11th Conference of Junior Neuroscientists of Tübingen

NeNa

Pioneering Neuroscience

From Past To The Future

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Invited Guest: Nick Wade

CIN Werner Reichardt Centre for Integrative Neuroscience

Eberhard Karls Universität Tübingen

Graduate School of Neural & Behavioural Sciences
International Max Planck Research School

Hertie-Institut für klinische Hirnforschung

11^{th} NeNa 2010

(‚Neurowissenschaftliche Nachwuchskonferenz' – ‚Conference of Junior Neuroscientists')

Welcome to the eleventh anniversary of the NeNa in the monastery in Heiligkreuztal, Germany. The NeNa is an annual conference organized by and for young scientists in neuroscience. After its initiation in 1999, the NeNa has turned out to be an excellent forum for young researchers to exchange ideas and discuss their research work besides sharing their experiences with science and within the scientific community.

The NeNa this year deals with an issue that is becoming increasingly important to the modern neuroscientist, that is, how to keep track with the accelerating pace at which these days neuroscience all over the world is flourishing, without loosing the ground and staying in touch with its rich history provided by those scientist who did the pioneering experiments. It shall be an attempt to not forget on whose giant shoulders nowadays we are dwelling.

We are very glad that Professor Nick Wade, currently an emeritus Professor, previously holding a chair in Psychology at the University of Dundee, has kindly agreed to join us as our guest speaker. Prof. Wade is among the most well known and respected scientists in the field of visual science addressing topics such as binocular vision, motion perception, and the interplay of perception and action. In parallel he takes a closer look to the history and development of visual neuroscience from the pioneering days onward. In addition he attempts to foster a closer relationship between visual neuroscientists and those who are applying the knowledge, the visual artists, in order to enable a fruitful collaboration . His vast knowledge in his field has led to more than dozens of books communication and sharing this mesmerizing topic with the public.

The conference in its present form would not have been possible without the contribution and support of various people. In particular, we would like to thank Professor Hans-Peter Thier as the initiator and patron of the NeNa conference. We would also like to thank Professor Horst Herbert, Dr. Katja Deiss and Mrs. Dagmar Heller-Schmerold for supporting the organization in various ways. Furthermore, we want to express our gratitude to the Graduate Training Centre of Neuroscience for their generous financial support.

We wish you an interesting and enjoyable stay here in Heiligkreuztal and hope that you and your research plans benefit from your experience at NeNa 2010.

Have fun!

This years organizers:

Regine Armann, Artin Atabaki, Nabil Daddaoua, Anette Giani, Marc Junker, Vishal Kapoor, Kathrin Kaulard

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Talks

Perceptual decisions speed up reflexive saccades

Hans-Joachim Bieg[1]

[1]Max Planck institute for Biological Cybernetics, Department Bülthoff, Tübingen, Germany

Reflexive saccades are fast eye movements that follow the sudden appearance of a salient visual stimulus in the visual field. This reflexive orienting mechanism could have evolved to enable quick evaluations of sudden changes in the environment and, in doing so, support potentially vital actions (e.g., flight). In light of this, it is surprising that reflexive saccades have mostly been studied with tasks that do not require the saccade to support a perceptual judgment. In the current study we measured properties of reflexive saccades in two conditions: In one condition, the saccade enabled the performance of an object discrimination task (discrimination), in the other, it did not (fixation). In the discrimination task, participants made reflexive saccades following the sudden onsets of Landolt squares (0.1 deg. visual angle) and decided if these squares had an opening at the top or bottom. In the fixation task, the same squares were presented but without an opening. Here participants were instructed to fixate the squares as quickly as possible. The results show that saccades supporting a discrimination task are faster and are initiated earlier than saccades that do not enable the completion of such a task. This demonstrates that reflexive saccades could be influenced by the demands of the task. Possible task-specific factors could include the difficulty of the task, time pressure, or the reward associated with completion of the task.

