Andreas Widmann, Erich Schröger, Thomas Jacobsen, Thomas Gruber, Matthias M. Müller, Jörg Jescheniak, Angela D. Friederici, Thomas C. Gunter, & Christoph S. Herrmann

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Evoked Potentials International Conference XIV
Leipzig Series in Cognitive Sciences 5

Leipziger Universitätsverlag

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Preface

Dear Colleague,

Welcome to the “Fourteenth Evoked Potentials International Conference” (EPIC XIV) in Leipzig.

The EPIC has traditionally been the most important scientific event for those working in the field of event-related potentials (ERPs) and related areas. Held only once every three years, it offers participants an opportunity to interact on a first-hand basis with many other investigators from throughout the world who are involved in ERP research.

EPIC XIV is intended to be a meeting about both basic and applied research including presentations that employ ERPs as well as newer methods of assessing brain function (such as fMRI, MEG, or TMS). The conference attracts professionals from many domains including cognitive neuroscience, experimental, cognitive, clinical, social, and developmental psychology, neuropsychology, neurology, neurophysiology, neuroradiology, psychiatry, magnetoencephalography, biomedical engineering, and psychopharmacology.

The areas covered in EPIC XIV include mental and bodily functions such as perception, action, memory, attention, language, emotion, motivation, multisensory processing, motor behavior, and cardiovascular responses. Presentations on normal functioning, development, clinical aspects and methodology will be given.

Contributions consist of four key-note lectures, fifteen organized symposia, six thematic sessions with oral presentations, and more than 90 posters. Special

emphasis is given to poster sessions to facilitate exchanges and discussions between the participants.

Leipzig is a modern city with an impressive history. For example, the Leipzig Fair is celebrated as the "mother" of all trade fairs. Johann Sebastian Bach was Leipzig's director of music and the cantor of St. Thomas's Church from 1723 until his death in 1750. Leipzig is the home of the Gewandhaus Orchestra, the oldest civic concert orchestra in Europe, dating back more than 300 years. The Leipzig Opera company is the second oldest opera in Germany. The "Alte Handelsbörse", where the first Key note lecture will be given, was built in 1687. In the old days, it was used by traders for closing their contracts. In Leipzig the Peaceful Revolution in 1989 began. The University of Leipzig (founded in 1409) has an impressive history as well: for example, the mathematician Gottfried Wilhelm Leibniz, the philosopher Friedrich Nietzsche, and the father of German literature Goethe studied in Leipzig. Interesting from the view of cognitive neuroscience, psychiatry, and psychology: Paul Flechsig and Emil Kraepelin worked at the University of Leipzig; Ernst Heinrich Weber and Gustav Theodor Fechner developed Psychophysics, and Wilhelm Wundt founded the world's first Institute for Experimental Psychology in 1879. This institute's 125th anniversary will be celebrated on Saturday, March 27, a day prior to the opening of EPIC XIV (http://www.uni-leipzig.de/~psycho/125jahre/).

We hope that you enjoy our lively city with its old tradition and wish you a very successful conference.

The Organizers of EPIC XIV

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Conference information

Getting to Leipzig

Arriving by plane. The journey from the airport Leipzig-Halle to the city center takes approximately 30 minutes. There is a direct train connection run by the Deutsche Bahn AG travelling between the airport and Leipzig Central Station every half hour. Alternate possible airport destinations close to Leipzig include Berlin (two hours by train from Leipzig), Frankfurt am Main (three hours by train from Leipzig) and Hannover (three hours by train from Leipzig). Trains commute regularly between Leipzig and all three cities.

Arriving by train. Using the Interregio- or Intercity trains you can travel to Leipzig from most European cities. Leipzig Central Station, one of the biggest and nicest in Germany, is located directly in the center of Leipzig.

Arriving by car. You reach Leipzig on highway A9 (Berlin-Nürnberg) or A14 (Halle-Dresden).

Conference venue

All events will be held in the center of Leipzig and are within walking distance of the railway station and the central hotels.

Sunday. The opening evening (registration and Key note lecture 1) will be held at the "Alte Handelsbörse" (Naschmarkt – see map). Nearby you can find the restaurant "Mövenpick" (Naschmarkt 1–3), where a Welcome Party (including buffet dinner) will take place directly after the Key note lecture.

Monday till Wednesday. All symposia, thematic sessions and poster sessions will be held at the lecture hall (2nd floor) of the University of Leipzig (Universitätsstraße 7 – see map).

There is a get-together-party on Tuesday (19:30) in the Panoramarestaurant at the top of the "City-Hochhaus" (Augustusplatz 9, see map).

Conference office and cloakroom

The conference office will be at the conference venue ("Alte Handelsbörse" on Sunday, University lecture hall from Monday til Wednesday). Opening hours will be from 8:30 to 18:00 from Monday to Wednesday. The cloakroom will be opened until 19:15 from Monday to Wednesday. On Sunday, registration is possible before the Key note lecture 1 between 16:30 and 18:00.

Message board is close to the conference office. Conference staff can be identified by yellow name tags. Please, don't hesitate to contact them for assistance.

Lunch, dinner, refreshments

Meals (including limited drinks) are included in the conference fees for Sunday's dinner (Restaurant "Mövenpick", Naschmarkt), Monday's and Wednesday's lunch (Moritzbastei, Universitätsstr. 9), and Tuesday's dinner (Restaurant "City-Hochhaus", Augustusplatz 9). Vouchers are required for these four occasions. You will receive them with your conference material at registration.

From Monday until Wednesday refreshments (coffee, water, and juice) will be available. Please, wear your name tag during the conference.

For Monday's dinner, Tuesday's lunch and Wednesday's dinner you are recommended to explore the Leipzig culinary scene. A list of restaurants and pubs is available at the conference office and can be found at:

http://www.leipzig.de/eng/tourist/indexts.htm.

Accomodation

Hotels can be found via our webpage:

http://www.uni-leipzig.de/~epic14/accomodation.shtml

Confirmation of participation

Confirmation of participation including the receipt will be with your conference material.

Exhibitors

Please, have a look at the exhibition in front of the lecture rooms.

Important phone numbers

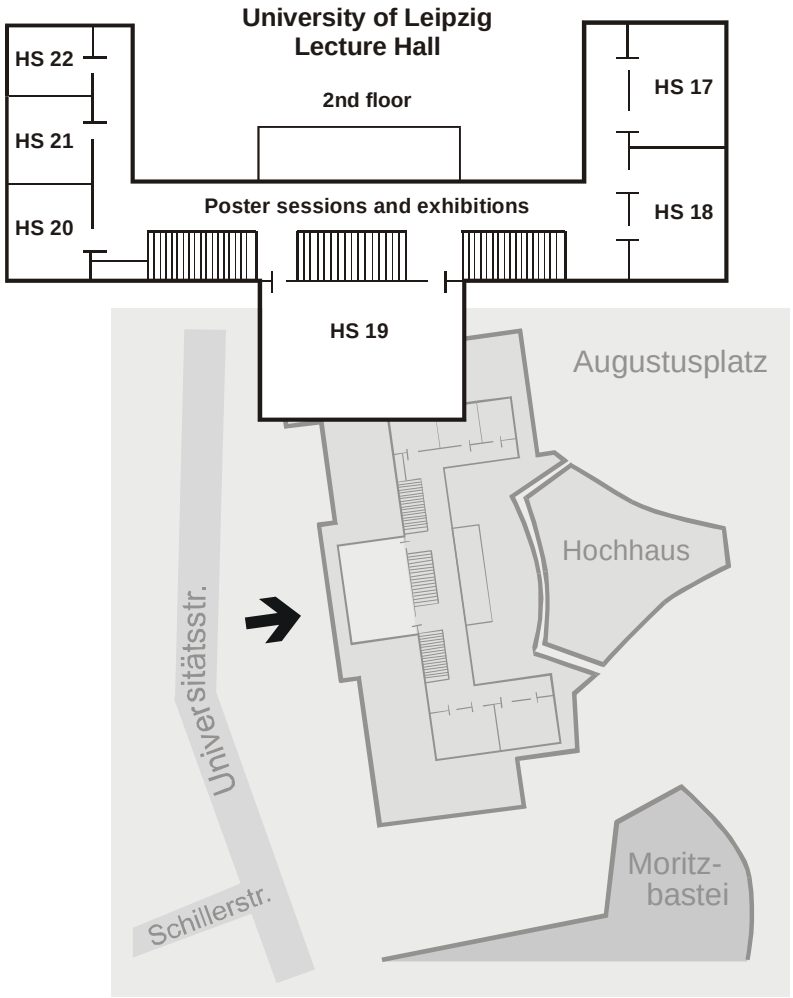
Emergency call: Rescue service 112
Police 110

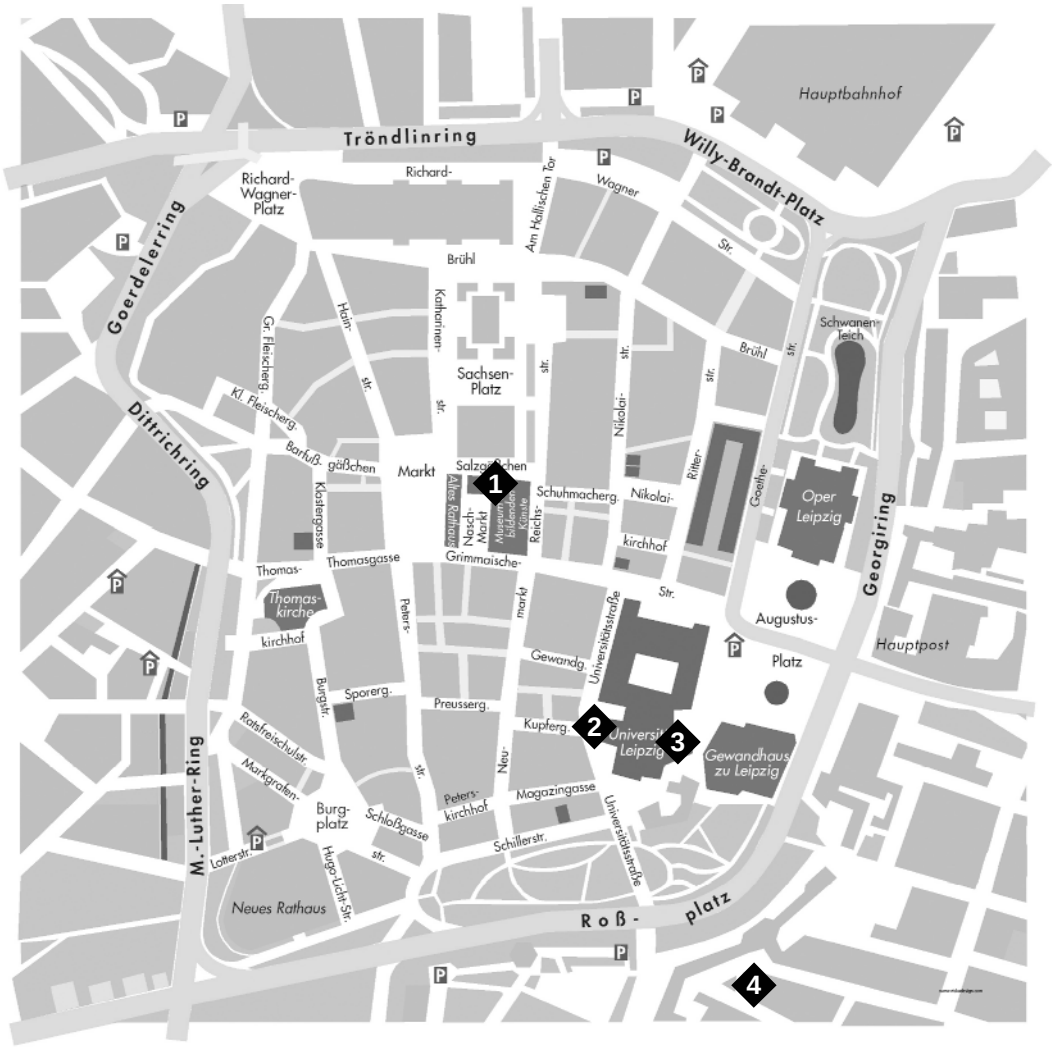
Acknowledgements

We are very grateful to the members of the Scientific Board, John T. Cacioppo, Marie-Helene Giard, Carles Escera, David Friedman, Marta Kutas, Ron Mangun, Axel Mecklinger, Risto Näätänen, Frank Rösler, Sidney J. Segalowitz, Pedro A.

Valdes-Sosa, Rolf Verleger, István Winkler, and Hirooki Yabe for reviewing all the abstracts and giving helpful comments. Also, we are very grateful to Nicole Lorenz for organizing the catering and her help in the conference office, Urte and Eckart Roeber for their help in the conference office and artistic matters, Adelheid Müller for administrating the finances, Stefan Röttger for organizing the cloakroom, Michael Schauer for coordinating the exhibitors, Andrea Gast-Sandmann for her help in designing this book and the poster, Heide Grünewald, Ines Braun, and Maria Etzkorn for their help in many concerns, and the uncounted number of helpers, who can not be listed by name here, but made it possible to organize this conference in Leipzig.

Maps





1 – “Alte Handelsbörse”, Naschmarkt and Mövenpick, Naschmarkt 1–3

2 – University of Leipzig, Lecture hall, Universitätsstr. 7

3 – “City-Hochhaus”, Augustusplatz 9

4 – Institut für Allgemeine Psychologie, Seeburgstr. 14–20

Program

Presentation media

Slide projector, overhead projector, and computer projector are available in each lecture room. Laptops will be provided for presentations only in urgent cases and upon request (often there are incompatibilities between operating systems, presentation software, fonts etc.). Please, arrange your schedule for EPIC so that you have time to organize the technical matters with your symposium/session chair at least 15–20 min before your symposium/session starts.

Posters

Posters can be mounted starting on Monday at 12:00. They can remain until the end of the conference. Posters can be up to 130 cm (height) by 100 cm (width). Pins and scissors for final poster formatting will be available on site.

Posters with odd numbering will be presented from 16:00–17:00 and posters with even numbering from 17:00–18:00 in order to avoid congestions in front of the posters.

Please note that each abstract has been reviewed by two members of the scientific board (except abstracts for symposia contributions which fell under the responsibility of the respective symposium chairs). We hope that reviews were helpful for making any final revisions in your submission.

	Sunday, March 28, 2004	Monday, March 29, 2004	Tuesday, March 30, 2004	Wednesday, March 31, 2004
9:00–12:30 (10:30–11:00 Coffee break)		• *Symposium 1:* Recent advances in human memory research (HS 17) • *Symposium 2:* Auditory attention (HS 18) • *Session 1:* Perception and cognition I: Vision (HS 20)	• *Symposium 6:* News about P3: The integrative component (HS 18) • *Symposium 7:* Episodic memory and the mesiotemporal lobes (HS 17) • *Symposium 8:* Pre-attentive speech perception (HS 20)	• *Symposium 11:* Cortical induced gamma band rhythms and higher cognitive function (HS 18) • *Symposium 12:* Processing words and sentences (HS 17) • *Session 4:* Perception and cognition II: Audition (HS 20) • *Session 5:* Audio-visual processing (11:00–12:30; HS 22)
12:30–14:00		Lunch		
14:00–16:00		• *Symposium 3:* Perceptual deficits and their remediation in dyslexia (HS 20) • *Symposium 4:* Performance monitoring (HS 17) • *Symposium 5:* Intracerebral generators (HS 18) • *Session 2:* Methods and analysis (HS 22)	• *Symposium 9:* What can ERPs tell us about cognitive aging? (HS 18) • *Symposium 10:* Movement planning and control: Structure, function, and temporal organisation (HS 17) • *Session 3:* Speech and language (HS 20)	• *Symposium 13:* Emotional Perception (HS 22) • *Symposium 14:* ERPs and fatigue (HS 20) • *Symposium 15:* Brain mechanisms of consciousness (HS 17) • *Session 6:* Prosody and music (HS 18)
16:00–18:00	Registration (16:30–18:00; "Alte Handelsbörse")	• *Poster session 1:* Emotion • *Poster session 2:* Cognition • *Poster session 3:* Attention	• *Poster session 4:* Clinical and pharmacological research • *Poster session 5:* Auditory processing and perception • *Poster session 6:* Methods and analysis	• *Poster session 7:* Speech and language • *Poster session 8:* Visual processing and perception • *Poster session 9:* Motor processing
18:00–19:00	*Welcome address and Key note lecture 1:* Olivier Bertrand (18:00–19:30; "Alte Handelsbörse")	*Key note lecture 2:* Seana Coulson (HS 19)	*Key note lecture 3:* Samuel Sutton Award: Bruno Rossion (HS 19)	*Key note lecture 4:* Hans-Jochen Heinze (HS 19)
19:30–	Registration and Welcome Party (Mövenpick)		Get-Together Party (Panorama-restaurant in the "City-Hochhaus")	

Sunday, March 28, 2004	
16:30–18:00	Registration (“Alte Handelsbörse”)
18:00–19:30	*Welcome address and Key note lecture 1:* *Olivier Bertrand (Inserm Unité 280, Lyon, France):* Local and large-scale oscillatory synchronization in humans: When and where do they occur, what do they mean? (“Alte Handelsbörse”; p. 33)
19:30–22:00	Registration and Welcome Party (Mövenpick)

Monday, March 29, 2004

9:00–12:30 (10:30–11:00 Coffee break)

Symposium 1: Recent advances in human memory research (Chair: Thomas Gruber; HS 17; pp. 119 sqq.)

