

Wednesday 10:30

Reading disappearing text: Is SWIFT able to account for the effects?

E. Richter (University of Potsdam, Psychology, P.O. Box 601553, 14415 Potsdam, Germany. E-Mail: richtere@rz.uni-potsdam.de), R. Engbert

Recently, some reading studies [Rayner et al, PsychSci, 14, 2003 and submitted; Liversedge et al, VisRes, 44, 2004] employed gaze contingent experiments blinding out word n (A) or word n and n+1 (B) 60 ms after the onset of a fixation on word n until the offset of the last subsequent fixation on word n. It has been shown that (A) yielded small effects compared to normal reading whereas (B) had quite disrupting effects. We will demonstrate that SWIFT [Engbert et al, submitted] is able to account for reported data to great detail when equipped with two reasonable assumptions: (i) Preprocessing for withheld words is impeded, (ii) Labile saccade programs are cancelled whenever the display changes [cf. Rheingold & Stampe, JEPHPP, 30, 2004]. In addition, SWIFT predicts further specific effects on different measures of fixation duration and saccade dynamics (e.g. increased incidence of regressions particularly for (B); gaze durations for (A) are only affected via single fixations).

PG-263

Wednesday 10:30

The time-course of the application of binding constraints in pronoun resolution: Evidence from eye-movement.

H. Kreiner (University of Glasgow, Department of Psychology, 58 Hillhead St., G12 8QB Glasgow, UK. E-Mail: hamutal@psy.gla.ac.uk), P. Sturt, S. Garrod (University of Glasgow)

Principle B in the binding theory (BT) accounts for the resolution of pronoun anaphors. The time-course of its application was investigated by recording participants eye movements (EM) while they read texts including pronoun anaphors (him, her). Two characters were introduced before the anaphor, only one was a grammatical antecedent for the anaphor according to BT. Data from early EM measures suggest that mismatching between the gender of the pronoun anaphor and the stereotypical gender of the grammatical antecedent results in processing difficulty, but mismatching with the ungrammatical antecedent has no such effect. However, during later stages mismatching of both types of antecedents affected processing. The results complement those of Sturt (2003) regarding Principle A, and support a two stage model where principles A and B act as an early but defeasible filter. This model is discussed with regard to the notion of bonding and resolution as distinct processes (e.g. Garrod, 1994).

Inference in context – effects of support and distance on reading.

M. Michael (University of North Carolina at Chapel Hill, Psychology, CB#3270 Davie Hall, NC 27599-3270 Chapel Hill, United States. E-Mail: MaryMichael1@nc.rr.com), P. Gordon (University of North Carolina at Chapel Hill)

Appropriate use of inference increases textual coherence, especially when prior context is used effectively. Using eye-tracking, we explored the effects of context on reading of target sentences that invited inference. Prior context either supported the inference, or not. Critical information occurred either just prior to the target sentence or three sentences earlier. We anticipated effects of context and distance on interpretation. Answers of “True” to a verification task suggested use of inference. Readers’ accuracy in returning to the appropriate textual information was also evaluated. Distance had limited effect on readers’ use of inference. Readers answered “True” more frequently when the informative contextual information appeared earlier in the passage but readers were no more likely to make the expected response. A supportive context led to faster reading. Distance had no effect on passage reading times, but the target sentence was read faster in the distant condition, as measured by total reading time and also right bound and regression path times on the first critical word.

Childrens’ and adults’ processing of implausible and anomalous thematic relations during reading.

H. Joseph (University of Durham, Psychology, Science Site, South Road, DH1 3LE Durham, UK. E-Mail: h.s.s.l.joseph@dur.ac.uk), H. Blythe, S. White, S. Liversedge (University of Durham)

Children’s and adults’ eye movements were monitored as they read sentences containing plausible, implausible and anomalous thematic relations.

- (i) The man used a pan to boil the thin spaghetti yesterday evening.
- (ii) a kettle to boil ...
- (iii) a feather to tickle

In implausible sentences (ii) the theme was incongruous with the instrument and verb. In the anomalous condition (iii) the theme could not be an argument of the verb. Results showed that while adults detected anomalous thematic relations during first pass, children exhibited only second pass effects. Adults detected implausible thematic relations during second pass, but children exhibited no reliable effects of implausibility. While children are able to detect thematic violations during reading, such processing is delayed. This indicates less efficient thematic computation in children, or less rigid thematic expectations concerning events in the real world.

Poster Sessions

PG-266

Wednesday 10:30

Underspecification in anaphoric reference to structured entities: Evidence from eye movements.