Directional bias of of proprioceptive hand position information - evidence from a patient with unilateral damage of the postcentral gyrus

Svenja Borchers

Sensory representations of arm and hand in the postcentral gyrus are usually supposed to be strictly lateralized and to allow a spatially unbiased representation of the position of the contralateral limb in egocentric space. Here we report a patient whose behavior suggests a different organization of proprioceptive representations. Patient R.W. demonstrated an isolated proprioceptive deficit without hemiparesis due to a lesion of the right postcentral gyrus. We examined her limb position sense in a finger position matching task. Target locations were defined by passively positioning the index finger of one hand beneath a table surface. With the other hand above the table R.W. indicated the perceived position of the finger below the table. Without visual feedback of either hand, we observed a significant leftward shift of perceived locations when reaching with the right hand and an opposite rightward shift when reaching with the left hand in comparison to age-matched healthy controls. These directional errors improved when vision of the active hand was allowed. However, position errors were still significantly different from the control group even with free view of the contralesional hand. Pointing to visual targets without feedback of the moving hand, R.W. revealed errors with both hands that were significantly different from the performance of healthy controls. However, pointing to visual targets with full visual feedback, R.W. was as accurate as controls with either hand. Thus we can exclude a contribution of subclinical visual or motor deficits to the observed impairments. In summary, our data show a contralesional shift of the perceived position of the contralesional hand suggesting a directional bias of proprioceptive representations. Furthermore, our data reveals an effect of the right hemisphere lesion on proprioceptive information processing for the ipsilateral hand.

Real-time support vector classification and feedback of multiple emotional brain states

Ranganatha Sitaram [1], Sangkyun Lee [12], Sergio Ruiz [124], Mohit Rana [12], Ralf Veit [1], Niels Birbaumer [13]

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An important question that confronts current research in affective neuroscience as well as in the treatment of emotional disorders is whether it is possible to determine the emotional state of a person based on the measurement of brain activity alone. Here, we first show that an online support vector machine (SVM) based classifier can be built to recognize two discrete emotional states, such as happiness and disgust from fMRI signals, in healthy individuals instructed to recall emotionally salient episodes from their lives. The classifier also showed robust prediction rates in decoding three discrete emotional states (happiness, disgust and sadness) in an extended group of participants. Subjective reports ascertained that participants performed emotion imagery and that the online classifier decoded emotions and not arbitrary states of the brain. Offline whole brain classification as well as region-of-interest classification in 24 brain areas previously implicated in emotion processing revealed that the frontal cortex was critically involved in emotion induction by imagery. We also demonstrate an fMRI-BCI based on realtime classification of BOLD signals from multiple brain regions, for each repetition time (TR) of scanning, providing visual feedback of emotional states to the participant for potential applications in the clinical treatment of dysfunctional affect.

Retest reliability of reward-related BOLD signals

Tim Rohe[1]

[1]University of Bonn Medical Center, Department of Epileptology and Life and Brain Center, Bonn, Department of Neuro Cognition

Reward processing is a central component of learning and decision making. Functional magnetic resonance imaging (fMRI) has contributed essentially to our understanding of reward processing in humans. The strength of reward-related brain responses might prove as a valuable marker for, or correlate of, individual preferences or personality traits. An essential prerequisite for this is a sufficient reliability of individual measures of reward-related brain signals. We therefore determined test-retest reliabilities of BOLD responses to reward prediction, reward receipt and reward prediction errors in the ventral striatum and the orbitofrontal cortex in 25 subjects undergoing three different simple reward paradigms (retest interval 7-13 days). Although on a group level the paradigms consistently led to significant activations of the relevant brain areas in two sessions, across-subject retest reliabilities were only poor to fair (with intraclass correlation coefficients (ICCs) of -0.15 to 0.44). ICCs for motor activations were considerably higher (ICCs 0.32 to 0.73). Our results reveal the methodological difficulties behind across-subject correlations in fMRI research on reward processing. These results demonstrate the need for studies that address methods to optimize the retest reliability of fMRI.

Distinct neurobiological bases (and individual differences) for speech perception and production abilities of second language in a German-speaking sample

Xiaochen Hu[123], Michael Erb[3], Herrmann Ackermann[2], Susanne Reiterer[14]