- *Otten, L. J.:* Neural correlates of memory encoding
- *Klimesch, W., and Schack, B.:* The relation between alpha and theta oscillations in memory tasks
- *Fell, J., Elger, C. E., and Fernández, G.:* The role of synchronized gamma activity in declarative memory formation
- *Herrmann, C. S.:* Evoked gamma activity reflects memory representations
- *Gruber, T.:* Induced gamma activity during various memory tasks in the human EEG

Symposium 2: Auditory attention (Chair: Elyse Sussman; HS 18; pp. 123 sqq.)

- *Schroeder, C. E., Chen, C., Shah, A. S., Lakatos, P., Mehta, A. D., Ulbert, I., and Karmos, G.:* Intermodal selective attention effects in monkey auditory cortex
- *Sussman, E. S.:* Auditory perception: The interaction between stimulus-driven processes and attentional control
- *Winkler, I.:* Stimulus-driven and top-down effects on sound organization
- *Schröger, E., Berti, S., and Roeber, U.:* Relation between pre-attentive deviance detection, involuntary attention, and working memory
- *Shafer, V. L.:* The allocation of attention in the development of speech perception

Session 1: Perception and cognition I: Vision (Chair: Jochen Kaiser; HS 20; pp. 175 sqq.)

- *Antal, A., Kincses, Z. T., Nitsche, M. A., Bartfai, O., and Paulus, W.:* Excitability changes induced in the human primary visual cortex by transcranial direct current stimulation: an electrophysiological evidence
- *Barnett, K. J., Kirk, I. J., and Corballis, M. C.:* Schizophrenia and communication between the hemispheres
- *Kaiser, J., Bühler, M., and Lutzenberger, W.:* Magnetoencephalographic gamma-band responses to illusory triangles in humans
- *Kirmizi Alsan, E., Bayraktaroglu, Z., Gurvit H., Emre M., and Demiralp T.:* Comparative analysis of event related potentials during Go-Nogo, CPT and Stroop tests: Decomposition of electrophysiological markers of response inhibition, sustained attention and resistance to interference
- *Kornmeier, J., and Bach, M.:* The Necker cube is disambiguated in early visual processing – evidence from a novel ERP-paradigm
- *Rossion, B., Curran, T., Collins, D., Kung, C.-C., Goffaux, V., and Tarr, M. J.:* Faces and non-face objects of expertise recruit overlapping visual processes indexed by the N170

12:30–14:00 Lunch

14:00–16:00

Symposium 3: Perceptual deficits and their remediation in dyslexia (Chair: Teija Kujala; HS 20; pp. 128 sqq.)

- *Widmann, A., Kujala, T., Tervaniemi, M., and Schröger, E.:* Brain responses to the matching of score-like visual symbols to sounds indicate a left hemispheric deficit in dyslexia
- *Hämäläinen, J., Guttorm, T. K., Lyytinen, H., and Leppänen, P. H. T.:* Brain responses in infants and children with and without risk for familial dyslexia: Processing differences and associations with behavioral measures
- *Baldeweg, T., Thomson, J., and Baker, K.:* ERP studies of sound feature and envelop processing in dyslexia and specific language impairment (SLI)
- *Heim, S., Keil, A., Eulitz, C., and Elbert, T.:* Changes in cortical activity during language processing and effects of affective context

Symposium 4: Electrophysiological and hemodynamic correlates of performance monitoring (Chair: Markus Ullsperger & William J. Gehring; HS 17; pp. 132 sqq.)

- *Gehring, W. J., and Willoughby, A. R.:* Multiple determinants of the medial frontal negativities related to error processing and feedback
- *Luu, P.:* Medial frontal cortex and the regulation of action
- *Ullsperger, M.:* Error processing, rewards, and motivational context
- *Yeung, N.:* Conflict and error processing in anterior cingulate cortex

Symposium 5: Intracerebral generators (Chair: George Karmos; HS 18; pp. 134 sqq.)

- *Ulbert, I., Halgren, E., Karmos, G.:* Laminar analysis of intracortical electrical activity in humans
- *Schroeder, C. E., Shah, A. S., Lakatos P., Knuth, K. H., Ding, M., and Bressler, S. L.:* Defining the physical mechanisms and physiological significance of ERP components.
- *Knake, S., Morand, S., Wang, C., Witzel, T., Ulbert, I., Steinvorth, S., Marinkovic, K., Schomer, D. L., Dale, A. M., and Halgren, E.:* Spatiotemporal dynamics of episodic memory: A combined study with fMRI, MEG and human laminar recordings
- *Knuth, K. H.:* Single-trial characterization of evoked responses: Bayesian estimation and differentially variable component analysis

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- *Quian Quiroga, R.:* Single-trial evoked potentials with wavelet denoising
- *Böcker, K. B. E., Bijma, F., Waldorp, L. J., Grasman, R. P. P. P., Kenemans, J. L., de Munck, J. C., and Huizenga, H. M.:* Advances in statistical source analysis of visual evoked potentials
- *Trimmel, M., and Meixner-Pendleton, M.:* Impact of the resting brain DC potential and task preceding slow potential shifts on response time and ERPs
- *Ergen, M., Ergenoglu, T., Erdal, E. M., Keskin, H. Y., Beydagı, H., and Demiralp T.:* The effects of MAO A gene polymorphism on N100 potential
- *Kornhuber, M. E., Nieder, C., and Zierz, S.:* Amplification of Long-Latency-Reflexes (LLR) by trains of stimuli

Monday, March 29, 2004

16:00–18:00

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[1] *Goydke, K. N., Urbach, T. P., Kutas, M., Altenmueller, E., and Münte, T. F.:* Perception of emotion from single sung notes: an event-related brain potential study of valence and identity matching

[2] *Johansson, M., and Mecklinger, A.:* A spatio-temporal principal component analysis of recognition memory ERPs to emotional and neutral faces

[3] *Milivojevic, B., McNair, N. A., Kirk, I. J., and Corballis, M. C.:* ERP effects of thatcherisation and emotional expression on upright and inverted faces

[4] *Pripfl, J., Fischmeister, F. P. S., Gerstmayer, A., Leodolter, U., and Bauer, H.:* Phylogenetic versus ontogenetic fear-relevant pictures: EEG-source localisation by means of LORETA

[5] *Sammler, D., and Koelsch, S.:* Music and emotion: electrophysiological correlates of the processing of pleasant and unpleasant music

[6] *Schacht, A., and Sommer, W.:* Emotional valence accelerates lexical decisions: functional localization with ERPs

[7] *van Hooff, J. C., Loader, R., and Thorsteinsson, I.:* Directed forgetting of emotion and neutral words

[8] *Werheid, K., Schacht, A., and Sommer, W.:* Is beauty context-dependent? A priming study on facial attractiveness.

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[9] *Czernochowsi, D., Brinkmann, M., Johansson, M., and Mecklinger, A.:* An ERP evaluation of the development of item and source memory in school-aged children and young adults

[10] *Doeller, C. F., Opitz, B., Krick, C., Reith, W., and Mecklinger, A.:* Extracting regularities in the human brain: Are there process- and domain-specific neural mechanisms?

[11] *Eppinger, B., Kray, J., Mecklinger, A., and John, O.:* Age-related differences in task-set selection and interference control: evidence from ERPs

[12] *Fehr, T., Schmiedt, C., Meistrowitz, A., Basar-Eroglu, C., and Herrmann, M.:* Neuromagnetic brain activity associated with visual working memory

[13] *Fiehler, K., Ullsperger, M., Grigutsch, M., and von Cramon, D. Y.:* Modulation of error processing by error significance: Electrophysiological and cardiac evidence

[14] *Galfano, G., Mazza, V., Angrilli, A., and Umiltà, C.:* Stimulus-driven arithmetic N400 effect

[15] *Gibbons, H., and Rammsayer, T. H.:* Temporal generalization in the range of milliseconds: ERPs suggest time perception within, and time estimation outside the P300 span

[16] *Kiefer, M., and Sim, E.-J.:* The structure of semantic memory: category-specific ERP effects during visual and functional judgement

Poster session 3: Attention (Foyer 2nd floor; pp. 59 sqq.)

[26] *Carriero, L., Vasile, E., Budai, R., Weis, L., and Battaglini, P. P.:* Arrows indicating direction modulate N1 amplitude

[27] *Giabbiconi, C.-M., and Müller, M. M.:* Attentional modulation of somatosensory steady-state in the human EEG

[28] *Kopp, F., Schröger, E., and Lipka, S.:* Recall modality affects rehearsal mechanisms in a delayed serial recall task: Evidence from an EEG coherence study

[29] *Lange, K., and Roeder, B.:* Uni- and cross-modal effects of orienting attention to a point in time: An event-related potential study

[30] *Wang, J. T., Friedman, D., Ritter, W., and Bersick, M.:* Attentional capture by prosodically salient information in unattended speech sounds: an ERP study

[31] *Wetzel, N., Berti, S., Widmann, A., and Schröger, E.:* Attentional orienting and reorientation in young children

[17] *Lang, S., Kanngieser, N., Jaśkowski, P., Heider, H., Rose, M., and Verleger, R.:* How the brain acquires explicit knowledge. Event-related potentials (ERPs) as predictive indices

[18] *Mouraux, A., Guérit, J. M., and Plaghki, L.:* The laser-evoked P600 may reflect 'Context Closure' rather than 'Context Updating'

[19] *Nan, Y., and Luo Y.-J.:* Processing numeracy with distractor's variation: A RT-ERP study

[20] *Nessler, D., Friedman, D., Johnson, R., Jr., and Bersick, M.:* Components of task switching: An ERP perspective

[21] *Overtoom, C. C. E., Vlierman, R. C., Kenemans, J. L., and van der Molen, M. W.:* Comparing the auditory and visual stop task: A psychophysiological study.

[22] *Salillas, E., Barber, H., and Carreiras, M.:* Agreement and number interference processes in Spanish: An ERP study

[23] *Sederberg, P. B., Madsen, J. R., and Kahana, M. J.:* Cortical oscillations during encoding predict successful recall

[24] *Willoughby, A. R., and Gehring, W. J.:* The error-related negativity as an electrophysiological correlate of learning

[25] *Yildirim, E., Bayraktaroglu, Z., Gurvit, H., Emre, M., and Demiralp, T.:* Event related potentials during verbal and non-verbal Sternberg paradigms

18:00–19:00 *Key note lecture 2: Seana Coulson (University of California, San Diego):* Getting the message: ERP studies of extra-linguistic information in language comprehension (HS 19; p. 34)

Tuesday, March 30, 2004

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Symposium 6: News about P3: The integrative component (Chair: Rolf Verleger; HS 18; pp. 138 sqq.)

- *Rektor, I.:* Cortical and subcortical generators of P3
- *Verleger, R., Jaśkowski, P., and Wascher, E.:* P3 integrates stimulus- and response-related processing
- *Croft, R. J., Gonsalvez, C. J., and Barry, R. J.:* Target-to-target interval versus probability effects on P300
- *Yordanova, J., and Kolev, V.:* Multiple functional subcomponents of P300: evidence from the time-frequency domain
- *Polich, J.:* Overview of P3a and P3b: Towards an integrative theory

Symposium 7: Episodic memory and the mesiotemporal lobes (Chair: Bertram Opitz & Ken Paller; HS 17; pp. 142 sqq.)

- *Paller, K. A.:* How does conscious recollection differ from priming?: Insights from amnesic patients and brain potentials
- *Wilding, E. L., and Aggleton, J. P.:* A selective impairment of recollection following medial-temporal lobe damage: behavioral and electrophysiological data
- *Duezel, E., Neufang, M., Schott, B., and Mai, H.:* Electromagnetic indices of memory-related theta oscillations and of theta-gamma covariance
- *Kahana, M. J.:* From oscillations to single-unit activity: the neurophysiology of human spatial navigation
- *Mecklinger, A.:* Differential neuronal correlates for familiarity and recollection during memory retrieval

Symposium 8: Pre-attentive speech perception (Chair: Thomas Jacobsen & István Winkler; HS 20; pp. 145 sqq.)

- *Cheour, M., Imada, T., and Kuhl, P.:* Magnetoencephalography is feasible for infant assessment of auditory discrimination
- *Eulitz, C.:* Sensitivity to phonetic contrasts is pre-attentively modulated by the phonological system
- *Csépe, V., Honbolygó, F., Ragó, A., Róna, Z., and Beke, A.:* MMN to suprasegmental cues
- *Shtyrov, Y., and Pulvermüller, F.:* Speech and language in the auditory odd-ball: Mismatch Negativity (MMN) studies
- *Jacobsen, T.:* Pre-attentive categorization of vowel formant structure in synthesized vowels and complex tones

12:30–14:00 Lunch

14:00–16:00

Symposium 9: What can ERPs tell us about cognitive aging? (Chair: David Friedman; HS 18; pp. 149 sqq.)

- *Czigler, I., Horváth, J., Sussman, E. S., and Winkler, I.:* Temporal integration and aging: ERP studies
- *Gaeta, H., and Friedman, D.:* ERPs reveal age-related changes in the inhibitory and updating sub-processes of working memory
- *Nessler, D., Friedman, D., Johnson, R., Jr., and Bersick, M.:* Behavioral and ERP aging effects during encoding and retrieval: Initial age-related recognition deficits are ameliorated by practice
- *Berti, S.:* Distraction and re-orientation of attention in elderly people

Symposium 10: Movement planning and control: Structure, function, and temporal organisation (Chair: Hartmut Leuthold; HS 17; pp. 153 sqq.)

- *Adam, J. J.:* Visuomotor preparation of discrete finger responses
- *Toni, I.:* Neuroimaging of movement representations: from blobs to content
- *Praamstra, P., and Seiss, E.:* The basal ganglia and inhibitory mechanisms in response selection: Subliminal priming of motor responses in Parkinson's disease
- *Leuthold, H.:* Preparation for action, motor programs, and the brain

Session 3: Speech and language (Chair: Thomas Gunter; HS 20; pp. 185 sqq.)

- *Fiorentino, R., and Poeppel, D.:* MEG evidence for early decomposition of compound words
- *Hoeks, J. C. J., Stowe, L. A., Prinsen, I., and Wijers, A. A.:* Processing syntax with two hemispheres
- *Kohls, G., Christmann, G., Jaremkiewicz, A., Maas, V., Rinker, T., Zachau, S., Hennighausen, K., and Schecker, M.:* Automatic processing of grammar: Insights from a Mismatch Negativity (MMN) study
- *Stowe, L. A., and Hoeks, J. C. J.:* Semantic illusions during sentence comprehension

16:00–18:00

Poster session 4: Clinical and pharmacological research (Foyer 2nd floor; pp. 64 sqq.)

[32] *Arnfred, S. M.:* Exploration of auditory P50 gating in schizophrenia by way of difference waves

[33] *De Luca, V., McNeely, H. E., King N., Trakalo, J., and Kennedy, J. L.:* Event related potentials during the Stroop task: Association study with DISC1 gene

[34] *Debatisse, D., Fornari, E., Foroglou, E., Foroglou, N., Ingvar-Maeder, M., Pralong,E., Campanella, S., Villemure, J.-G., and Maeder, P.:* P300 auditory oddball paradigm by using CEPs and fMRI in vegetative comatose: Interest for a consciousness model in clinical use

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Poster session 5: Auditory processing and perception (Foyer 2nd floor; pp. 78 sqq.)

[49] *Bruneau, N., Vidal, J., Gomot, M., Roux, S., Barthélémy, C.:* Interhemispheric asymmetry of tone stimuli processing in 5- 6-year-old children : an AEP topographic study

[50] *Carral, V., Corral, M. J., Amenedo, E., and Escera, C.:* Event-related potentials as a function of auditory abstract change magnitude: a parametric study.