R. Filik (University of Glasgow, Department of Psychology, 58 Hillhead Street, G12 8QB Glasgow, UK. E-Mail: r.filik@psy.gla.ac.uk), A. Sanford, P. Sturt (University of Glasgow), M. Poesio (University of Essex)

There is evidence that mental representations built while reading may vary in detail. We investigated this in relation to anaphoric reference, by assessing disruptions in processing using eye-tracking. For sentences like (1) The engineer hooked up the engine and boxcar and sent it to London., the potential antecedents (engine and boxcar) are part of a single structure (train), and using the word it to refer to any of these entities is equivalent, so readers may underspecify concerning what it refers to in this case. This should not happen in control sentences like (2) The engineer saw the engine and the boxcar and sent it to London. Results showed that readers found it more difficult to process in sentences like (2) than (1), supporting the hypothesis that anaphoric reference may be underspecified when potential antecedents are part of a single structure, making the interpretations equivalent. Implications for how structured objects may be mentally represented will be discussed.

PG-267

Wednesday 10:30

How clear is cleartype? The effects of clear type on eye movements in reading.

T.J. Slattery (University of Massachusetts, Amherst, Psychology, Tobin Hall, 1003 Amherst, Ma, United States of America. E-Mail: tslatter@psych.umass.edu), K. Rayner (University of Massachusetts)

Computer programs use the display characteristics of the monitor to smooth the text in order to present text as it would appear on the printed page. ClearType, by the Microsoft Corporation, is specifically designed to display smoother characters by turning on and off parts of pixels on LCD monitors. We tracked the eye movements of subjects as they read short passages on an LCD monitor with or without ClearType in 3 different fonts. We found that text rendered in ClearType was read faster than text displayed in the same font without the use of ClearType. This increase in reading rate was due to a combination of shorter average fixation durations and fewer total fixations on passages using ClearType text. This effect cannot be explained by a speed-accuracy trade-off, because the accuracy for the ClearType passages was at least as high as for the controls. We also found effects of the different fonts on total reading time, accuracy, average fixation duration, and number of fixations.

PG-268**Wednesday 10:30**

Effects of initial letter capitalization on eye movements and word processing.

C. Vorstius (Florida State University, Florida Center for Reading Research, 227 N Bronough St, Suite 7250, 32301 Tallahassee, United States of America. E-Mail: vorstius@psy.fsu.edu), D. Corbic (RWTH Aachen University), R. Radach (Florida State University)

German script has the unique property of writing all nouns with capital initial letters. The ongoing controversy in Germany, Austria and Switzerland on the current spelling reform raised questions about the usefulness of this convention. As capitalization is a major source of parafoveal word shape information, research on this issue is relevant for the study of reading in general. One question of particular interest is at which point in the time line of processing do capitalization effects come into play. Participants read sentences containing 7-letter target nouns with capital or non-capital initial letters. Saccade contingent display changes were used to present nouns parafoveally in irregular non-capitalized format. Results show substantial capitalization benefits for fixation and gaze duration. However, there are no differences in incoming saccade amplitudes and landing positions. Results will be discussed in relation to current theories on eye movement control in reading.

PG-269**Wednesday 10:30**

Eye movement control during reading: Effects of orthographic familiarity and word frequency.

S. White (University of Durham, UK, Department of Psychology, Science Laboratories, South Road, DURHAM, DH1 3LE Durham, UK. E-Mail: s.j.white@dunelm.org.uk),

The variables of word frequency and orthographic familiarity were independently manipulated in an eye movement reading study. The critical words were frequent and orthographically familiar (e.g. town), infrequent and orthographically familiar (e.g. cove) or infrequent and orthographically unfamiliar (e.g. quay). For orthographically familiar words, reading times were longer on infrequent compared to frequent words, and frequent words were more likely to be skipped than infrequent words. Lexical characteristics of words directly influenced saccade programming. Orthographic familiarity had effects on early reading time measures, whilst word frequency also influenced later measures of processing. In addition, there were parafoveal-on-foveal effects of orthographic familiarity, but critically, not of word frequency. These results will be discussed in relation to models of eye movement control during reading.

Poster Sessions

PG-270

Wednesday 10:30

Comprehending counterfactuals: Evidence from eye-movements.