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It is a commonplace observation that people differ in their aptitude, capacity, success and speed of foreign language acquisition, specifically with regard to their pronunciation ability (degree of foreign accent). Motor theory of speech perception (Lieberman, 1967) proposed that speech perception involves the process of determining the articulatory gestures (production) that would produce the acoustic signal. This idea challenged the prevailing viewpoint of the majority of researchers, who are still skeptical towards a decisive role of motor systems in speech perception, admitting, if at all, only a subsidiary role of motor areas and reserving the critical role to superior temporal lobe and inferior parietal lobe (Hickock & Poeppel, 2007).
The current study tested a group of 68 German native speakers on their second language (English) speech production/perception abilities. Four extreme groups (low production, high production, low perception, high perception) were built according to their production/perception scores (n=10 for each group, according to 15% upper or lower end of each score). High and low production groups differ significantly in production scores but have no differences in perception scores. High and low perception groups differ significantly in perception scores but have no differences in production scores. All four groups underwent two fMRI experiments: the sentence imitation task, which tested language imitation (production) ability; and the sentence discrimination task, which tested language perception ability.
During the sentence imitation task the high production group showed higher BOLD activity than the low production group in left inferior frontal gyrus (IFG) and left middle frontal gyrus; while low production group showed higher BOLD activity than the high production group in supplymentary motor area (SMA). During the sentence discrimination task the high production group showed higher BOLD activity than the low production group in bilateral middle and superior temporal gyrus, left supramarginal gyrus, left precentral gyrus, left insula, and right heschl gyrus; while the high perception group showed higher BOLD than low perception group in right IFG, right middle frontal, right precentral gyrus and right SMA.
These results indicate that distinct regions are recruited by different individuals for the same task and therefore are related to individual differences in higher production or perception abilities/functions. Higher production ability related to increased activity in left-sided language motor and bilateral phonological loop areas during both perception and production tasks and higher perception ability, in contrast, only related to increased activity in right-sided language motor areas and supplementary motor area (SMA) during the perception task but not production task. The hyperactivity of the low perception group in SMA during the production task may reflect their compensatory motor activity after the failure of the

perception process. The results suggest that the puzzling disagreement between opposing theories, such as in this case, the motor theory of perception (Lieberman, 1967) and general language processing theories (e.g. Hickock & Poeppel, 2007) may be solved by understanding language perception and production processes under the viewpoint of individual differences in recruiting distinct brain areas.

Ultra-High Field Magnetic Resonance Imaging

Frank Mühlbauer

One of the major advances in magnetic resonance imaging (MRI) is continuous increase of the static magnetic field. This development is motivated by the increases in signal-to-noise ratio (SNR), blood-oxygenation levelâdependent contrasts, and spectral resolution. However, going to ultra-high fields (7T and above) also requires new techniques and methods to make use of the full potential for human imaging. This talk provides an overview of the advantages and challenges of ultra-high field human MRI. Furthermore, results of recent projects at the 9.4T scanner of the Max Planck Institute for biological Cybernetics are presented.

Retinotopic mapping using perfusion contrast and velocity selective arterial spin labeling

Mustafa Cavuşoğlu[12]

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Arterial Spin Labeling (ASL) is a magnetic resonance imaging (MRI) method to map the cerebral blood flow (CBF). ASL present a non-invasive alternative to the contrast agent and ASL techniques are capable of providing quantitative information about local tissue blood flow by tracking the inflow of magnetically labeled arterial blood into an imaging slice.
Retinotopy describes the correspondence between visual field locations and their cortical representations. Many studies have used blood oxygenation level-dependent (BOLD) fMRI to non-invasively reveal retinotopic maps. Their accuracy therefore depends on the spatial extent of the metabolic and hemodynamic changes induced by the neural activity. Many studies using gradient-echo MRI at 1.5T and 3T showed that most of the BOLD signal originates from macroscopic veins which might lead to a spatial displacement from the actual site of neuronal activations reducing the specificity for functional localization. In this study we performed perfusion contrast based retinotopic mapping of the human brain at 3T by using arterial spin labeling (ASL) which provides improved sensitivity and better functional localization relative to the BOLD signal. We determined retinotopic maps from both of the fMRI imaging modalities, tested their robustness and replicability across different sessions, and calculated the overlap of the resulting visual areas V1, V2, V3, hV4, V3A/B obtained between the two imaging modalities.
Velocity selective ASL (VS-ASL) is a specific form of ASL methods which labels the blood below or above a certain velocity threshold by using velocity selective RF pulses instead of a spatial selection. Here we will describe the ASL methods in basics, retinotopy of the human brain with perfusion contrast as an application and the implementation of VS-ASL as a specific pulse sequence.

The effects of TMS over the parietal cortex on binocular rivalry

Natalia Zaretskaya

Human fMRI studies of binocular rivalry and other bistable phenomena suggest that a network of frontal and parietal areas, predominantly in the right hemisphere, is particularly involved during switches between the two conflicting percepts. However, these studies do not provide information about causality, i.e. whether fMRI activity is a consequence or a cause of the perceptual change. In the current study we localized areas that were activated during perceptual switches in individual subjects using fMRI. We then tested the effect of disturbing neural processing in two distinct parietal regions along the ventral-dorsal axis in both hemispheres using 2 Hz repetitive transcranial magnetic stimulation (TMS). Our results show that on the group level, TMS over the right intraparietal sulcus (IPS) prolonged the periods of stable percepts. In individual subjects, the IPS in the hemisphere with higher fMRI activation also showed a stronger TMS effect, as reflected in the positive correlation between the lateralization of TMS effects and that of fMRI activations. Our results thus demonstrate a causal, de-stabilizing effect of the IPS on perceptual continuity and provide a direct link between correlational and causal measures of cortical function during conscious perception.