[51] *Grimm, S., Widmann, A., and Schröger, E.:* MMN reflects differential processing of duration changes within short and long sounds

[52] *Horváth, J., and Winkler, I.:* Event-related potential correlates of repetitions in random auditory stimulus sequences

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Poster session 6: Methods and analysis (Foyer 2nd floor; pp. 86 sqq.)

[59] *Ademoğlu, A., Duru, D., Demiralp, T., Istefanopulos, Y., and Baykan, B.:* Source localization of electrical dipoles using wavelet prefiltering and MUSIC scanning

[60] *Brázdil, M., Dobsik, M., Mikl, M., Daniel, P., Pazourkova, M., Krupa, P., and Rektor, I.:* Depth ERPs and fMRI comparative study of auditory oddball task

[61] *Debatisse, D., Pralong, E., Campanella, S., Villemure, J. G., Gondoin, P., Despland, P. A., Lang, J. M., Maeder-Ingvar, M., and Gleis, M.:* Time Index of Neural Network Variability (TINNV) during CEPs

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16:00–18:00 (cont'd)

Poster session 4: Clinical and pharmacological research (cont'd; Foyer 2nd floor; pp. 64 sqq.)

[35] *Ergen, M., and Cuhadaroglu C.:* Evaluating the cognitive effects of Bupropion HCl during smoking cessation using event-related brain potentials

[36] *Eryasar, B., Bilgic, B., Hanagasi, H., Aydin, U., Emre, M., and Demiralp, T.:* Target P3b potentials in the novelty paradigm are more sensitive than oddball P3b potentials in detecting cognitive impairment in early stage Alzheimer's Disease (AD)

[37] *Hentrich-Hesse, T., Kuckuck, R., Remer, M., Schlag, B., Schumann, E., Klein, C., Schmidtke, K., and Schecker, M.:* Neurolinguistic aspects of P300 in Alzheimer's disease

[38] *Juckel, G., Gallinat, J., Riedel, M., Sokullu, S., Schulz, C., Müller, N., and Hegerl, U.:* Serotonergic dysfunction in schizophrenia assessed by loudness dependence of primary auditory cortex evoked activity

[39] *Jung, J., Morlet, D., Confavreux, C., and Fischer, C.:* Cognitive dysfunction in multiple sclerosis patients: electrophysiological and psychometrical assessment in 46 patients

[40] *Kaper, M., Meinicke, P., and Ritter, H.:* Single trial P300 recognition by machine-learning algorithms for brain-computer interfacing

[41] *Kolev, V., Yordanova, J., Heinrich, H., and Rothenberger, A.:* Increased event-related theta activity as a psychophysiological marker of hyperactivity in children

Poster session 5: Auditory processing and perception (cont'd; Foyer 2nd floor; pp. 78 sqq.)

[53] *Jentschke, S., and Koelsch, S.:* Neurophysiological correlates of music perception and musical expertise: A developmental view

[54] *Kruck, S., Hahnemann, N., Nubel, K., and Gross, M.:* Segmentation of syllables during the first year of life

[55] *Müller, D., Widmann, A., and Schröger, E.:* Deviance-repetition effects as a function of stimulus dimension, feature variation, and timing: A Mismatch Negativity study

[56] *Oceák, A., Winkler, I., Sussman, E. S., and Alho, K.:* Stimulus omission and temporal integration: Temporal structure or loudness summation

[57] *Takegata, R., Brattico, E., Tervaniemi, M., Varyiagina, O., Näätänen, R., and Winkler, I.:* Pre-attentive conjunction of auditory features in simultaneous, spatially distributed objects

[58] *van Zuijen, T. L., Simoens, V., Paavilainen, P., Näätänen, R., and Tervaniemi, M.:* The effect of implicit or explicit knowledge on MMN elicitation and deviance detection

Poster session 6: Methods and analysis (cont'd; Foyer 2nd floor; pp. 86 sqq.)

[62] *Demiralp, T., Bayraktaroglu, Z., Ademoğlu, A., Dilber, B., and Yıldırım, O.:* A user-friendly ERP analysis software with time-frequency and spatial decomposition facilities

[63] *Margada, S., Laloyaux, O., and Hansenne, M.:* Impact of low frequency transcranial magnetic stimulation on event-related brain potentials

[64] *Nakajima, Y., and Kohno, Y.:* Scalp-recorded potentials evoked by TMS

[65] *Pralong, E., Bisdorff, A., Campanella, S., Villemure, J. G, Maeder-Ingvar, M., Despland, P. A., Tetreault, M. H., and Debatisse, D.:* Influence of the Click Evoked Myogenic Potentials (CMEP)

[42] *Krauel, K., Baving, L., Santel, S., Düzel, E., and Hinrichs, H.:* Episodic memory in patients with attention-deficit/hyperactivity disorder (ADHD)

[43] *Kujala, T., Halmetoja, J., Leinonen, S., Lyytinen, H., Näätänen, R., and Sussman, E. S.:* Impairment of pseudo-word and complex-sound segmentation in dyslexia

[44] *Lachmann, T., Berti, S., Kujala, T., and Schröger, E.:* Diagnostic subgroups of developmental dyslexia have different deficits in neural processing of tones and phonemes

[45] *Meinke, A., Thiel, C. M., and Fink, G. R.:* P1 and N1 do not reflect the nicotine induced facilitation of the processing of unattended stimuli

[46] *Schmiedt, C., Brand, A., Hildebrandt, H., and Basar-Eroglu, C.:* Event-related oscillations during working memory tasks in schizophrenic patients and healthy controls

[47] *Schmiedt, C., Meistrowitz, A., Basar-Eroglu, C., and Herrmann, M.:* Impairment of visual working memory in patients with Parkinson's disease: a time-frequency analysis

[48] *Stürmer, B., Schefter, T., Sommer, W., and Stadelmann, A.:* Effects of Cannabis and delta-9-Tetrahydrocannabinol on response priming in humans

18:00–19:00 *Key note lecture 3: Samuel Sutton Award: Bruno Rossion (University of Louvain, Belgium):* The time-course of face processing: evidence from studies on the N170 face-sensitive component (HS 19; p. 35)

19:30– Get-Together Party (Panorama-restaurant in the "City-Hochhaus")

Wednesday, March 31, 2004

9:00–10:30

Symposium 11: **15 years after: Cortical induced gamma band rhythms and higher cognitive function (Chair: Matthias Müller; HS 18; pp. 156 sqq.)**

- *Kreiter, A. K.:* The role of neuronal synchronization in cognitive processing
- *Bertrand, O., Bidet-Caulet, A., Bauchet, F., and Fischer, C.:* Modulations of auditory induced gamma/beta oscillations in human intracranial recordings
- *Lachaux, J. P., Mainy, N., and Kahane, P.:* Modulation of gamma band activity by attention during a verbal short-term memory task in human intracranial recordings
- *Keil, A., Moratti, S., Stolarova, M., and Ihssen, N.:* Neural dynamics during acquisition of motivational significance
- *Müller, M. M.:* Induced gamma band responses in the human EEG and selective stimulus processing

Symposium 12: **Processing words and sentences: ERP evidence from patients (Chair: Sonja Kotz; HS 17; pp. 160 sqq.)**

- *Rüsseler, J., Wildner, J., Sambale, J., and Münte, T. F.:* Picture naming in developmental dyslexia: evidence from event-related brain potentials
- *Hagoort, P., and Wassenaar, M.:* Sentence-picture matching electrified
- *Pulvermüller, F.:* Word-evoked potentials as a reflection of recovery from aphasia?
- *Kotz, S. A., Hofmann, J., von Cramon, D. Y., and Friederici, A. D.:* The role of the anterior temporal lobe in semantic processing: ERP patient evidence
- *Grunwald, T., Kurthen, M., and Elger, C. E.:* Functions of the human hippocampal formation: episodic memory or more?

Session 4: **Perception and cognition II: Audition (Chair: Eero Pekkonen; HS 20; pp. 188 sqq.)**

- *Escera, C., Corral, M. J., Yago, E., Corbera, S., and Nuñez, M. I.:* Attention capture by significant stimuli: semantic analysis follows attention switching
- *Hertrich, I., Mathiak, K., Lutzenberger, W., and Ackermann, H.:* Right-hemisphere dominance of phase-locked auditory evoked field components in response to periodic signals
- *Jongsma, M. L. A., Eichele, T., Coenen, A. M. L., Hugdahl, K., Nordby, H., Van Rijn, C. M., and Quian Quiroga, R.,:* The auditory evoked P3 and the omission evoked potential decrease with predictability: a single-trial analysis with wavelet denoising reveals individual learning curves
- *Keskin, H. Y., Demiralp, T., Ademoğlu, A., and Ergen, M.:* Wavelet components of auditory event related potentials (ERPs) in relation with signal discrimination, motor response, response inhibition and updating of working memory

10:30–11:00

Coffee break

11:00–12:30

Session 5: **Audio-visual processing (Chair: Marie-Helene Giard; HS 22; pp. 193 sqq.)**

- *van Wassenhove, V., Grant, K. W., and Poeppel D.:* Neural dynamics of auditory-visual speech fusion
- *Lebib, R., Papo, D., Douiri, A., de Bode, S., and Baudonnière, P.-M.:* Does the McGurk effect always fool the brain?
- *Besle, J., and Giard, M.-H.:* Is visual information represented in auditory sensory memory?

- *Pekkonen, E., Osipova, D., Sauna-Aho, O., and Arvio, M.:* Cortical evoked auditory responses are abnormal in Down syndrome: an MEG-study

12:30–14:00 Lunch

14:00–16:00

Symposium 13: Emotional Perception (Chair: Annette Schirmer; HS 22; pp. 164 sqq.)

- *Calder, A. J.:* Facilitative and inhibitive components of same-expression priming
- *Campanella, S.:* Neurophysiological correlates of facial emotional discrimination in anxious and depressive people
- *Schirmer, A.:* Emotional speech processing: Effects of gender and culture
- *Vuilleumier, P.:* Neural mechanisms and time-course of emotional attention

Symposium 14: ERPs and fatigue (Chair: Monique Lorist & Michael Falkenstein; HS 20; pp. 167 sqq.)

- *Gundel, A., Bröcker, R., Marsalek, K., and ten Thoren, C.:* EEG, sleepiness and mental fatigue
- *Rohrbaugh, J. W., Sirevaag, E. J., Vedeniapin, A. B., and Stern, J. A.:* EEG signs of fatigue: Temporal aspects and relationship with oculomotor activity
- *Dickson, B. T., Barrett, G., Moorhead, I., and Holmes, S. R.:* Electrophysiological markers of mental fatigue
- *Lorist, M. M., and Meijman, T. F.:* Mental fatigue and cognition: what is going on?
- *Falkenstein, M.:* Changes of error-related ERP components with time-on-task

Symposium 15: Brain mechanisms of consciousness (Chair: Claude Tomberg; HS 17; pp. 171 sqq.)

- *Desmedt, J. E.:* Physiology and phylogeny of consciousness
- *Tomberg, C. A.:* Brain mechanisms of consciousness and cognitive unconscious in real time: kinetics of 40 Hz prefrontal binding
- *Fink, G. R.:* Representation of the self and neglect
- *Schönle, P. W.:* Conscious brain mechanisms in patients recovering from vegetative state

Session 6: Prosody and music (Chair: Mari Tervaniemi; HS 18; pp. 196 sqq.)

- *Hruska, C., Kotz, S. A., Alter, K., von Cramon, D. Y., and Friederici, A. D.:* About the nature of the Closure Positive Shift (CPS)
- *Isel, F., Alter, K., and Friederici, A. D.:* Is prosody a good predictor of up-coming information? ERPs evidence from spoken German sentences
- *Tervaniemi, M., Kruck, S., Szameitat, A., Schröger, E., De Baene, W., Alter, K., and Friederici, A. D.:* Neurocognition of speech vs. music sound processing: An ERP and fMRI study
- *Knösche, T. R., Neuhaus, C., Haueisen, J., Maess, B., Alter, K., Friederici, A. D., and Witte, O. W.:* An electrophysiological marker for phrasing in music

Wednesday, March 31, 2004

16:00–18:00

Poster session 7: Speech and language (Foyer 2nd floor; pp. 92 sqq.)

[66] *beim Graben, P., and Frisch, S.:* Symbolic resonance analysis of event-related potentials unveils different cognitive processing demands

[67] *Dominguez, A., Morera, Y., and De Vega, M.:* Event related brain potentials for morphological priming on the word-pseudoword pairs

[68] *Friedrich, C. K., Alter, K., and Friederici, A. D.:* ERP effects of mismatch in word fragment priming

[69] *Friedrich, M., and Friederici, A. D.:* N400 maturation during the second year of life

[70] *Heim, S., Stolterfoht, B., Gunter, T., and Alter, K.:* Focus on focus: The brain's response to focus particles and accents in German

[71] *Hoeks, J. C. J., Stowe, L. A., and Wijers, A. A.:* Processing syntactic ambiguities and the effect of pragmatic context

[72] *Hofmann, J., Friederici, A. D., and Kotz, S. A.:* Grammatical gender in the sphere of minimal context: An ERP investigation

[73] *Jescheniak, J. D., Hahne, A., and Feld, H. K.:* Retrieving words in a second language

[74] *Khader, P., and Rösler, F.:* Changes of power and coherence in the EEG during verb and noun processing

[75] *Koester, D., Gunter, T. C., and Friederici, A. D.:* Morphosyntax in German compounds: Prosody turns plural morphemes into linking elements

Poster session 8: Visual processing and perception (Foyer 2nd floor; pp. 107 sqq.)

[84] *Bayraktaroglu, Z., Ergenoglu, T., Yıldırım, O., Dilber, B., Devrim, M., Beydagi, H., and Demiralp, T.:* Alpha rhythm of the EEG modulates visual detection

[85] *Engst, F. M., Sommer, W., and Martin-Loeches, M.:* Recognizing famous faces and famous buildings: An ERP-analysis of repetition priming

[86] *Fischmeister, F. P. S., Pripfl, J., Tschida, U., Leodolter, U., and Bauer, H.:* Cortical areas related to depth perception of natural images: a LORETA analysis.

[87] *Min, B. K., Busch, N. A., Debener, S., Kranczioch, C., Engel, A. K., and Herrmann, C. S.:* Differentiating evoked and induced visual alpha activity by exogenous parameters

[88] *Roeber, U., Widmann, A., Herrmann, C. S., and Schröger, E.:* Observer's perceptual state in binocular rivalry modulates early ERP components

[89] *Roman, R., Brázdil, M., Jurák, P., Rektor, I., and Kukleta, M.:* Intracerebrally recorded ERPs in a frequency range of 5.5-15 Hz in visual oddball paradigm

[90] *Schubö, A., Meinecke, C., and Schröger, E.:* Detecting pop-out targets in displays of varying set sizes

Poster session 9: Motor processing (Foyer 2nd floor; pp. 114 sqq.)

[91] *Eichele, T., Hugdahl, K., and Nordby, H.:* Effects of musical training on response timing, motor related cortical potentials, task related power and coherence in a simple synchronization tapping task

[92] *Praamstra, P., and Seiss, E.:* Dynamics of motor cortex activation in response selection: Activation and inhibition following subliminal response priming

[93] *Stahl, J., and Rammsayer, T. H.:* Differential effects of stimulus discriminability on processing speed at different stages of sensorimotor processing

[94] *Vasile, E., Carriero, L., Budai, R., and Battaglini, P. P.:* Executed and imagined movement: an EEG study.

[95] *Yordanova, J., and Kolev, V.:* Response-synchronized EEG theta oscillations in sensorimotor tasks

[76] *Müller, J., Hahne, A., Fujii, Y., and Friederici, A. D.:* ERP correlates of miniature language learning: What's learnt within five days

[77] *Möller, J., and Münte, T. F. :* Error monitoring during speech production: Evidence from ERPs in tongue twisters

[78] *Pannekamp, A., Toepel, U., Alter, K., Hahne, A., and Friederici, A. D.:* ERPs to prosodic processing in normal and deviant speech

[79] *Paulmann, S., Elston-Güttler, K. E., and Kotz, S. A.:* Language control: Interlingual homographs and their influence on L2 processing – an ERP study

[80] *Pulvermüller, F., Hauk, O., Shtyrov, Y., Johnsrude, I., Nikulin, V., and Ilmoniemi, R. J.:* Brain connections of language and actions

[81] *Shtyrov, Y., and Pulvermüller, F.:* Evidence of early category-specific semantic processing in the brain: Responses to english action words in auditory odd-ball

[82] *Sivonen, P., Maess, B., and Friederici, A. D.:* Coughing is disturbing: delayed semantic reconstruction of words with obliterated speech sounds

[83] *Stowe, L. A., and Hoeks, J. C. J.:* Do readers use prediction in on-line sentence processing?