H. f (University of Glasgow, Department of Psychology, 58 Hillhead Street, Glasgow, Scotland, G12 8QB Glasgow, Scotland, UK. E-Mail: h.ferguson@psy.gla.ac.uk), A. Sanford (University of Glasgow)

Counterfactuals are defined as cases of possibly valid reasoning from premises that are false in factuality. To date, limited research has explored the mechanisms that underlie comprehension of counterfactual statements. We report an eye-movement study investigating the word-by-word processing of counterfactual information. Three experimental conditions were employed. No-mismatch, whereby a mismatch between the second clause and our world knowledge makes sense due to the context of the first clause; mismatch, whereby there is a mismatch between the second clause and our world knowledge that is not clarified by information in the first clause; and control sentences. Eye movements showed that mismatch sentences resulted in longer reading times, with more regressions at the critical region than no-mismatch and control sentences that did not differ significantly from each other. Results support a theory that counterfactual information is integrated into our world knowledge immediately.

PG-271

Wednesday 10:30

An exploration of individual differences in the eye movements of readers of English text.

T.M. Lehtimäki (National University of Ireland, Maynooth, Department of Computer Science, National University of Ireland, Maynooth, 0 Maynooth, Co. Kildare, Ireland. E-Mail: taina@cs.nuim.ie), H. Koesling, R.G. Reilly (National University of Ireland)

We present the results of a reading study to explore if significant individual differences in oculomotor reading strategy exist in a homogenous group of skilled readers. We analyse reading data of 15 university-level science students who speak English as their first language. The text used is a popular science article consisting of approximately 10,000 English words. Selected target words were grouped by word length (4-5, 7-8, and 10-11 letters) and statistical word frequency (less than 10, 10-100, and over 100 per million). We comprehensively compared eye movements of individual readers in terms of fixation duration, saccade length, initial landing position, word skipping, refixation probability, and amount of regressive saccades. Our data suggest that even in a homogenous group of skilled readers there is more than one successful oculomotor reading strategy.

PG-272**Wednesday 10:30**

Binocular coordination during reading.

S.P. Liversedge (University of Durham, Psychology, Science Site, South Rd, Durham, UK, DH1 3LE Durham, UK. E-Mail: s.p.liversedge@durham.ac.uk), S.J. White (University of Durham), B.J. Juhasz (University of Massachusetts), J.M. Findlay (University of Durham), K. Rayner (University of Massachusetts)

A basic assumption in reading is that each eye fixates the same letter within a word. We conducted several eye tracking experiments to investigate binocular coordination during reading. Sentences contained a critical compound word that we presented dichoptically (half the word presented to one eye and the other half presented to the other). We also included an alternating case condition. Results showed that each eye fixated 1-2 letters apart on 47% of fixations and that the majority of disparate fixations were uncrossed. Systematic vergence movements occurred during fixation. The dichoptic manipulation influenced fixation durations, but not fixation positions. Also, alternating case did not modulate fixation disparity. We conclude that the assumption that both eyes fixate the same location is not correct for all fixations, processing difficulty does not reduce fixation disparity and the oculomotor control system operates according to a fused visual signal.

PG-273**Wednesday 10:00**

Reading constant-width words.

S. McDonald (University of Edinburgh, Psychology, 7 George Square, EH7 4AN Edinburgh, UK. E-Mail: scott.mcdonald@ed.ac.uk),

Word length is an important determinant of eye movement behaviour in reading. The current study is the first attempt to disconfound effects of number-of-letters from spatial extent. In a sentence-reading experiment where the screen width of all word lengths was held constant, clear differences were observed between closely-matched target words that subtended the same visual angle but differed in number of letters: the more letters in the word, the more fixations made on the word, and the longer the duration of these fixations. Analyses of the full set of sentence words confirmed these results for a wider range of word lengths, and are consistent with a role for number-of-letters distinct from spatial extent. The most plausible explanation for these findings is that long words are subject to a greater degree of visual crowding, which is costly for both temporal and spatial eye movement systems

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Exhibitors

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A quarter of a century ago, in 1980, initiated by Rudolf Groner and Dieter Heller, a trans-disciplinary network called European Group of Scientists active in Eye Movement Research was founded. This group included scientists who used eye movement registration as a research tool and developed models based on oculomotor data obtained from a wide spectrum of phenomena, ranging from the neurophysiological to the perceptual and the cognitive level. The group was intended to serve the purpose of (1) exchanging information about current research, equipment and software, (2) organizing a conference (ECEM) at a different location all over Europe every other year.

This volume contains the abstracts submitted for presentation at the Thirteenth European Conference on Eye Movements ECEM13, Bern, August 14 – 18, 2005.

- 6 invited lectures
 - 13 workshops with 67 oral presentations
 - 15 thematic sessions with 80 oral presentations
 - 7 poster sessions with 114 poster presentations
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