Neurons in the supragranular layers of monkey area V1 compensate receptive field shifts due to ocular counter roll

N. Daddaoua, P. Dicke, P. Thier

We perceive the world as stable and upright despite ego motion. To construct a world-centered percept of our visual environment our visual system must compensate for the orientation of the eyes in the head and of the head in space. Previous work has suggested that the construction of such a world-centered representation is accomplished at later stages in the cortical processing of visual information, building on a fully retinal representation of the visual world in striate visual cortex (V1). Contrary to this widely held belief, we demonstrate that subsets of V1 neurons use information about eye torsion to keep receptive fields stable relative to the head despite tilt-induced ocular counter roll. This conclusion is based on the analysis of 89 neurons recorded from V1 layers 2-4 of a behaving monkey whose receptive fields were compared with the monkeyÂ´s head and body kept in different roll orientations. We obtained high-resolution receptive field maps using the reverse correlation technique while the monkey was actively fixating a target located in the middle of a computer screen. We repeated the same procedure with the monkey and the monitor presenting the stimuli roll tilted by 50deg and, finally, repeated the same procedure when the monkey was rolled back to the upright position. 2-D eye position was monitored using the search-coil technique and eye torsion was measured by means of a camera system. Roll-tilting the monkey by 50deg induced 4 to 5deg of ocular counter roll. 88% of neurons showed a shift of their receptive field location on the monitor, suggesting that they were not able to compensate for ocular counter roll. However, to our surprise, the remaining 12% exhibited receptive fields that did not shift on the monitor despite tilt-induced counter roll. In other words, they were head-centered. Head centered neurons were mostly located in the superficial layers 2 (3 of 39) and 3 (7 of 32) whereas 17 of 18 layer 4 neurons showed significant receptive field shifts, i.e. they were not head-centered. This layer-specific distribution of coordinate frame preferences suggests that non-retinal information on eye torsion is used to convert retinocentric signals in the major recipient of geniculate input, layer 4, into a head-centered format in supragranular primary visual cortex. On the other hand, the lack of any evidence for world-centered responses in V1 suggests that the integration of information about head orientation, requiring vestibular input, is reserved to extrastriate visual cortex. In other words, the construction of a world-centered representation of the perceptual visual world seems to take place in at least two steps associated with distinct parts of visual cortex.

Cognitive categories of emotional and conversational facial expressions are influenced by dynamic information

Kathrin Kaulard[1], Christian Wallraven[12], Stephan de la Rosa[1], Heinrich H. Bülthoff[12]

[1]Max-Planck Institute for Biological Cybernetics/Germany [2]Department of Brain and Cognitive Engineering/Korea

Most research on facial expressions focuses on static, 'emotional' expressions. Facial expressions, however, are also important in interpersonal communication ('conversational' expressions). In addition, communication is a highly dynamic phenomenon and previous evidence suggests that dynamic presentation of stimuli facilitates recognition. Hence, we examined the categorization of emotional and conversational expressions using both static and dynamic stimuli.

In a between-subject design, 40 participants were asked to group 55 different facial expressions (either static or dynamic) of ten actors in a free categorization task. Expressions were to be grouped according to their overall similarity. The resulting confusion matrix was used to determine the consistency with which facial expressions were categorized.

In the static condition, emotional expressions were grouped as separate categories while participants confused conversational expressions. In the dynamic condition, participants uniquely categorized basic and sub-ordinate emotional, as well as several conversational facial expressions. Furthermore, a multidimensional scaling analysis suggests that the same potency and valence dimensions underlie the categorization of both static and dynamic expressions.

Basic emotional expressions represent the most effective categories when only static information is available. Importantly, however, our results show that dynamic information allows for a much more fine-grained categorization and is essential in disentangling conversational expressions.