18:00–19:00 *Key note lecture 4: Hans-Jochen Heinze (University of Magdeburg, Germany):* Connecting top-down and bottom-up information: Area V1 as a site of interaction (HS 19; p. 36)

Key note lectures

Key note lecture 1

Sunday, March 28, 18:00–19:00; “Alte Handelsbörse”

Local and large-scale oscillatory synchronization in humans: When and where do they occur, what do they mean?

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Mental processes are known to activate distributed networks of specialized neural structures. Neuroimaging techniques provide more and more precise pictures of these networks in different sensory and cognitive situations but the neural mechanisms underlying the network dynamics has been much less explored. It has been proposed that the co-operation within or between brain areas involved in sensory and cognitive processes could be based on the dynamic synchronization of the underlying neural populations in an oscillatory mode (in the beta and gamma ranges). This hypothesis has been supported at different levels, with unit and local field potential recordings in animal studies, and at intermediate (intracranial EEG) and more macroscopic levels (scalp EEG/MEG) in humans. We will review these human findings showing a functional role of beta/gamma oscillations in various mental processes related to perception, attention and memory. The contribution of

these different levels of recording to investigate local- versus large-scale cortical synchronization will also be discussed.

Key note lecture 2

Monday, March 29, 18:00–19:00; HS 19

Getting the message: ERP studies of extra-linguistic information in language comprehension

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Understanding one another often requires more than identifying words in order. In conversation, we make use of cultural knowledge, social interactional cues, and gestures in order to help get our point across. Perhaps because the presence of a combinatorial syntax is a unique feature of human communication systems, most electrophysiological investigations of language comprehension have addressed how the brain responds to syntactic and semantic information. However, as noted above, successful communication relies on extra-linguistic information to a considerable extent. In this talk, we describe a number of event-related related brain potential (ERP) studies that address the processing of these sorts of communicative cues. We consider how language users integrate linguistic information with background knowledge about the physical and social world, how speakers process co-speech gestures, and how “back channel” information in speech disfluencies affects language comprehension.

Key note lecture 3: Samuel Sutton Award

Tuesday, March 30, 18:00–19:00; HS 19
Chair: David Friedman

The time-course of face processing: evidence from studies on the N170 face-sensitive component

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Electrophysiological recordings on the human scalp have shown that the processing of faces and other objects start to differ reliably between about 130 and 170 ms following stimulus onset: faces elicit a larger occipito-temporal N170 than other object categories. Here I will review evidence from a number of electrophysiological studies showing that the N170 reflects much more than the simple occurrence of a face-specific detection system, and can be used as a tool to clarify the time-course of face and object processing stages. EEG analysis suggests that the N170 is the only scalp electrophysiological response that differs between the perception of faces and objects (but also among object categories), thus probably carrying information about several object and face categorization stages. In agreement with this proposal, it will be argued that (1) multiple cortical sources contribute to elicit the N170, with perhaps little contribution from face-sensitive areas in the middle fusiform gyrus; (2) faces and non-face objects in a domain of expertise compete for the same visual processes reflected by the N170 during object categorization; (3) both the detection of a face (vs. non-face object categories) and the individual recognition of faces occur at this level.

Key note lecture 4

Wednesday, March 31, 18:00–19:00; HS 19

Connecting top-down and bottom-up information: Area V1 as a site of interaction

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Poster sessions

Poster session 1: Emotion

Monday, March 29, 16:00–18:00; Foyer 2nd floor

Perception of emotion from single sung notes: an event-related brain potential study of valence and identity matching

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The current study asked whether single notes, like brief presentations of faces and pictures, had affective valence, i.e., could be perceived as happy or sad. To that end, 10 participants listened to the same sequential pairs of sung tones (300 to 600 ms in length) under two task conditions. In the Valence Matching Task, participants were asked to indicate via a button press whether the emotions conveyed by the note pairs were the same or different. In the Voice Matching Task, participants were asked to indicate whether or not the singer of the first (S1) and second note (S2) was same. Though finding it difficult participants were able to perceive the affective valence of single notes (valence task: 64%; voice task: 66%). Concurrently recorded event-related brain potentials (ERPs), aimed at assessing the

time-course and spatial distribution of the categorization processes, showed that regardless of task, the ERP to S2 had a greater positivity from 200–1000 ms post tone-onset when preceded by an incongruent than a congruent sound; neither the timing nor distribution of the mismatch effects differed for voice vs. valence matching. In sum, musical units as small as single notes are suitable for expressing basic emotions, which can be decoded by the brain within 200 ms, at least when attended. This finding suggests affective information in music is carried not only by large-scale features such as tempo and rhythm but also by some features of individual notes.

A spatiotemporal principal component analysis of recognition memory ERPs to emotional and neutral faces

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Previous behavioral and event-related potential (ERP) research have suggested that emotion may exert an influence on memory accuracy as well as on the subjective state of awareness accompanying recognition. The present study used a spatiotemporal principal component analysis (PCA) approach to investigate old/new memory effects for positive, negative, and neutral faces and emotion-specific modulations in the ERPs. The factors extracted in an initial spatial PCA were subjected to a second temporal PCA to obtain spatiotemporal factor combinations. The results reveal midfrontally distributed factors coding for old-new differences for all emotion types within a 300–600 ms time window and additional posteriorly distributed factors for negative faces. Specifically, the old/new effect for negative faces were associated with an early occipital (~400 ms) and a somewhat later parietal (~600 ms) spatiotemporal factor. Emotion-specific modulations were observed predominately over midfrontal regions in a time window similar to the frontal old/new effects. The present results are in accord with view that negative valence may act to facilitate the formation and/or retrieval of bound memory representations making negative stimuli recollected to a greater extent than positive and neutral stimuli. Supported by the German Research Society (grant FOR448).

ERP effects of thatcherisation and emotional expression on upright and inverted faces

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The "Thatcher illusion" refers to a perceptual phenomenon whereby a face whose eyes and mouth have been inverted appears grotesque in an upright orientation, but normal in an inverted position. The normal appearance of inverted thatcherised faces has been attributed to a decrease in configural and an increase in feature-based processing with face inversion. The present study was designed to determine whether the effects of thatcherisation are due, at least in part, to perceived emotion. High density ERPs were recorded from sixteen individuals while they viewed neutral, angry, smiling and thatcherised faces at upright and inverted orientations. The subjects' task was to determine whether the faces were male or female.

The ERP effects of face type depended on whether the faces were upright or inverted. At upright, five time windows were identified, coinciding with the N170, P250, P360 and a late positive (LP) ERP components. ERPs to angry and thatcherised faces were similar, and differed from those to neutral and happy faces. At inverted orientations, three time windows were identified, coincided with the P1, P250 and the LP ERP components. Here, ERPs to happy and thatcherised faces were similar, and differed from those to angry and neutral faces. These results suggest that ERP effects of upright thatcherised faces are due primarily to perceived negative emotion, while inverted thatcherised faces are perceived as happy. The difference between the effects at the two orientations suggests that the perception of emotional expression may be dependent on configural or featural encoding.

Phylogenetic versus ontogenetic fear-relevant pictures: EEG-source localisation by means of LORETA

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Purpose: Evolution has made some objects innate sources of fear (Russell, 1979) and has shaped some relatively hardwired and reflexive escape responses; however, mammals are also able of learning to fear initially neutral objects that have signaled danger through Pavlovian conditioning. This study addressed the question whether phylogenetic fear-relevant stimuli (e.g., spiders) are processed by different brain-structures than onotgenetic fear-relevant stimuli (e.g., pointed guns).

Methods: 4 categories of pictures (neutral, ontogenetic fear-relevant, phylogenetic fear-relevant 'snakes' and 'spiders') were randomly presented to female subjects. Multi-channel evoked slow cortical potentials (SCPs; Bauer, 1998) were recorded during picture viewing. Low resolution electromagnetic tomography (LORETA; Pascual-Marqui, 1995) was used for quantitative localization of neural activity within the gray mater of the cortex. Inference-statistical analysis of the LORETA-values was done by means of 'statistical non-parametric mapping' (SnPM; Holmes et al., 1996).

Results: LORETA localized the sources of the EEG-data for all categories in the same brain regions (highest values were found in the ventral visual pathway) and SnPM indicated stronger activation in these regions for phylogenetic than for ontogenetic fear-relevant stimuli. Neutral stimuli elicited the lowest activation. Results are valid for N2, P3 and SCPs up to 3000 ms post-stimulus.

Conclusion: Our results show that phylogenetic as well as ontogenetic fear-relevant pictures are processed through the same cortical regions. However, the activity differences may reflect that more resources are assigned to phylogenetic than to onotgenetic fear-relevant cues, perhaps due to the influence of the amygdala.

Music and emotion: electrophysiological correlates of the processing of pleasant and unpleasant music

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Music is a powerful tool in the investigation of emotion. The purpose of the present study was to investigate oscillations during the processing of pleasant and unpleasant music. Subjects were presented with joyful musical excerpts and their manipulated dissonant counterparts to induce pleasant and unpleasant emotions. Participants were asked to listen carefully to the music, to tap the metre and to rate how (un)pleasant they felt after each piece of music. Furthermore, the experiment comprised silence periods to enregister a baseline condition. Behavioral data show that participants felt rather pleasant during the presentation of consonant musical excerpts, while dissonant pieces mainly induced unpleasant emotions. Contrasting the power spectra of music vs. rest, data show an overall delta synchronization, a frontal theta synchronization and a frontal beta desynchronization during the listening condition, probably reflecting different aspects of auditory processing and attention. Motor activity due to the finger tapping was reflected by left central alpha and beta desynchronization and a right parietal alpha synchronization. Contrasting the processing of pleasant and unpleasant musical excerpts, we found left frontal power differences within the delta and the upper alpha band. Results indicate that spectral analysis provides an appropriate method for systematically illuminating the underlying correlates of emotion processing, motor activity and perceptual processing during the listening to music.

Emotional valence accelerates lexical decisions: functional localization with ERPs

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Previous studies showed enhanced memory for emotional stimuli compared to neutral ones: participants remember emotional words, pictures and events better in

both recall and recognition tasks. Furthermore there is some evidence for faster processing of emotional stimuli compared to neutral ones. The mechanism(s) underlying these effects are mostly unknown. The aim of the present study was to elicit this speed advantage for emotional stimuli in a simple word comprehension paradigm according to behavioral parameters, and to localize this effect within the information processing system by means of recording event-related brain potential (ERP) components.

A lexical decision task was performed by 18 participants (11 women) while ERPs were recorded from 36 electrode sites. Stimuli were 240 German verbs and 240 pseudowords. Words were emotionally positive (e.g., ENJOY), negative (e.g., ANNOY) or neutral (e.g., PASTE) as determined by independent ratings. Reaction times showed an emotional valence effect especially for the items that had received the most consistent valence ratings. Emotionally negative verbs were always responded to faster than neutral verbs. Positive verbs were also faster than neutral ones but only when RTs were relatively fast. ERPs did not differ as a function of valence before the start of the late positive complex (LPC). Negative verbs elicited a larger parietal positive-going LPC than both neutral and positive verbs between 450 and 550 and again between 650 and 700 ms. Therefore the effects of emotional valence as observed here seem to be localized in late perceptual processes, and probably also later.

Directed forgetting of emotion and neutral words

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This ERP study aimed to investigate the underlying mechanisms of directed forgetting of emotion and neutral words. Cognitive theories suggest that multiple processes underlie the effects of directed forgetting, including differential encoding of to-be-remembered (TBR) and to-be-forgotten (TBF) items, and selective inhibition of TBF items during retrieval. It has furthermore been demonstrated that the emotional nature of test items often interferes with memory performance, possibly due to increased arousal and/or semantic cohesiveness. Participants (N = 17) were presented with 50 negative/anxious words and 50 neutral words. The colour in which the words were presented indicated whether they needed to

be remembered or forgotten. In the test phase, participants were required to indicate recognition of the previously presented words, regardless of encoding instruction. Recognition performance was better and quicker for TBR items than TBF items. There was also a significant recognition bias (Br) for emotion items. ERPs during encoding showed a prolonged fronto-central positivity (400–600 ms post-stimulus) for the emotional items compared to the neutral items. A similar ERP effect was found during the test phase, although it had a slightly earlier onset and a more widespread scalp distribution. There was no apparent ERP effect of remember or forget instruction during encoding, suggesting that these items were not differentially encoded. Finally, the parietal ERP old/new effect was present for the TBR items but not for the TBF items, suggesting that directed forgetting effects in this study/test paradigm were primarily the result of mechanisms acting during the retrieval phase.

Is beauty context-dependent? A priming study on facial attractiveness.

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Recent research on affective face processing has revealed dissociable brain responses to attractive versus non-attractive faces. However, everyday experience suggests that judgments of attractiveness are context-dependent. The present study employed a priming technique in order to specify the influence of affectively congruent, incongruent or neutral primes on judgments of facial attractiveness.

Event-related potentials were recorded from twenty-four participants (12 female) while classifying faces as attractive or non-attractive. Each target face was preceded either by an affectively congruent or an incongruent portrait of another person. Additionally, pictures of objects from everyday life and scrambled faces served as affectively neutral primes. All stimuli were selected on the basis of pilot ratings.

The comparison of the three different prime type conditions revealed that the presence of an emotionally significant prime as compared to a neutral prime altered the processing of target faces, as indicated by attractiveness judgments, reaction times, and event-related potentials. When faces were preceded by another

face, priming effects were found in affectively congruent as compared to incongruent trials. Our results support the view that judgments of facial attractiveness are influenced by the presence and by the valence of its immediate affective context.

Poster session 2: Cognition

Monday, March 29, 16:00–18:00; Foyer 2nd floor

An ERP evaluation of the development of item and source memory in school-aged children and young adults

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An important issue in contemporary memory research is whether memory for content (item memory) and memory for context (source memory) are mediated by different neuronal circuitries. We examined developmental aspects of both forms of memory. Two groups of children (6–8 yrs, 10–12 yrs) and young adults (20–29 yrs) performed an item memory (inclusion) task and a source memory (exclusion) task while event-related potentials (ERPs) were recorded. Performance in the inclusion task increased linearly with age, with children and adults using different response strategies: children adapted a conservative response criterion and gave their recognition judgments mainly on the basis of recollection as evident in a left parietal ERP old/new effect. Adults adopted a more liberal response criterion that was paralleled by a widely distributed old/new effect. This suggests that adults in contrast to children gave their recognition judgments on the basis of both recollection and familiarity. In the exclusion task, both groups of children performed less accurate than adults. This was mainly due to children's elevated false alarm rates to nontargets. Together with the absence of any frontal ERP old/new effect in the two groups of children, these findings suggest a selective impairment in retrieving a bound representation of an item and its study context, presumably caused by the delayed maturation of the PFC.

Extracting regularities in the human brain: Are there process- and domain-specific neural mechanisms?

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The hippocampus has been associated with building context-specific memories. This latter form of memory can be contrasted with decontextualized memories about regularities across specific experiences. Using fMRI we investigated the neural correlates of both types of memories. Volunteers had to learn conjunctions between objects and positions. In an invariant learning condition, positions were held constant, enabling subjects to extract spatial regularities across trials. In a context-specific condition objects and positions were variable across trials. Performance increase in the invariant condition was paralleled by an increase of inferior middle frontal gyrus (iMFG) and a decrease of hippocampal activity. Conversely, in the context-specific condition the hippocampus was activated continuously. These data suggest that the hippocampus is critically involved when information is represented in a context-specific way by binding variable objects to variable positions, whereas the iMFG mediates the extraction and maintenance of spatial regularities across episodes.

By increasing the number of object-position conjunctions and the duration of the learning phase in behavioral follow-up studies, we could show that performance increase within blocks was pronounced in an early phase of the experiment and diminished at the end. These data suggest that learning regularities might be based on two distinct mechanisms: A process operating within blocks and a process operating across blocks. A follow-up fMRI experiment will address two questions: (1) Are different brain regions involved in the proposed two learning mechanisms and (2) by contrasting a spatial and an object invariance condition, is the extraction of regularities a domain-general or a domain-specific neural mechanism?

Age-related differences in task-set selection and interference control: evidence from ERPs

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We used event-related potentials (ERPs) to investigate age differences in executive control. A cue-based task-switching paradigm with standard Stroop stimuli was employed, in which the participants were instructed either to name colors or to read words (single blocks) or to alternate between both (mixed blocks). Task-set selection was examined by comparing ERPs for single versus mixed blocks, interference control by comparing ERPs for compatible versus incompatible targets. Results of 14 younger (mean age = 22 years) and 14 older adults (mean age = 63 years) indicated a greater P3 component in the cue interval for mixed compared to single blocks for both age groups, showing a parietal-maximum distribution in younger and a more widespread distribution in older adults. This finding suggests that older adults have impairments in updating task-relevant information. Furthermore, older adults showed a substantially greater contingent negative variation (CNV) in mixed compared to single blocks, whereas no such difference was observed in younger adults. We assume that it reflects a stronger engagement in response preparation processing in the elderly. Finally, an enhanced negativity for incompatible targets (IN) was found, that was substantially smaller for older adults. The smaller IN in older adults presumably reflects age-related deficits in interference control.

In a follow-up study with a subset of the subjects from the first experiment we manipulated control demands by varying the probability of compatible/incompatible Stroop trials in order to examine whether this affects age-related changes in the three ERP components.

Neuromagnetic brain activity associated with visual working memory

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Neural correlates of visual working memory (WM) were examined using a task involving different delay conditions and requiring a constant monitoring of morphing figures. As stimuli we presented geometrical figures that could not easily be associated to common figures (such as triangles, stars). The preliminary analysis of the behavioral data of 11 healthy subjects showed a significant increase of reaction times and decreased performance accuracy with longer delay conditions. Lower performance accuracy was associated with less complex memorizing strategies. In addition, the subjects performed a control task with lower cognitive demand, to examine the impact of cognitive load and attention on different neurophysiological parameters. In this condition subjects were instructed to search for a simple triangle amongst an ongoing stream of (morphing) common geometrical figures. The delay conditions in this task were adapted to the WM task with higher cognitive load. High density magnetoencephalographic recordings (148-channel whole-head neuromagnetometer, 4D) were obtained during each of the conditions described above. Source space analyses were performed on band-pass filtered data determined by event-related Fourier spectrum analyses and wavelet procedures. Different event-related time epochs were analysed by minimum-norm estimates and multiple dipole density procedures. Neuromagnetic generator activity was discussed due to the behavioral performance.

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Modulation of error processing by error significance: Electrophysiological and cardiac evidence

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An event-related potential (ERP) associated with error processing has often been described and named error-related negativity (ERN). Evidence in the literature for the modulators of the ERN is inconsistent. Examples are strength of response conflict, individual importance or awareness of the errors.

We investigated the ERN and corrective behavior by recording ERPs and heart rate (HR) during the performance of a modified flankers task. Participants were randomly divided into two groups: The correction-instructed (CI) group who was asked to immediately correct all encountered errors and the correction-non-instructed (CN) group who was unaware that corrective responses were recorded.

The intention to correct errors significantly increased the correction rate. Effects of incompatibility were observed on the behavioral as well as on the HR level: Incompatible trials revealed more errors, longer reaction times and greater HR deceleration than compatible trials. Errors elicited faster reaction times and greater HR deceleration compared to correct responses.

The ERN was observed for incorrect responses showing a more negative amplitude for the CN group. When considering the behavioral results we assume that the ERN was modulated by the motivational significance of the errors reflected by fewer errors, more late responses as well as post-error slowing in the CN group. This assumption was strengthened by a trend of increased error related HR deceleration in the CN group. According to Crone and colleagues (in press) the result suggests a stronger violation of the performance-based expectations in the CN group compared to the CI who had the possibility to correct their errors.

Stimulus-driven arithmetic N400 effect

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ERPs elicited by stimulus-driven retrieval of arithmetic facts related to multiplication were investigated. We recorded the electrophysiological activity from the scalp of participants while they were performing a number-matching task. Crucially, arithmetic was task-irrelevant within this paradigm, because participants were simply to physically compare a cue composed of two one- or two-digit numbers and a single target number. In accordance with previous studies, behavioral data showed that, in non-matching trials, participants were significantly slower and less accurate to respond when the target number was the product of the two numbers in the cue compared to when the target number was arithmetically unrelated (i.e., neutral) to those numbers (interference effect). In line with recent findings on ERPs associated with task-relevant arithmetic facts retrieval, we showed that the interference effect resulted in a modulation of the amplitude of an N400-like ERP component, with neutral targets generating relatively more negativity than product targets. The observed dissociation between behavioral data and ERP measures is interpreted as evidence of activation spreading in the lexicon of arithmetic facts, since alternative explanations relying on strategic factors such as expectancy or semantic matching would have predicted the two measures to show a converging trend.

Temporal generalization in the range of milliseconds: ERPs suggest time perception within, and time estimation outside the P300 span

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In a series of EP experiments, auditory temporal generalization in the range of milliseconds was compared to pitch generalization, with difficulty held constant across tasks. Participants had to identify a previously memorized standard stimu-

lus among deviant stimuli, either with respect to pitch or duration. Identical sets of stimuli were presented in both tasks, using sine tones that varied independently along both the duration, and the pitch dimension. Two ranges of durations were investigated, 200 ms and 400 ms. For the 200-ms range, in three experiments inconsistent EP correlates of temporal vs. pitch generalization were found, whereas for the 400-ms range, there were no significant pitch - duration EP differences at all. However, within-task EP comparisons between stimuli of different duration yielded highly consistent results across the three experiments. Only when duration was attended to, variations in stimulus duration were accompanied by amplitude modulations of both a posterior P3b, and a fronto-central P500, but not during passive listening or while attending to pitch. P3b/P500 amplitude modulations, therefore, represent EP correlates of actively processed duration information. Furthermore, the nature of these EP correlates suggests real-time comparison of the current stimulus against a perceptual representation of the standard duration (200 ms). For the 400-ms range of durations, EP correlates of actively processed stimulus duration were qualitatively different. Stimulus duration was positively correlated with resolution time of a broad negative slow wave. Temporal processing in this longer time range appears to involve intense memory processes. It is concluded that durations below 300 ms (or, within the P300 span) are subject to time perception, whereas longer durations require memory-based time estimation.

The structure of semantic memory: category-specific ERP effects during visual and functional judgement

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Previous studies on the organization of semantic knowledge indicate that natural (animals) and artifactual (tools) objects activate different cortical areas in object identifications tasks (category-specific effects). This dissociation indicates that specific aspects of semantic knowledge are differentially relevant for representing natural (visual features) and artifactual objects (functional). However the functional and structural organization of the semantic system and the interpretation of category-specific effects are still a matter of controversy. Within a repetition priming paradigm, we tested the prediction whether visual and functional aspects

of semantic knowledge are differentially important for artifactual and natural objects by measuring event-related brain potentials (ERPs). A categorization task was used in the learning phase and a visual and functional judgment task, respectively, in the test phase. Stimuli in the test phase were words denoting artifactual and natural objects, which were either new or previously presented (old). Only for the visual judgment, we found greater positivity in natural than artifactual objects at occipito-parietal electrodes (category effect). At the same electrodes repetition priming effects differed between categories. The present results support the relevance of visual features for natural categories (modality-specific subsystems) and show that category-specific brain activation depends on task-demand.

How the brain acquires explicit knowledge. Event-related potentials (ERPs) as predictive indices

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The present study was a variation of the number reduction task of Woltz et al., 2000 and was designed to get new insights into the differences of implicit and explicit learning processes. The experiment consisted of a serial arithmetic problem structured in a special manner (ABCCB) which allowed a strategy change. The subjects had to respond to the numbers presented on the screen depending on specific rules. The participants were alluded to the possibility to shorten their key entries if they recognize the structure of the task. However, this instruction was formulated implicitly. During the task ERPs were recorded. The subjects were subdivided into two groups according to whether they discovered (explicit group, EG) or not (implicit group, IG) the rule. The hypothesis was that explicit learning and implicit learning is reflected in differences in the ERPs before strategy change. Twenty-six subjects participated in the experiment. Six of them were assigned to the EG and 20 to the IG. The EG showed a significant larger P2 and P3 to the first number of the series compared to the IG ($p = 0.011$ and $p = 0.003$, respectively). The results indicate that subjects differ in the ERPs before they are aware of the regularity. One can suppose that explicit learners are not only more attentive than implicit learners but also additional modules are activated.

The laser-evoked P600 may reflect 'Context Closure' rather than 'Context Updating'

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Laser-evoked potentials (LEPs) are brain responses related to the activation of cutaneous A∂ nociceptors. Occurring between 120–450 ms for hand stimulation, LEPs mainly consist of a negative-positive complex (N2-P2) maximal at CZ. Peaking around 600 ms, an additional parietal positivity is often described. As its amplitude is enhanced when evoked by rare target stimuli presented in an oddball paradigm, investigators proposed that this P600 is equivalent to the P3B evoked by other modalities. The P3B is hypothesized to reflect either updating of working memory following arrival of new information ('Context Updating' model) or closure of information processing occurring when expectations are terminated ('Context Closure' model). To test these hypotheses, eleven subjects participated in two experiments. Laser stimuli were applied to the hand dorsum. In the first experiment, trials consisted of single stimuli. After each trial, subjects were asked to rate intensity of perception. In the second experiment, subjects were told that each trial would consist of two consecutive stimuli occurring with varying stimulus onset asynchrony (SOA). Instructions were to rate separately intensity of both perceptions. In four trial categories, two consecutive stimuli occurred with four different SOAs (range 280–2100 ms). In a fifth category, one single stimulus occurred. Results showed that stimuli evoked clear P600 responses only when ending the sensory detection task (i.e. single stimuli when a single stimulus was expected, second of two consecutive stimuli when two were expected). These observations give clear support to the 'Context Closure' model for the P600 component.

Processing numeracy with distractor's variation: A RT-ERP study

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The fast and accurate apprehending of small sets of 1–3 items arouses more and more interest in neuropsychological research. What is the nature of the mental process for quantifying numbers that do not exceed three? Are subitizing and counting two different types of processings with different neural substrate, or the same process but with different difficulty? The Event-Related Potentials (ERPs) were recorded while 14 normal young subjects (age range 18–23 years) were counting the number of the presented rectangles. The goal of the present research is to investigate the enumeration abilities with or without distractors, and sheds light on the relationship of subitizing and counting. We hypothesized that if subitizing and counting are processed functionally similar results should show no difference of their temporal patterns across all the levels of the experiment. The results show that the good ERP predicator of the functional difference of the two enumeration processings: the discontinuity of the effects of the variation of distractors from the subitizing range to the counting range. The electro-physiological evidences support the idea of the two processes being implemented in functional different systems. The distractor's number variation caused different type of ERPs waveforms in two enumeration processings. For subitizing, a more pronounced negative-going effect was found than counting, mainly in parietal area. It better demonstrated the difference of the two enumeration abilities from a new perspective. It also compensated the early behavioral methods' shortcomings of poor temporal resolution and gave us a clear understanding of the temporal patterns of the two enumeration processings, the results confirmed the argument that subitizing and counting are two functionally different processings, they can be differentiated by the different effects of the variation of distractors.

Components of task switching: An ERP perspective

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Switching between tasks involves executive control processes, such as inhibiting the previous task regime while reconfiguring response requirements by retrieving the current task set and storing it in working memory. Recent hemodynamic imaging research suggests the involvement of prefrontal and parietal cortices in task switching behavior. In the current study, switching was assessed by presenting digits under two task sets, more than/less than 5 and odd/even. Subjects responded via choice reaction time (RT). In No Switch blocks the same task was repeatedly presented. In Switch blocks, subjects began with one of the two tasks. After 7 to 13 items, a cue presented simultaneously with the digit indicated the requirement to switch to the other task. ERPs were recorded from 62 channels in 15 young adults. RTs were longer during switch compared to no-switch blocks. In switch blocks, RT was prolonged on switch relative to pre-switch trials. Additionally, a residual RT switch cost was observed on the trial following the switch, relative to the trial preceding the switch. Relative to pre-switch trials, switch trials were associated with a large-amplitude positivity (~500 ms) with a right pre-frontal scalp focus, which preceded mean RT by ~600 ms. Relative to the ERPs associated with pre-switch trials, the trial immediately following the switch was associated with negative activity that had a parietal-occipital scalp focus (~400 ms), and occurred ~300 ms before mean RT. The positivity might reflect inhibition of the previous task set, while the negativity may reflect task set reconfiguration.

Comparing the auditory and visual stop task: A psychophysiological study.

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Background: Successful stopping in the stoptask with an auditory stopsignal is associated with more fronto-central positivity (P3) compared to unsuccessful stopping (De Jong et al., 1990; Overtoom et al., 2002). On the other hand stopping with a visual stopstimulus evoked more negativity (Pliszka et al., 2000). It seems that successful stopping in the auditory modality is associated with more positivity and that in the visual modality stopping is associated with more negativity. Falkenstein et al. (1999) reported the presence of a visual N2 at NoGo trials in a Go/NoGo task but this negativity was absent in the auditory modality. It could be that the presence of positivity or negativity is modality specific. Therefore we investigated in the current study both modalities in the stoptask and expected an N2 in the visual stoptask and fronto-central positivity in the auditory task.

Methods: Performance and event-related potentials (ERPs) from 18 adults were compared in a visual and auditory stop-task. ERPs were recorded from 64 electrodes.

Results: The stop-signal reaction time (SSRT) was shorter in the auditory condition than in the visual one. The fronto-central positivity(P3) was present in both modalities and was larger in the successful stoptrials compared to the unsuccessful stoptrials. Furthermore, the longer SSRT in the visual condition could also be identified in a latency shift of the visual P3. However, no N2 was detected in either task.

Conclusions: The absence of the N2 in both stoptasks may indicate that the N2 might be more interpreted in terms of a response conflict than to be related to inhibition.

Agreement and number interference processes in Spanish: An ERP study

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Agreement processes represent a challenge to sentence processing systems in production and comprehension. Several experiments have investigated agreement processes between subject and verb in production by using complex noun phrases. Disruption of the local noun have been reported in production (e.g., Bock & Miller, 1991; Bock et al., 1999;Vigliocco, et al., 1995, 1996) and in comprehension (Nicol et al., 1997; Pearlmutter, et al., 1999) with behavioral measures.

We measured ERPs while reading sentences (a-c) that contained a complex noun phrase (NP1 of the NP2) followed by an adjective that had to agree with the first noun. We investigated the effect of the disruption of the local noun in grammatical sentences (a) and in ungrammatical sentences (b) as compared to the control condition (c), by manipulating the number mismatch between the head noun etiqueta (label) and the local noun botella/s (bottles) and the number agreement between the head noun and the adjective bonita/s (nice).

a. La etiqueta de las botellas siendo bonita fue arrancada. (mismatch, congruent) The label of the bottles being nice (singular) was taken off.

b. La etiqueta de las botellas siendo bonitas (plural) fueron arrancadas. (mismatch, incongruent)

c. La etiqueta de la botella siendo bonita (singular) fue arrancada. (match, congruent)

The results showed that the amplitude of the P600 was larger in the mismatch conditions (a and b) than in the baseline (c), but importantly, was larger in the number disagreement condition (b) as compared to mismatch- agreement condition (a), especially in a late window. Results will be discussed according to current models of agreement and feature tracking.

Cortical oscillations during encoding predict successful recall

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Successful formation of new episodic memories is associated with a variety of physiological markers (Paller and Wagner, 2002). Recent work has shown that gamma phase synchrony in medial temporal lobe (MTL) during study predicts subsequent recall (Fell et al., 2001). Recording intracranially from 793 widespread cortical and subcortical sites in 10 epileptic patients undergoing invasive monitoring, we examined oscillatory power at frequencies ranging from 2 to 64 Hz as participants studied lists of common nouns. Results showed that significant increases in oscillatory power in the 4–8 Hz (theta) and 28–64 Hz (gamma) frequency ranges predicted successful retrieval of list items. At some sites, oscillatory activity, primarily in 9–28 Hz range, decreased with successful encoding. Electrodes exhibiting increases in theta oscillations that predicted successful recall clustered in the right temporal and frontal lobes. Sites where gamma oscillations positively correlated with subsequent recall were found at many cortical locations, but especially in the temporal lobe and subtemporal occipital region. These findings point to a widespread network of cortical regions whose activity is modulated during successful episodic memory formation.

The error-related negativity as an electrophysiological correlate of learning

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Medial-frontal negative potentials have been elicited by performance feedback in choice reaction time tasks and by monetary losses in simple gambling tasks. One theory of the functional significance of these potentials suggests it is responsive to the emotional significance of an event, whereas the Holroyd and Coles (2002) model posits that it is an error signal generated in response to detecting an out-

come that is worse than expected. To investigate these theories this experiment involved participants learning probabilistic relationships between stimuli and monetary values. First, the participant was shown a shape; next, they indicated which monetary outcome they thought was associated with that shape and rated their confidence in their choice; then they were given accuracy feedback; and finally, they were presented with the associated monetary outcome. A major finding was that the amplitude of the ERN was greatest in response to error feedback stimuli at the beginning of learning the association, consistent with the Holroyd and Coles model. A further result, however, showed that the waveforms in response to monetary outcomes that were better than expected did not differ from those elicited by outcomes that were worse than expected.