Are we explaining consciousness yet? - A philosophical and empirical consideration of the central theories of consciousness

Anna Lucia Fernandez Cruz

Vegetative state (VS) patients are awake but are not aware of themselves or their environment. By definition they lack the capability of thinking and having sensations of any kind. Given that VS patients are awake and have reflexes that are difficult to dissociate from voluntary actions e.g. crying, smiling, moving extremities, it is a challenge for physicians and neuroscientists to determine the degree of awareness of these patients. Hence, the main difficulty that pose disorders of consciousness such as VS, is whether it is possible to define a state of neural activity that needs to be reached by a person in order to be considered as (un)conscious? Studies on this topic have shown that establishing an objective neuroscientific definition of a conscious mental state is not as easy as people commonly think. How should we then approach the problem of consciousness? This talk aims to highlight the limitations and possibilities that we have when approaching the problem of consciousness with empirical methods and to expose which difficulties can be theoretically overcome so as the reasons why others resist to be elucidated. Specifically the hard and easy problems of consciousness and the problem of the subjective character of consciousness will be described. Afterwards, two leading theories of consciousness and the way they deal with enigmatic experimental results will be presented. Finally, the general discussion will suggest that we currently don't have the adequate sets of concepts required to understand how a physical objective event can give rise to the subjective experience of consciousness.

[0]Dennett, D. Are we explaining consciousness yet? Cognition 79, 221-37(2001)

Electromagnetic brain function mapping: Multiple Sparse Priors and Beamforming

Eric Ortiz

t.b.a.

Poster

A lot of hand-waving - Motor Interference versus Simulation

Abhilash Dwarakanath[1], Bartosz Helfer[1], Alexandra Kupferberg[1], Stefan Glasauer[1]

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Motor Interference is defined as the increase in the variance of a movement performed while observing a human or conspecific agent perform a similar but non-congruent movement. Previous studies have shown that this effect is greater when the agent resembles the self closely, i.e., it is greatest with a human agent followed by a humanoid robot. With industrial robots, virtually no motor interference is observed. However, every study employs a different kind of experimental paradigm and analysis, so that it seems difficult to draw conclusions.
In a previous study, we observed that when confronted with a robot that has a non-biological velocity profile subjects tended to imitate that specific movement rather than performing a smooth natural motion as intended. In another experiment, subjects watching an industrial robot moving with a more natural minimum-jerk profile spontaneously tended to imitate the robot with their whole body. These observations suggest that motor interference could be a subset of imitation and purely depends upon the physical parameters of the movement.
To test this hypothesis, we employed a novel, ground-level analysis which considers the physical parameters of frequency, amplitude, and offset. We formulated a probabilistic model to predict the time-course of the physical parameters depending on changes in visual stimulation. As a long-term goal, we seek to investigate whether the effect of Motor Interference can be redefined as a sub-set of motor simulation, which would let us establish a new framework to reinterpret previous and own experimental results.

Role of eye movement goals in motor plan updating

Marina Fridman[1]

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Goal-directed reaches are represented in the parietal cortex as a motor plan directed to the spatial location of the goal. As spatial information is usually visual, an eye shift before a reach is completed requires an updating of the reach plan. Several studies have provided evidence that the efference copy of eye movements is used by the reach system to update the reach plan after an eye movement. In this study, we hypothesized that pre-movement knowledge of the eye endpoint (or goal) can also be used for spatial updating. To investigate how this additional information contributes to reach error and reaction time in humans, we manipulated knowledge of the eye endpoint in a memory reach task. Instead of saccades, which are usually employed to study updating, we instructed subjects to perform smooth pursuit eye movements to preselected targets. On some trials, subjects were not provided with the end target location and therefore, did not have information about the end location of the eye. Preliminary results show that having eye endpoint information does not reliably affect reach error but decreases reaction time. Faster reaction times implies that eye endpoint information allows updating to occur earlier, perhaps by using a vector calculated as the difference of current eye position and the projection of the target on the retina. These results provide evidence for multiple mechanisms of updating and have important implications for our understanding of how reaching targets are encoded, and how the brain can predict future states and therefore prepare future actions.

Investigating the effect of IPS TMS-stimulation on auditory and visual processing A TMS-fMRI Study

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Recent studies show that the activity in the visual cortex can be decreased by simultaneous auditory input, and vice versa in the auditory cortex. It remains unclear whether these modulations are mediated via low-level interactions between sensory cortices or top-down effects from higher association cortices. The bidirectional anatomical connectivity from the intraparietal sulcus (IPS) to visual and auditory areas renders it ideal for integrating inputs from multiple senses. Here, we aim to determine how applying TMS on the right IPS influences the activation in the visual cortex during (1) visual stimulation (visual induced activations) and (2) auditory stimulation (auditory induced deactivations).