Event related potentials during verbal and non-verbal Sternberg paradigms

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Sternberg paradigm is one of the neuropsychological tests that assesses working memory. In this study two Sternberg experiments with letters or meaningless figures were used in order to determine the electrophysiological correlates of distinct subsystems of working memory. In each block, 3 and 5-item memory sets were presented with 2 s intervals to the subjects on the computer screen. After 3 s, a set of 6 or 10 probes were presented, respectively, and the subjects were told to push the left button of the computer mouse if the subject thought that the stimulus on the screen belongs to the memory set, and the right button of the mouse if not. Eighteen right-handed, healthy volunteers with a mean age of 25.9 took part in the study. 30-channel-ERP recordings were carried out during the tests. Mean amplitudes of the ERP waveforms were measured for 15 intervals of 50 ms duration between 0 and 750 ms. The analysis of the reaction times (RT) of 3 and 5 item memory sets shows that each additional item in the memory set increases the RT by 28 ms, which is in accordance with the earlier studies. In ERPs, the most important finding was a right lateralized positivity consistently observed at 200 ms after stimulus presentation in each condition, which seems to reflect the beginning

of the comparison of the presented stimulus with the memory set. Following this, a P300-like potential with a midline parietal maximum was observed whose latency was prolonged in line with the RTs with increasing memory load. Distractors and meaningless figures further prolonged the latency of this late potential, which seems to reflect the end of the comparison and the decision making process.

Poster session 3: Attention

Monday, March 29, 16:00–18:00; Foyer 2nd floor

Arrows indicating direction modulate N1 amplitude

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It is well documented that N1 amplitude of the visual evoked potentials (ranging from 100 to 200 ms after visual presentation) is sensitive to the orientation and location of a stimulus (O'Donnell et al., 1997). Attention directed to a specific region of the visual filed, also enhances the N1 component elicited by stimuli presented in the same region (Heinze et al., 1990; Rugg et al., 1987). N1 probably reflects the flow of information from V1 to extrastriate cortex (Hillyard et al., 1998). We tested whether spatial attributes of a visual cue modulate early VEP components, namely N1 amplitude. Arrows pointing to the right or to the left were presented lateralized. Subjects had to release, as soon as they could, a right or a left key with the corresponding hand according to the arrow direction, and to ignore its position. In the two control conditions arrows were replaced by non-directional cues or by arrows pointing either upward or downward. Again subjects had to release a key according to specific stimulus features and ignoring their position. Event Related Potentials (ERP) were recorded using a 32-channel system in a modified 10-20 system. Significant shorter RT and greater N1 amplitudes were obtained when arrows were presented instead of controls. We concluded that

the efficiency of motor response to spatially oriented stimuli is modulated at early stages of visuomotor processing by N1 component.

Attentional modulation of somatosensory steady-state in the human EEG

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Focusing attention to a specific location in the environment has been shown to improve perception of objects or events that are within the so-called 'spotlight of attention'. The steady-state response (SSR) in the human EEG has been used in the visual and auditory modality in order to investigate attentional mechanisms in the human brain. As of today, little is known about the attentional modulation of the somatosensory steady-state evoked potentials (SSSEPs) and their underlying cortical mechanisms. We elicited somatosensory steady-state evoked potentials by mechanical vibratory stimulation applied to the second metacarpal of the left and right index finger (4.9 Newton) and subjects were instructed to selectively attend to one finger while ignoring the other. We showed a significant increase of SSSEP amplitude for attended stimuli for frequencies in the 20 Hz range. Further, we replicated this effect in a high density EEG experiment, allowing us to examine the topographical distribution of the attentional SSSEP modulation. The importance of this result for research on attention, in particular cross-modal integration and clinical research will be discussed.

Recall modality affects rehearsal mechanisms in a delayed serial recall task: Evidence from an EEG coherence study

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Serial recall of visually presented words is markedly impaired when irrelevant speech is presented. Using EEG coherence, a previous experiment investigated the

underlying phonological rehearsal network and found coherence changes as a function of rehearsal processes (quiet vs. irrelevant speech condition) at central and left frontal electrode sites in the Gamma frequency band. In the current study we varied the recall modality of a delayed serial recall paradigm to test whether participants show similar synchronization patterns when being forced to encode the visual items into a phonological code (spoken recall) or not being forced to do that (written recall). The duration of high EEG coherence during the retention phase revealed different patterns for different frequency bands: In the Gamma band, the spoken conditions showed the previously observed decrease of coherence duration from quiet to irrelevant speech in central and frontal electrode combinations whereas the written conditions did not. In contrast, Theta coherence showed an increase for the speech compared to the quiet condition in fronto-parietal electrode combinations only in the memory tasks with written but not in those with spoken recall. The results are interpreted as indicating that differences exist concerning the networks involved in the rehearsal mechanisms employed in the two different tasks.

Uni- and crossmodal effects of orienting attention to a point in time: An event-related potential study

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Attending to a particular location affects both the processing of stimuli of the attended and of the unattended modality. Using event-related potentials, the present study investigated if similar crossmodal effects exist when attention is oriented to a point in time.

Short (600 ms) and long (1200 ms) empty intervals, marked by a tactile onset and an auditory or tactile offset marker (200 ms long), were presented. In each run, the participants had to attend to one of the two intervals and one of the two modalities and were instructed to respond to infrequent “gap” offset markers (same duration as standard offset markers, but stimulation interrupted in the middle) of this interval and modality.

Event-related potentials to auditory and tactile standard offset markers of attended as compared to unattended intervals were characterized by an enhancement of early negative deflections of the auditory and somatosensory event-related potentials (audition: 100–140 ms; touch: 130–180 ms, 190–230 ms) when audition and touch was attended, respectively (unimodal effects of temporal attention). Similar effects were found for auditory stimuli when touch was task relevant (crossmodal effect of temporal attention).

These results suggest that temporal attention modulates early sensory processing stages both within audition and touch. Moreover, the crossmodal attention effect in the auditory modality provides preliminary evidence that similar links between the modalities, as have been shown for spatial attention, can also affect stimulus processing when attention is focused on a point in time.

Attentional capture by prosodically salient information in unattended speech sounds: an ERP study

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It has been argued that attentional resources are preferentially allocated to information occurring early in the speech stream. However, a burgeoning behavioral literature has demonstrated that phoneme detection is faster and more accurate for prosodically salient (stressed) than unstressed syllables, regardless of their temporal positions in a word. This finding suggests that word prosody is important in capturing attention during speech perception. We investigated whether for unattended speech sounds, temporally or prosodically salient information would capture attention. In an auditory oddball paradigm, native English speakers were asked to ignore binaurally presented stimuli and to watch a silent movie while ERPs were recorded. After completion of that phase, all volunteers participated in a behavioral discrimination task. The unattended phase was divided into two sessions. In the following, capital letters indicate the stressed syllable. In the first session, acoustic stimuli included initially stressed disyllables. The standard was "BAga," and the two deviants "BAka" and "PAga". In the second session, stimuli consisted of non-initially stressed disyllables. The standard was "baGA," and the

two deviants “baKA” and “paGA.” While MMNs were observed in the ERPs to all deviants in the unattended session (the largest amplitudes to BAka and baKA), the P3a, indicative of involuntary attentional capture, was only seen to the deviants “PAga” and “baKA”. Behavioral discrimination was higher for the deviants “PAga” and “baKA” than for the other two deviants. It is concluded that prosodic rather than temporal salience triggers involuntary attentional capture for unattended speech sounds.

Attentional orienting and reorientation in young children

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The aim of this study was to investigate attentional processes in young children on electrophysiological and behavioral levels. More specifically, we were interested in processes involved in the involuntary orientation to task-irrelevant distracting sound features and the voluntary reorientation to task-relevant aspects of stimulation. We developed a new distraction paradigm suited for children (5 to 6 years). The children’s task was to distinguish between different animal voices. Rare and task-irrelevant changes of the sound’s location served as deviants. Results revealed effects similar to those obtained in adult studies with a traditional auditory distraction paradigm: on the behavioral level, elongated reaction times were obtained in the animal voice discrimination task in location deviant trials. The deviance-related ERPs showed a pattern of negative and positive deflections resembling the MMN, P3a and RON. Therefore we assume that the children in the age of 5–6 years do already reveal a series of processes consisting of deviance detection, attentional involuntary orientation to the distractor, and voluntary reorientation to the primary task analogues to that in adults. However, subsequent studies are needed to investigate these effects and the development of distractibility in children in more detail.

Poster session 4: Clinical and pharmacological research

Tuesday, March 30, 16:00–18:00; Foyer 2nd floor

Exploration of auditory P50 gating in schizophrenia by way of difference waves

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The hypothesis of a sensory gating defect in schizophrenia has been supported by studies demonstrating deficient auditory P50 gating in the patients. P50 gating is the relative attenuation of P50 amplitude in the auditory evoked potential following the second click stimulus in a stimulus pair.

Difference waves have mostly been employed in studies of later event related potentials but here the method is applied exploratory on auditory P50 gating data of un-medicated schizophrenia spectrum patients (n = 17) and healthy controls (n = 24).

The patients had an attenuated difference P50. This attenuation was primarily seen in the sub-sample of patients with severe negative symptoms.

The low frequency difference waveform uncovered abnormalities, which cannot entirely be understood within the sensory gating theory.

Event related potentials during the Stroop task: Association study with DISC1 gene

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Using Event-Related potentials (ERPs), an impairment in the P300 amplitude has been found in families carrying a balanced translocation on chromosome 1 (1;11) (q22;q14.3), leading to the suggestion that ERP abnormalities may be useful as an

endophenotype. ERPs could represent a narrow phenotype relative to current psychiatric disorders, thus minimizing heterogeneity and increasing "signal-to noise" ratio in tests of genetic association. In addition, physical and quantifiable measures such as ERPs are easier to assess than other psychiatric behavioral phenotypes.

We investigated whether a single nucleotide polymorphism (RefSNP# 2255340) of Disc1 gene close to the break site on chromosome 1 is associated with ERP change in drug-free subjects.

The results demonstrated no differences in late component amplitude among the genotype groups. Our findings suggest that the DISC1 polymorphism does not play a major role in the late component of the ERPs.

P300 auditory oddball paradigm by using CEPs and fMRI in vegetative comatose: Interest for a consciousness model in clinical use

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Medical, ethical, legal, and economic reasons justify the assessment of possible conscious remnants in comatose and vegetative patients. One of the issue as to whether it is possible to bypass communication and examine consciousness thanks to the recording of scalp electrical brain activities (electroencephalogram, evoked potentials) both with fMRI study, can only be achieved on the basis of an operational model of consciousness. The Oddball paradigm are often used in clinical domain to get information on (1) the integrity of stimulus analysis in sensory-specific cortex (N1-P2); (2) the patient's ability to orient his/her attention to a target stimulation (N2-P3a); and (3) cognitive processing related to memory and/or response (P3a-P3b). In this study, 3 patients in a vegetative comatose state were confronted with a classical auditory oddball P300 design during the recording of event-related potentials (ERPs) and during fMRI with the same stimuli. CEPs and fMRI data were compared in order to assess whether a brain response was generated by deviant rare stimuli, thereby providing some information on the

level of the patient's consciousness. According to two recent models (the consciousness model developed by Damasio and the one of Guerit for the CEPs in comatose), we suggest that clinical neurophysiology in association with fMRI may be of the great help to discriminate and monitories comatose patients and more specifically in vegetative comatose patients.

Evaluating the cognitive effects of Bupropion HCl during smoking cessation using event-related brain potentials

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Objective: To measure the cognitive effects of Bupropion SR on heavy tobacco smokers during Bupropion SR treatment by event-related brain potentials (ERPs).

Materials & Methods: P3a and P3b ERPs of 10 smokers were evaluated using the Novelty P3 paradigm. The ERPs were recorded after abstaining overnight and after the first dose, and additionally on the 7th and 45th days of the therapy. Repeated measures ANOVA was applied for the statistical analyses.

Results: The examination of electrophysiological data with respect to drug use showed that there was a significant overall increase ($p < 0.05$) in P2 latency after 7 days of Bupropion treatment in responses to standard stimuli. Drug use x topography interaction induced a trend-level increase in P3b amplitude ($p = 0.07$) at the parietal area after the first dose. On the other hand, there was a significant increase ($p < 0.05$) in P3a amplitude at the parieto-central area due to chronical use of Bupropion SR.

Conclusions: The reduction of P3a at the frontal area suggests a decreased distractibility due to task-irrelevant novel events, which may be interpreted as an augmentation of focused attention to task-relevant target events. The increase in P3b at the parietal area is in line with this hypothesis. Based on Broadbent's dual process arousal mechanism, it is suggested that noradrenergic activation helps to focus on task-relevant behaviors by attenuating the influence of distracting stimuli. Therefore, we can assume that the augmentation of focused attention by bupropion is mediated by its noradrenergic mechanisms.

Target P3b potentials in the novelty paradigm are more sensitive than oddball P3b potentials in detecting cognitive impairment in early stage Alzheimer's Disease (AD)

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Alzheimer's Disease (AD) is characterized by progressive amnesia resulting in global dementia. The most consistent electrophysiological findings involve a prolonged latency and decreased amplitude of P300 in oddball paradigms. However, these findings remain relatively unnoticeable in the early stages of the disease. In this study, P3b and P3a potentials in auditory oddball and novelty paradigms were measured from 14 healthy volunteers and 22 patients at the early to medium stages of AD (early, GDS ≤ 4 and CDR < 2, medium, GDS > 4 or CDR ≥ 2) with the aim to find a more sensitive sign of the early AD. All patients, who were referred from the Department of Behavioral Neurology and Movement Disorders, were evaluated with MMSE, and Global Deterioration (GDS) and Clinical Dementia Rating Scales (CDR). In the oddball paradigm the differences in P3b amplitudes and latencies between the AD patients and the control group were not statistically significant. P3a amplitudes to novel events showed a significant overall latency prolongation, but no significant amplitude reduction. However, the amplitude of the P3b generated by target stimuli of the novelty paradigm showed a highly significant decrease in the parietal leads. These findings suggest that there is a delay in the processing of distracting novel stimuli in the novelty paradigm, and that this causes a difficulty in focusing the attention to target stimuli. In this study, the oddball P3b amplitude and latency changes reported in the literature have not been observed possibly due to the subjects' being in an early stage of the disease. However, the P3b potentials obtained in the novelty paradigm are more sensitive in detecting early stage AD subjects than classical oddball paradigm.

Neurolinguistic aspects of P300 in Alzheimer's disease

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While neuropsychological test material is commonly used by speech therapists to positively diagnose a Demence of Alzheimer's Disease (DAT), other brain-imaging methods such as CT and MRI have been employed to ensure the absence of other disorders. Further, several research groups are presently investigating whether neuropsychological measures can be used to provide additional diagnostic information.

From a neurophysiological point of view, event-related potentials (ERPs) seem to yield the most interesting results. This is particularly true for the P300 component whose latency and amplitude is closely associated with cognitive processes and cholinergetic functions. In Alzheimer patients, increases in latency and decreases in amplitude of this component could be found even at the early stage of the disease. An additional finding is that patients suffering from Alzheimer's disease or age-associated dysmnesia showed decreases in P300 latencies when under medication with nootropics.

Nonetheless, the clinical importance of the P300 for the differential diagnosis of Alzheimer's disease will be and has to be critically discussed. This discussion will stress the fact that, as a single measure, alterations in the P300 cannot provide reliable information for a differential diagnosis of DAT as there is a great overlap between the latency and amplitude values of patients suffering from DAT and age-matched controls. It is assumed that in an Alzheimer's Disease – and only here – working processes, that are related to a P300, are selectively slowed down. Accepting this aspect, it will be logical to correlate the latencies of a N100 to the P300: the difference in latency from P300 to N100 might be typical for an Alzheimer's Disease.

However, we make the point that, when used as an additional tool, the P300 can provide useful information that goes beyond the results obtained from neuropsychological measures. From a scientific standpoint, this additional information on the alterations of the P300 might also provide new perspectives in the search for the causes of Alzheimer's dementia.

This contribution shall show scientific concepts, but before ending our project, no first data can be published.

Serotonergic dysfunction in schizophrenia assessed by loudness dependence of primary auditory cortex evoked activity

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Increased serotonergic activity is discussed as an important pathogenetic factor in schizophrenia. Further support for this hypothesis is difficult to obtain due to the lack of valid indicators of the brain's serotonin system. A great deal of evidence discovered through human and animal studies suggests that a weak loudness dependence of auditory evoked potentials (LDAEP) indicates high serotonergic activity and vice versa. This is true only for the LDAEP of the primary auditory cortex, since this region is more highly innervated by serotonergic fibers than the secondary auditory cortex. The LDAEP (N1/P2 component) of 25 inpatients with schizophrenia free of medication and 25 healthy controls matched by age and gender, were recorded. Using dipole source analysis, the LDAEP of primary (tangential dipole) and this of secondary auditory cortex (radial dipole) was separately analyzed. Following a 4-week treatment with the 5-HT2 antagonists clozapine or olanzapine, patients were once again studied. The LDAEP of the primary, but not of the secondary auditory cortex, was significantly weaker in the patients with schizophrenia than in healthy volunteers, indicating enhanced serotonergic neurotransmission. After treatment with the 5-HT2 antagonists, the LDAEP (of the right hemisphere) tended to be increased, indicating normalization of serotonergic function in the patients with schizophrenia. These results suggest that the loudness dependence of primary auditory cortex evoked activity is well suitable to assess serotonergic dysfunction in schizophrenia.

Cognitive dysfunction in multiple sclerosis patients: electrophysiological and psychometrical assessment in 46 patients

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Background: Multiple sclerosis (MS) is a major cause of physical disability in young adults. Moreover neuropsychological deficits are frequent in MS. Several studies have shown attentional deficits, particularly involving controlled information processing. Little is known about automatic information processing. Mismatch Negativity (MMN) is classically assumed to be a neurophysiological index of automatic information detection.

Goal of the study: The aim of our study was to assess automatic information processing in MS using ERPs and to evaluate MMN as a putative index of global cognitive dysfunction.

Subjects and methods: Our study included 46 MS patients assessed with a passive oddball paradigm using duration deviants, compared to a group of 46 healthy subjects. Measurements included latencies and amplitudes of the N1P2 complex, MMN wave and P3 wave. 18 of the 46 patients underwent psychometrical evaluation including global intellectual functioning test (Mattis), attentional skills test (TEA), verbal memory test and information processing speed test (PASAT).

Results: N1P2 complex amplitude, MMN and P3 areas were reduced in MS patients. MMN and P3 latencies were shortened in our patients. Neuropsychological testing showed attentional deficits and global intellectual deficits at a group level. MMN area and N1P2 complex amplitude reduction was more pronounced in cognitively impaired patients.

Conclusion: Automatic information processing as indexed by MMN is altered in MS patients, and MMN area may be even more critically reduced in cognitively impaired patients. We speculate that MMN could represent an objective index of cognitive dysfunction in MS.

Single trial P300 recognition by machine-learning algorithms for brain-computer interfacing

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Within the area of Brain-Computer Interfacing (BCI), the P300-Speller paradigm, originally proposed by Farwell & Donchin (1988), utilizes the P300 in an oddball-like paradigm to construct a BCI, which is independent of training of participants. In a 6 x 6 matrix filled with symbols, rows and columns are flashing, resulting in a P300 in the EEG-pattern for an attended symbol.

We fitted the machine-learning technique Support-Vector Machines (SVM) to the demands of the P300-Speller paradigm. We applied the algorithm on data from own experiments and were able to accelerate the P300-Speller paradigm from about 12 bits/min up to 84.7 bits/min, making it a very fast EEG-based BCI. Using this technique, we were able to classify P300 trials with an accuracy of up to 94% within a single trial. By analyzing what was learnt by the SVM, inferences might be made about psychophysiological details.

Increased event-related theta activity as a psychophysiological marker of hyperactivity in children

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The spontaneous EEG has consistently manifested increased slow wave activity from the theta (4–7 Hz) frequency range in children with psychiatric disorders, which is regarded as reflecting cerebral dysfunctions. Notably, event-related oscillations from the theta frequency band have been correlated with processes of cognitive stimulus evaluation in attention and memory conditions. Yet, it is not known whether a pathological background theta activity in children with psychiatric disorders may affect cognitive stimulus processing as reflected by event-related theta oscillations.

Spontaneous and event-related theta activities were studied in children with attention-deficit hyperactivity disorder (ADHD), multiple tics disorder (TD), combined ADHD+TD, and healthy controls. Phase-locked theta responses (TRs) were elicited in a selective attention auditory task, in which only the targets presented to an attended ear had to be responded to by button pressing. TRs were analyzed in two time windows after stimulus: early (0–250 ms) and late (250–500 ms). Major results showed that both the early and late TRs were significantly larger in children with hyperactivity (HA, ADHD and ADHD+TD) than in children without HA (controls and TD). In addition, early and late TRs of the co-morbid (ADHD+TD) children were specifically increased for the to-be-attended stimuli. Correlational analyses demonstrated that HA-related increase of TR to unattend stimuli was associated with larger spontaneous theta activity, whereas TR increase to attend stimuli correlated with the level of hyperactivity and psychopathology. It is suggested that in children with hyperactivity disorder, different psychopathological mechanisms may affect processing in the attended and unattended channels.

Episodic memory in patients with attention-deficit/hyperactivity disorder (ADHD)

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Patients with attention-deficit/hyperactivity disorder (ADHD) have been reported to show significant episodic memory impairments beside attentional deficits. Attentional deficits in ADHD are mainly attributed to a dysfunction of the executive attentional control system. The aim of the current study was to separate whether episodic memory deficits in ADHD patients are due to a general prefrontal executive control deficit or whether basal, mediotemporal memory processes are affected.

ADHD patients (age 11–17) and age-matched controls performed a “levels-of-processing” (LOP) paradigm posing different demands on cognitive control. In LOP-paradigms, the depth of processing during encoding is manipulated by the instruction to either attend to perceptual or semantic aspects of a stimulus.

Healthy subjects, in general, show better memory performance after semantic instructions ("LOP-effect"). In the current experiment we used visual stimuli of low and high emotional salience (e.g., stimuli from the International Affective Picture System) to induce different needs for cognitive control, namely to process stimuli independent of their salience according to the instruction. During encoding, the EEG was recorded from 30 electrodes (Neuroscan). Recognition of old (n = 240) and new stimuli (n = 120) was immediately assessed after the study phase. First data show that a group of patients showed severely reduced recognition rates, although the LOP effect was intact for both neutral and emotional pictures. Further behavioral and ERP data in response to perceptually and semantically processed stimuli in dependence of emotional salience are reported and discussed.

Impairment of pseudo-word and complex-sound segmentation in dyslexia

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Dyslexic individuals have speech- and non-speech sound discrimination dysfunctions even at the early level of cortical discrimination as suggested by mismatch negativity (MMN) studies. For example, discrimination of features such as temporal patterns and pitch are problematic for dyslexic individuals, whereas their sound-duration discrimination is not affected. We evaluated how duration changes in segments of 3-syllable pseudo-words and their acoustic correlates were pre-attentively and attentively discriminated by dyslexic and control adults. Consistently with previous results, no MMN amplitude differences were found between the groups for duration changes, whereas there was a MMN topography difference between the groups for the change in the last tone segment. In addition, the N2b, elicited while attending to the sounds, was smaller in the dyslexic than control subjects for the tone changes in all three segments and for the pseudo-words in the last segment. Furthermore, the dyslexic subjects were impaired in behaviorally discriminating the deviant segments. These results suggest that even such sound

contrasts that are discriminated at the early sensory memory level in dyslexic individuals may be difficult to identify when presented in words or comparable complex sounds.

Diagnostic subgroups of developmental dyslexia have different deficits in neural processing of tones and phonemes

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The present study addressed auditory processing in dyslexic 8–11-year old children by the means of event-related brain potentials (ERP). Cortical sound reception was evaluated by recording N250 responses to syllables and tones and cortical sound discrimination by analyzing the mismatch negativity (MMN) to syllable and tone changes. Furthermore, we assessed whether different diagnostic subgroups of dyslexic individuals show different patterns of cortical activity. It was found that both cortical sound reception and sound discrimination was impaired in dyslexic children. The analysis of the data obtained from the two dyslexic subgroups, Dyslexics-1 being impaired in non-word reading (or both non-word and frequent word reading) and Dyslexics-2 in frequent word reading but not in non-word reading, revealed that the MMN was specifically diminished in the latter group whereas it was normal-like in Dyslexics-1. However, no differences were found between these sub-groups in sound reception as suggested by the responses elicited by the standard stimuli. These results show that different diagnostic subgroups of dyslexic individuals have different patterns of auditory processing deficits as suggested by similarly impaired sound reception in the two dyslexic groups and the sound-discrimination impairment specific to one of the groups. The results are discussed within the Functional Coordination Deficit model of dyslexia.

P1 and N1 do not reflect the nicotine induced facilitation of the processing of unattended stimuli

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We examined how nicotine affects the processing of targets in a spatial cuing paradigm. Nicotine is known to specifically reduce the costs of invalid cuing which suggests that nicotine reduces the spatial inhibition processes which underlie the costs of invalid cuing. In ERPs, the amplitude of the P100-component is often associated with the costs of invalid cuing, whereas the N100-component is thought to reflect the benefits of valid cuing. We accordingly hypothesized that nicotine specifically influences the amplitude of the P100 component to invalidly cued targets if the nicotine effects are implemented at an early visual processing level. 20 non-smokers completed a discrimination task in a within subject paradigm after chewing a nicotine gum (NICORETTE® 2 mg) or a placebo gum. Informative central cues and uninformative peripheral cues were used to orient attention to one of two target locations. Behaviorally, nicotine reduced the validity-effect in both cuing conditions. By contrast, no significant nicotine effect was found on the P100 and N100 ERP components. The data suggest that the nicotine induced reduction of the validity effect does not occur at the early visual processing level.

Event-related oscillations during working memory tasks in schizophrenic patients and healthy controls

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Recent findings substantiate the view that event-related oscillations (EROs) are functionally involved in cognitive processing [1, 2, 3]. For example there are many observations that imply a connection between especially frontal theta oscil-

lations, information coding and function of working memory (WM). In order to examine differences in neurophysiological changes associated with WM-load between schizophrenic patients (n = 10) and matched controls (n = 10), we recorded ERPs (Fz, Cz, Pz, Oz, F3, F4, T5, T6) during a n-back WM task, and a control task for simple actions. The data were analyzed by means of Fast Fourier Transform (FFT) and digitally filtered in different frequency bands.

The behavioral data showed that the patients had longer reaction times in all tasks as well as poorer performance accuracy in the one- and two-back tasks. The results of the EROs analyses presented a gradual increase of theta and gamma oscillations after stimulus onset with WM-load in controls, whereas in the schizophrenic patients reduced fronto-central theta was observed. However, gamma oscillations with high amplitude values were found without any specific topographic differences, which remained constant over all task conditions.

Our results show a selectively distributed, task-related oscillatory system in controls during WM demand. Therefore, the observed task-unrelated distribution of oscillatory activity in patients can be interpreted as a disorder of this system and this may be one of the possible explanations for a general brain dysfunction in schizophrenia.

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Impairment of visual working memory in patients with Parkinson's disease: a time-frequency analysis

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Neural correlates of visual working memory (WM) in non-demented patients with Parkinson's disease (PD, n = 9) and age-matched healthy controls (n = 11) were examined using a task involving different delay conditions and requiring a constant monitoring of continuously morphing figures. As stimuli we presented geometrical figures that could not easily be associated to common figures. Electroen-

cephalogram (EEG) was recorded from F3, F4, C3, C4, P3, P4, T5, T6, O1, O2 locations during the task described above. Linked earlobes served as reference. The EEG was analysed and discussed with respect to Fourier estimation of spectral power in selected frequency bands as well as by means of wavelet based time-frequency analysis.

The preliminary analysis of the behavioral data showed slower reaction times only in the shortest delay condition in the group of PD patients compared to the age-matched healthy controls. Furthermore, the PD patients showed significantly more errors mostly marked in the longest delay condition. The lower performance accuracy in the patient group was associated with less complex and apparently less effective memorizing strategies. Since this specific visual WM paradigm demands continuous monitoring of stimuli over different delay conditions, these data may be interpreted as resulting from impairments in interference-control or deficits in allocation of attention resources.

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Effects of Cannabis and delta-9-Tetrahydrocannabinol on response priming in humans

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The Simon effect refers to the finding of faster responses in case stimulus and response positions correspond than when they do not. Dual route models propose that spatial stimulus features prime the corresponding response via a direct route, whereas response selection occurs via an indirect route. The Simon effects depends on the correspondence condition of the predecessor, that is, the Simon effect is absent after a noncorresponding predecessor, it only shows up after a corresponding predecessor. We account for this finding by executive control over direct route priming achieved by dorsolateral prefrontal cortex (DLPFC) functioning.

Recent studies showed an increase of spatial conflicts by Cannabis. For example, the execution of antisaccades and spatial working memory was hampered

indicating the involvement of DLPFC. Therefore, we investigated whether Cannabis interferes with executive control over response priming. A double-blind study was run with healthy adults getting delta-9-THC, Cannabis or a placebo. Event-related brain potentials were recorded in the Simon task, and the lateralized readiness potential (LRP) was calculated as an indicator of specific hand activation. Usually, in noncorresponding conditions there is an early incorrect activation in the LRP replaced by correct response hand activation later on. This early LRP lateralization is seen to reflect response conflict and does not occur after a noncorresponding predecessor. In line with our assumption a Simon effect after a noncorresponding predecessor was present with medication affecting also the early LRP lateralization. Moreover, delta-9-THC and Cannabis enlarged early attention related ERP components but reduced the later P300.

Poster session 5: Auditory processing and perception

Tuesday, March 30, 16:00–18:00; Foyer 2nd floor

Interhemispheric asymmetry of tone stimuli processing in 5- 6-year-old children : an AEP topographic study

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Late auditory evoked response recorded at fronto-central sites in young children is constituted of a positive wave culminating at around 100 ms followed by a negative wave culminating at around 250 ms. Topographical analyses (scalp potentials and scalp current density mapping) of these responses were performed according to ear of stimulation. Fifteen right-handed children (8 girls) aged from 5 years to 6 years (mean ± sem: 5 yrs 8 mths ± 2 mths) participated in the study. Auditory stimulations were monaural tones (1100 Hz, 70 dBSPL, 50 ms duration) delivered at four different interstimulus intervals (700, 1100, 1500, 3000 ms). Both P100 and N250 waves involved generators in the supratemporal cortex as indicated by

bilateral sink/source currents localized at infero-temporal sites. The orientation of these sink/source complexes were opposite for P100 and N250. Amplitude of currents decreased for P100 and increased for N250 when rate of stimulation increased. For both waves amplitude of temporal currents were significantly greater on the left hemisphere and greater for contralateral than for ipsilateral ear stimulation. On the right hemisphere responses were of smaller amplitude and did not differ according to the ear stimulated. Left lateralized brain activation were previously demonstrated in response to speech stimuli both in infants and in children. Our results therefore indicated a left-lateralized brain activation also for tone-stimuli.

Event-related potentials as a function of auditory abstract change magnitude: a parametric study.

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We tested the accuracy of the human auditory system to represent abstract rules in the auditory environment by means of the MMN and P3a event-related brain potentials (ERPs). For this purpose, ERPs were recorded to pairs of auditory stimuli in 16 adults. The abstract rule was the direction of the frequency within the pair. Standard pairs (p = 0.8) were formed by two pure tones of the same frequency. Deviant pairs (p = 0.2) were formed by tones of different frequency (the second tone being 2, 4, 6 or 8 musical steps of the tempered scale higher or lower in frequency than the first one). Each deviant type was presented in a separated block, thus having four conditions of ascending and four of descending frequency. There were thirteen frequency levels and five different physical pairs for each stimulus type. Stimuli pairs were presented with a stimulus-onset-asynchrony of 700 ms. EEG was recorded from ten electrodes (Fp1, Fp2, F3, F4, Fz C3, C4, Cz, LM, RM; reference: nose). Epochs of 700 ms were averaged including a 100 ms prestimulus baseline from the first stimulus of the pairs. The MMN and P3a ERPs increased linearly as a function of the magnitude of the abstract rule. These results indicate that, in addition to extracting abstract rules from among discrete stimuli, the auditory system can represent these relationships quantitatively.