The Anaphase Promoting Complex is required for the extinction of fear memories

Tanja Kuczera[1], Roman Stilling[1], Hung-En Hsia[1], Sanaz Bahari-Javan[1], Stefan Irniger[2], Farahnaz Sananbenesi[13] & Andre Fischer[1]

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Learning and memory processes critically involve the orchestrated regulation of de novo protein synthesis. On the other hand, it has become clear that regulated protein degradation also plays a major role in neuronal plasticity and learning behavior. One of the key pathways mediating protein degradation is proteosomal protein destruction. The anaphase-promoting complex/cyclosome (APC/C) is an E3 ubiquitin ligase that targets proteins for proteosomal degradation by the 26S proteasome. While the APC/C is essential for cell cycle progression, it is also expressed in postmitotic neurons where is has been implicated with axonal outgrowth and neuronal survival.

In this study, we addressed the role of APC/C in learning and memory function by generating mice that lack the essential subunit APC2 from excitatory neurons of the adult forebrain. Those animals are viable but exhibit a severe impairment in the ability to extinct fear memories, a process critical for the treatment of anxiety diseases such as phobia or post-traumatic stress disorder.

In conclusion our data provides genetic evidence that APC/C activity in the adult forebrain is required for cognitive function, especially the extinction of fear memories.

FMRI of superior colliculi and oculomotor brainstem nuclei in humans

Walter Linzenbold, Marc Himmelbach

Although the oculomotor brainstem system is well described in non-human primates, functional measurements of this system remain a challenging task due to technical constraints and anatomical characteristics. The vast majority of oculomotor fMRI studies investigating reflexive saccades found no reliable signal changes in brainstem nuclei. In rare cases of positive findings, these are typically confined to the superior colliculus. Despite of the fundamental role of the brainstem nuclei for oculomotor control, examinations of their functional status in humans represent a neglected issue in human neuroimaging. Using high-resolution fMRI we searched for BOLD signal increases in nuclei of the oculomotor system using a reflexive saccade task in a group of healthy subjects. Our measurements were conducted with a conventional 3T Trio Siemens Scanner using a 12-channel head coil. EPI volumes were acquired with a slice thickness of 2 mm and an in-plane resolution of 1.5 x 1.5 mm2. Our group analysis revealed task-related BOLD increases in the superior colliculus, the oculomotor nucleus, the abducens nucleus, and in the paramedian pontine reticular formation. An additional visual stimulation paradigm led to increased signal levels in the superior colliculus consistent with its visual properties but no corresponding signal changes in other brainstem nuclei. In light of the eminent difficulties of brainstem functional neuroimaging in humans, our data demonstrate the feasibility of functional examinations of the oculomotor brainstem system in humans. In combination with refined structural imaging that allows for unequivocal localization of brainstem nuclei, such functional examinations could contribute to conclusive descriptions of neurological disorders affecting the oculomotor system.

Tandem affinity purification and mass spectrometry for the isolation of protein complexes from cytosolic and mitochondrial fractions of mammalian cells

Alessandra Zanon[1], Christine Schwienbacher[12], Andrew A. Hicks[1], Christine Klein[3], Peter P. Pramstaller[145], Irene Pichler[1], Aleksandar Rakovic[3]

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To understand how proteins confer specific properties to a host cell, information regarding protein expression levels, posttranslational modifications, the cellular localization, and the interactions with different partners is necessary. Isolation and characterization of native multiprotein complexes and the identification of interacting protein partners is therefore a central topic in functional genomics and proteomics. The development of the tandem affinity purification (TAP) method with subsequent protein identification by high-throughput mass spectrometry (MS) has enabled the systematic characterization of native protein complexes and transient protein interactions under near-physiological conditions. Like coimmunoprecipitation, this strategy depends on specific protein-protein interaction allowing the selective and rapid recovery of the associated target complex from extracts. However, in contrast to coimmunoprecipitation, the various steps of the TAP protocol reduce background contamination which is essential for the recovery of highly purified complexes present at very low concentration.

The TAP strategy used in our laboratories in Bolzano/Bozen and Lübeck involves the fusion of two protein tags to the target protein and its expression in mammalian host cells (Stratagene, La Jolla, USA). The affinity tags consist in a streptavidin binding peptide (SBP) and a calmodulin binding peptide (CBP). Tandem affinity purification yields the tagged protein of interest and interacting proteins using gentle washing and small molecule elution conditions. In the first purification step, the mammalian cell lysate is applied to a streptavidin column and eluted using biotin. In the second purification step, the eluate is applied to a calmodulin column and released using a chelator such as EGTA, which removes calcium. The interacting proteins are not disrupted and can be further analyzed by techniques like Western blotting and MS. The two affinity tags can be fused to either the N- or C-terminus of the gene of interest. To characterize the purified proteins, we precipitated the final eluate using MeOH/CHCl3, resolved the protein complexes by SDS-PAGE, stained the gel with a mass-spectrometry compatible silver staining kit (Invitrogen, Paisley, UK), and cut the stained protein bands. The protein bands were then trypsin digested followed by LC/MS/MS analysis. In addition to whole cell lysates as starting material, the TAP method was also used to isolate protein complexes for mitochondrial and cytosolic fractions separately. Whereas for whole cell lysates 1x108 cells were used, for affinity purifications of cell fractions, the double

amount of cells was grown. Taken together, the TAP strategy has proven useful in our hands as a generic two-step affinity purification protocol to quickly purify protein complexes and associated proteins for subsequent analysis by MS, starting from whole cell lysates as well as cellular fractions.

Neural correlates of sound localization in a multisound environment

Ida Zündorf

Localizing and identifying sounds when multiple sound sources are competing is an every day experience. This was described by Cherry (1953) as the cocktail party phenomenon. Although this effect has been extensively studied, it is still insufficiently understood how the brain is able to filter the stimulus of interest from the overall auditory information received. Our purpose was to investigate the underlying neural correlates of the cocktail party effect by functional magnetic resonance imaging, implementing a sound localization task with multiple competing sounds. Our results indicate that mainly identical areas are involved in active localization of sound sources presented in complex environments and in isolation. The auditory spatial attention network, overlaps the localization network primarily in IPL, MFG, and IFG. These latter areas correspond to the area of overlap of both dorsal and ventral attention networks described for visual processing, thus suggesting attentional processing of multisensory spatial information in these areas.

Information Theoretic Analysis of Spike Train from Rat Trigeminal Ganglion

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Rats use their whiskers to sense the environment in a set of different tasks, such as object recognition, location, and spatial representation of their surroundings (Vincent, 1913). Studies have shown that the neurons responsible for signal transduction on the whisker pathway can be classified into rapid (RA) and slowly adapting (SA, Zucker & welker, 1969, Lichtenstein et al., 1990) and that these two types align with two psychophysical channels found in the rat somatosensory system (Stüttgen et al., 2006).
The aim of this project was to classify the RA and SA cells according to their information carrying capabilities. Using extracellular single unit recordings made on anesthetized animals, whiskers were mechanically stimulated with âwhite noiseâ signal. Results show that the recorded neurons fire with great time precision and reliability (as shown to be true for other sensory modalities, Bialek et al., 1991, Haag & Borst, 1997) and are able to convey information about the stimuli at high transmission rates (200bits/sec). Further analysis indicate that transduction of the whisker movement to spike trains occurs in a rather linear fashion for stimulating frequencies between 10 and 100 Hz.

Learning and Recognizing 3D Objects by Combination of Visual and Proprioceptive Information

Björn Browatzki

One major difficulty in computational object recognition lies in the fact that a 3D object can be seen from an infinite number of viewpoints. Thus, the issue arises that objects with different 3D shapes often share similar 2D views. Humans are able to resolve this kind of ambiguity by producing additional views through object manipulation or self movement. In both cases the action made provides proprioceptive information linking the visual information retrieved from the obtained views. Following this process, we combine visual and proprioceptive information to increase recognition performance of a computer vision system.

In our approach we place a 3D model of an unknown object in the hand of a simulated anthropomorphic robot arm. The robot now executes a predefined exploratory movement to acquire a variety of different object views. To assure computational tractability, a subset of representative views is selected using the Keyframe concept by Wallraven et al. (2007). Each remaining frame is then annotated with the respective proprioceptive configuration of the robot arm and the transitions between these configurations are treated as links between object views. For recognizing objects this representation can be used to control the robot arm based on learned data. If both proprioceptive and visual data agree on a candidate, the object was recognized successfully.

We investigated recognition performance using this method. The results show that the number of misclassified results decreases significantly as both sources â visual and proprioceptive â are available, thus demonstrating the importance of a combined space of visual and proprioceptive information.

Probabilistic Assignment of Chemical Shift Data for Semi-Automatic Amino Acid Recognition

Jens Hooge

Traditionally, resonance assignment of protein backbone and side chains is done in a two-steps manner. First the backbone resonances are assigned. This is usually achieved from sequential information provided by three chemical shifts: CA, CB and C'. Once the sequence is solved, the second assignment step takes place. For this purpose, the CA-CB and HA chemical shifts are used as a start point for assignment of the side chain resonances, thus connecting the backbone resonances to their respective side chains. This strategy is unfortunately limited by the size of the protein due to increasing signal overlap and missing signals. Therefore, amino acid recognition is in many cases not possible as the CA-CB chemical shift pattern is not sufficient to discriminate between the 20 amino acids. As a result, the first step of the strategy described above remains tedious and time consuming. The combination of modern NMR techniques with new spectrometers now provide information that was not always accessible in the past, due to sensitivity problems. These experiments can be applied efficiently to measure a protein size up to 45 kDa and furthermore provide a unique combination of sequential carbon spin system information. The assignment process can thus benefit from a maximum knowledge input, containing âallâ backbone and side chain chemical shifts as well as an immediate amino acid recognition from the side chain spin system. We propose to extend the software PASTA (Protein ASsignment by Threshold Accepting) to achieve a general sequential assignment of backbone and side-chain resonances in a semi- to full-automatic per-residue approach. PASTA will offer the possibility to achieve the sequential assignment using any kind of chemical shifts (carbons and/or protons) that can provide sequential information combined with an amino acid recognition feature based on carbon spin system analysis.

Virtual Storytelling of Fairy Tales: Towards Simulation of Emotional Perception of Text

Ekaterina Volkova

Emotion analysis (EA) is a rapidly developing area in computational linguistics. For most EA systems, the number of emotion classes is very limited and the text units the classes are assigned to are discrete and predefined. The question we address is whether the set of emotion categories can be enriched and whether the units to which the categories are assigned can be more flexibly defined. Six untrained participants annotated a corpus of eight texts having no predetermined annotation units and using fifteen emotional categories. The inter-annotator agreement rates were considerably high for this difficult task: 0.55 (moderate) on average, reaching 0.82 (almost perfect) with some annotator pairs. The final application of the intended EA system is predominantly in the emotion enhancement of human-computer interaction in virtual reality. The system is meant to be a bridge between unprocessed input text and visual and auditory information, like generated speech, facial expressions and body language. The first steps towards integrating text-based information annotated for emotion categories and simulation of human emotional perception of texts in story telling scenarios for virtual reality are already made. We have created a virtual character, whose animation of face and body is driven by annotations in text.

Visual stimulus timing precision in Psychtoolbox-3: Tests, pitfalls & solutions

Mario Kleiner

Visual stimulation paradigms in perception research often require accurate timing for presentation of visual stimuli. Acquisition of exact stimulus update timestamps in realtime is often crucial, both for synchronization of stimulus updates between different presentation modalities and for logging. Modern graphics hardware, multi-core processors and operating systems provide a far higher level of functionality, flexibility, and performance in terms of throughput, than systems a decade ago. They also pose new challenges for precise presentation timing or timestamping. Typical causes of interference are, eg the dynamic power management of modern graphics cards and computers, novel hybrid graphics solutions, user interface desktop composition and the properties of graphics- and CPU-scheduling of the latest generation of operating systems. This work presents results for the accuracy and robustness of visual presentation timing and timestamping tests, conducted within Psychtoolbox-3 (Kleiner et al, 2007 Perception 36 ECVP Supplement, 14) on different operating systems and graphics cards under realistic stimulus presentation loads. It explains some of the common pitfalls one can encounter when trying to achieve exact timing and some methods to avoid timing problems or reduce their severeness.

Proteins - Single particle reconstruction based on 2d crystals

Markus Ryll

Structural biology is a new branch of basic research and avails oneself of knowledge from many other sciences like molecular biology, chemistry, biophysics and computer science. The goal of structural biology is a better understanding of biological processes at atomic resolution. To reconstruct proteins three different techniques do exist: X-ray crystallography, PNRM and single particle refinement. At the Karolinska Institute we developed a new method basing on single particle refinement combined with the knowledge we gain from the symmetric order of a crystal. Therefore we developed and implemented two new process steps for the well known reconstruction software EMAN2. The first process step improves the boxing tool - the cutting of single protein unit cells from the TEM image. The second step improves the refinement by decreasing the number of possible Eularian angles.
To proof our results we tested the new software package on the sugar symporter MelB. The best resolution of MelB gained by single particle is 8Å [Purhonen: Three-dimensional structure of the suger syporter. Journal of Structural Biology, 152:76-83, 2005]. Based on the first experiments and testings it seems that a resolution better than 6Å can be achieved with the same number of iterations and the same image set as used in the 8Å-refinement. The refinement process according to the less number of alignments is much faster now. About 40% of less time is necessary.

Electromagnetic brain function mapping: Multiple Sparse Priors and Beamforming

Eric Ortiz

t.b.a.

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