MMN reflects differential processing of duration changes within short and long sounds

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The processing of time has been a subject of research since centuries. It is controversial whether the psychological time is mapped by means of a unique mechanism or whether separate mechanisms are relevant for time processing. A few findings assume brief durations, shorter than 500 ms, to be processed sensorially, whereas long durations are processed via cognitive operations. In an electrophysiological experiment we tested the assumption of different modes of processing of short and long durations. For this purpose the Mismatch Negativity to duration deviants was measured in a 2 x 2 factorial design in blocks of short and long duration sounds in ignore and attend conditions. Our results show comparable MMNs evoked by deviants in the attend condition in both short and long duration blocks. However, in ignore condition no MMN was measured in the long duration blocks. In short ignore condition a distinct MMN was obtained, albeit not as high in amplitude compared to the short attend condition. These results possibly suggest that directing attention to the auditory stimuli has, in some way, an influence on the duration MMN. Furthermore, the pattern of results in ignore condition could be explained by the breakdown of the sensorial mechanism regarding duration processing for long sounds when they are not attended. This seems to be in line with the assumption of different mechanisms for duration processing.

Event-related potential correlates of repetitions in random auditory stimulus sequences

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Recent studies (Wolff & Schröger, 2001; Horvath et al., 2001; Näätänen & Rinne, 2002) indicate that occasional repetitions in a sequence of random frequency

tones elicit a frontally negative event related potential (ERP) deflection in the latency range of 100–250 ms from stimulus onset.

The characteristics of this ERP are very similar to that of the mismatch negativity (MMN) ERP component. MMN is elicited when some regular feature of a sound sequence is violated. Therefore, if the component elicited by occasional repetitions in an ever-changing sound sequence is truly MMN, it can be assumed that the auditory system pre-attentively extracts a "change regularity", that is, an abstract notion of change itself.

However, it was not investigated, whether the repetition per se elicits the component.

In the current study we investigated whether the elicitation of the repetition-related ERP component is dependent on the probability of repetitions in the sequence. If the component is truly an MMN, then a higher repetition probability would result in a decreased ERP amplitude. In two experiments, tones varying on five distinct pitch levels were presented in random order. The probability of tone repetition was 5%, 20% and 50% (Conditions 1, 2 and 3 respectively). In Experiment 1, pure sinusoidal tones were presented, whereas in Experiment 2 spectrally rich tones were used to enhance discriminability. Results showed that the elicitation of the repetition-related ERP component is probability-dependent, i.e. higher probabilities resulted in smaller amplitudes.

Neurophysiological correlates of music perception and musical expertise: A developmental view

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Violations of expectancies in the processing of complex regularity-based musical contexts are reflected in the ERAN. The ERAN is larger in adults with formal musical training (musicians) than in those without, reflecting that more specific representations of musical regularities lead to more specific musical expectancies. The purpose of this study is to investigate effects of musical training in children. Therefore we conducted a music experiment with chord sequences ending either with a (regular) tonic or with a (irregular) supertonic chord. Comparing two groups of subjects with and without musical experience at different ages, we ex-

pected a larger amplitude for the ERAN for the groups with musical experience. The difference between the groups should increase with age because of the longer lasting experience with the learned instrument.

Segmentation of syllables during the first year of life

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Processing of relevant environmental sounds becomes increasingly specialized during early infancy. This specialization is correlated with changes in the cognitive components of the Auditory Evoked Potential (AEP). Among other factors onset latencies of AEPs in response to short auditory stimuli, such as syllables presented in isolation, decrease in the course of infant development. In general, identification of syllables within a complex speech stream is very important for language acquisition. Therefore we examined infants' ability to process syllables as separate units during their first year of life. As part of the longitudinal German Language Acquisition Development study (www.glad-study.de) we tested groups of 1-month-olds, 5-month-olds, 13-month-olds, and an adult control group. Using a simple oddball paradigm, we presented the infants with bi-syllabic consonant vowel combinations, with /da-da/ as the standard and /da-ba/ as the deviant. The duration of the gap between the two syllables of each stimulus was either 50 ms in the 'short-' or 150 ms in the 'long-gap' condition. At different stages of development infants' AEPs differed from adult AEPs in distinctive ways. Adults showed a mismatch negativity (MMN) for the detection of the second syllable in both conditions. In 1-month-olds no indicator of change detection from /da-da/ to /da-ba/ was observed. At the age of 5 months a mismatch-like response could be observed, which was restricted to the 'long-gap' condition. Finally, at the age of 13 months a mismatch-like response was elicited in both conditions, indicating the development of the ability to detect single syllables within complex sound structures.

Deviance-repetition effects as a function of stimulus dimension, feature variation, and timing: A Mismatch Negativity study

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The human auditory pre-attentive change detection system indicated by the mismatch negativity component (MMN) of the event-related brain potential is known to be sensitive for the successive presentation of tones deviating in frequency. The present study investigated deviance-repetition effects as a function of the feature defining deviancy, the type of the second deviant (bearing a different vs. the same feature value as compared to the first deviant) and the stimulus-onset asynchrony (SOA). Using the features frequency or location for defining deviancy MMNs elicited by the second of two successive deviants were reduced significantly. However, the reduction of MMN-amplitude is markedly smaller if the second of two successive tones deviates in a different feature value (e.g., a right localized deviant is followed by a left localized deviant) as compared to if the second deviant bears the same feature value as the first deviant (e.g., a right localized deviant is followed by a right localized deviant). The variation of SOA across the temporal window of integration did not influence the deviance-repetition effects. It is argued, that the pre-attentive change detection system evaluates the informational content of the succession of deviants enabling an effective scanning of the auditory environment for potentially relevant events.

Stimulus omission and temporal integration: Temporal structure or loudness summation

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Infrequently omitting a stimulus from a repetitive tone sequence elicits MMN when the constant stimulus onset asynchrony separating successive tones is shorter than 200 ms. This phenomenon is usually explained on the basis of the

temporal window of integration (TWI). It is assumed that the human auditory system integrates the sounds arriving within a single TWI period into a common trace. Omitting a sound from an isochronous sequence results in the formation of a memory trace that differs in its temporal structure from the regular one and, thus, evokes the MMN response.

However, it is also possible that omissions cause deviation from the regularity of the sound sequence by allowing the after-effect of the stimulus preceding the omission to be integrated into the sensory memory trace of this stimulus, thereby increasing its perceived loudness. Regular sounds of the sequence are perceived as being softer, because the sound following them within the TWI period prevents full integration of their after-effect.

When stimulus onset asynchrony (SOA) is randomly varied within the sound sequence (within the range of the TWI), the two explanations lead to different predictions. 1) On the temporal structure violation explanation, no MMN can be expected for infrequent omissions, because no constant integrated memory trace can be formed in the random-SOA sequence. 2) The loudness summation explanation predicts that MMN will be elicited, because the sound preceding the omission will be louder than those sounds, which are followed by another sound within the TWI period.

Significant MMN responses were observed in both experimental conditions although the MMN amplitude was significantly lower in the random-SOA condition. These results support the loudness-summation interpretation of omission MMN.

Pre-attentive conjunction of auditory features in simultaneous, spatially distributed objects

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Recent studies using the mismatch negativity (MMN) component, an index of automatic detection of sound change, suggested that the conjunctions of auditory

features are preattentively represented in the brain. These studies, however, used only sequentially presented sounds and thus are not fully comparable with related studies on vision. Hence, the present study employed simultaneous, spatially distributed sounds and tested whether the auditory features of concurrent sounds can be correctly conjoined without focal attention to the sounds.

Twelve young adults without formal musical education participated in the study. Stimulus sequences consisted of repetitive two types of sounds differing from each other in timbre and pitch. These two types of sounds were presented simultaneously through separate loudspeakers. Subjects were engaged in a visual 1-back or 3-back working-memory task and ignored the sounds. Occasional reversals of pitch- timbre conjunction elicited MMNs of a very similar amplitude and latency irrespective of the task load, thus indicating that auditory features are preattentively conjoined even when two sound objects are simultaneously presented.

The effect of implicit or explicit knowledge on MMN elicitation and deviance detection

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We investigated whether the mismatch negativity (MMN) of the auditory event-related potentials can be elicited on the basis of implicit knowledge and what the effect of explicit knowledge compared to implicit knowledge is on deviant detection. We recorded the MMN to occasional changes in the pitch relation of tone-pairs roving on different pitch levels. The experiment consisted of a video watching block, an attend block and again a video watching block interleaved with interviews to determine whether the subjects possessed implicit or explicit knowledge of the deviants. Our results confirmed that the MMN can be elicited in subjects that have implicit knowledge only. The MMN of subjects with explicit knowledge was, however, larger compared to subjects with implicit knowledge only. Explicit knowledge compared to implicit knowledge lowered the RT and gave rise to a P3 that was absent in subjects with implicit knowledge. The results indicate that implicit knowledge is sufficient for MMN elicitation but that explicit

knowledge to some degree can affect the change detection processed underlying the MMN as well as the subsequent target detection processes.

Poster session 6: Methods and analysis

Tuesday, March 30, 16:00–18:00; Foyer 2nd floor

Source localization of electrical dipoles using wavelet prefiltering and MUSIC scanning

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The electrical dipole source localization in the 3-D brain structure is performed using a realistic head model based on an average human MRI data released by the Montreal Neurological Institute (MNI). The EEG data is preprocessed using integer spline wavelet prefiltering to enhance the visual inspection of the multichannel waveforms used for localization. The forward and inverse problems are solved by Boundary Element Method (BEM) and MUSIC (Multiple Signal Classification) scanning algorithms, respectively. The technique is tested on clinical cases with secondary epileptic seizures based on morphological lesions that could be depicted in the anatomical MRI examinations of the patients. The estimated locations of the generators of interictal epileptiform signals correspond well to the surrounding neural tissue of the lesions. The wavelet prefiltering facilitates the visual inspection and detection of the interictal epileptic spikes and the BEM based on a realistic head model gives an accurate anatomical localization for the focus. A focal source model is widely accepted in many cases of epilepsy and the MUSIC scanning seems to be very suitable for localizing these type of sources. The method is currently modified to handle the localization of cortical and distributed source models for the EEG which seem to be more appropriate for the event related potentials.

Depth ERPs and fMRI comparative study of auditory oddball task

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Event-related fMRI (efMRI) was repeatedly used to seek the neural sources of endogenous event-related potentials (ERP). Significant discrepancies between the efMRI data and the results of previously published intracranial ERP studies of oddball task were revealed.

To evaluate the capacity of efMRI to define the sources of the P3 component of ERP within the human brain, both efMRI and intracerebral ERP recordings were performed in eight patients with intractable epilepsy (five males and three females) during their preoperative invasive video-EEG monitoring. An identical auditory oddball task with frequent and target stimuli was completed in two sessions. A total of 606 intracerebral sites were electrophysiologically investigated by means of depth electrodes.

In accordance with the finding of multiple intracerebral generators of P3 potential, the target stimuli evoked MRI signal increase in multiple brain regions. However, regions with evident hemodynamic and electrophysiological responses overlapped only partially. A P3 generator was always found within a hemodynamic-active site, if this site was investigated by means of depth electrodes. On the other hand, unequivocal local sources of P3 potential were apparently also located outside the regions with a significant hemodynamic response (typically in mesiotemporal regions).

Both methods should be viewed as mutually complementary in investigations of the spatial distribution of cortical and subcortical activation during oddball task.

The study was supported by MSMT CR Research Program no. 112801

Time Index of Neural Network Variability (TINNV) during CEPs

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The P300 wave is a positive wave induced when an infrequent (target) stimulus is randomly mixed in series of repetitive frequent (non target) stimuli. The P300 auditory oddball design is defined by numerous components (N1-N2-P2-P3a, P3b and closing processing (CP)) that are believed to represent the adaptation of the working memory to the new stimuli (context switching) or the closing of the usual context (context closure). Since 15 years, we have collected P300 data in normal subjects (from 10 to 90 years old) and in pathological states by using this kind of auditory oddball paradigm. While we were able to show that P300 latency increases with aging, we were not able to discriminate between pathological states, probably because we mixed (by using grand averages) a lot of different neural processes. In this study, we have developed and analyzed EPs by dividing the presented auditory stimulations in subsequent blocks of 5 endogenous (infrequent) CEPs compared with 20 exogenous (frequent) CEPs. We have computed the "time-evolution of the neural network variability" (TINNV) on the basis of the P300 parameters (amplitude and latency) between these different blocks. More precisely, we compare the TINNV during a weak task (count target) and a strong constraining task (updating a date at each target), in normal and in 2 pathological groups (showing pure memory defect or memory defect associated with depression (DMS4)). By using this new index (TINNV) we can statistically discriminate between these two pathological populations.

A user-friendly ERP analysis software with time-frequency and spatial decomposition facilities

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Event related brain potential (ERP) waveforms consist of several components extending in time, frequency and topographical space. Therefore, an efficient processing of data which involves the time, frequency and space features of the signal, may facilitate to understand the plausible connections among the functions, the anatomical structures and neurophysiological mechanisms of the brain. Wavelet transform (WT) is a powerful signal processing tool for extracting the ERP components occurring at different time and frequency spots. Using the frequency selectivities and spatial features of the event-related EEG changes, it is also possible to identify event-related potentials in single trials that are not time- or phase-locked to the event. Our previous studies since 1993 show that WT can be very useful in both identifying the subcomponents of averaged ERPs that are more specifically related to distinct subprocesses of the main cognitive operation in an ERP paradigm and in the detection of main event related signal features in single trials. Based on this experience, we developed a software with a graphical user interface, that can handle original data files from various ERP equipment suppliers and standard data file formats such as EDF in both continuous and epoched forms using conventional analysis techniques and WT based temporal and spatial decomposition tools. The facilities of the software will be presented using both previously published data on normative groups and on recent clinical data obtained from patients with Alzheimer's disease and Schizophrenia.

Impact of low frequency transcranial magnetic stimulation on event-related brain potentials

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Repetitive transcranial magnetic stimulation (rTMS) is a new method to investigate the relationship between cortical activity and cognitive processes. Contradictory findings exist concerning the inhibitory function of low frequency rTMS. In order to clarify this point, this study examines the impact of different duration of low frequency rTMS on event-related potentials (ERPs). In 17 subjects, auditory ERPs were measured before and after 1 Hz rTMS delivered over the left prefrontal cortex during 10 min (600 pulses) and 15 min (900 pulses), in comparison to a sham stimulation. Results showed that 15 min of 1 Hz rTMS induced a significant increase of P300 latency. No effect was found after both 10 min and sham application. There was no effect for early ERP components (N100, P200 and N200). This study confirms and extends that 1 Hz rTMS produces a real inhibitory effect of the central nervous system only when the duration of the stimulation is about 15 min. Moreover, the data suggest that rTMS applied to the left prefrontal cortex modifies the speed of cognitive processing rather than the energetical aspect of information processing, and that cortical inhibition induced by the magnetic stimulation affects principally the controlled cognitive processes and not the automatic ones.

Scalp-recorded potentials evoked by TMS

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Objective: To establish the physiological basis of cerebral potentials evoked by using transcranial stimulation (TMS), this study was conducted.

Methods: Magnetic stimulus was transcranially delivered over the primary motor area of the right thumb in normal subjects. Evoked potentials were recorded at F4, C4, and P4 with a reference of the left ear.

Results: Two potentials were evoked; the earlier negative potential had a latency of 14 ms (N14) and the later negative one had a latency of around 100 ms (N100). Both potentials showed the largest amplitude at C4. The N100 component was increased in amplitude with increasing the stimulus intensity. In addition, it was increased in amplitude when the subjects counted the skin sensation induced magnetic stimulus.

Discussions & Conclusions: To identify the N14 component that may be the transcallosal response, contamination of the blink reflex or EMG of the temporal muscle should be eliminated. The origin of N100 component is complicated because somatosensory and auditory pathways are stimulated at the same time by TMS. Then, we discuss on the possible N100 component evoked by cortical stimulation.

Influence of the Click Evoked Myogenic Potentials (CMEP)

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In response to auditory stimulation, a vestibular evoked potential defined as a short latency electromyogram and called “click evoked myogenic potential” (CEMP), can be recorded from surface electrodes over the tonically contracted sternocleidomastoid muscles. Now, it is well established that, in normal subjects, the earliest response, p13-n23, is dependent upon vestibular activation, specifically saccular afferents. During EEG and CEPs recordings, subjects are generally tested in sitting position. In this study, we investigated whether a CEMP can be recorded in classical brainstem and middle latency auditory evoked potentials (BAEP, MAEP) by using A1-Cz, A2-Cz and sterncleidomastoid derivations (40 subjects). We studied the effect of the CEMP in multichannel cognitive evoked potentials (32 channels during auditory oddball tasks). The important points are: (1) CEMP potential should not be confused with a neural response; (2) this would allow us to simultaneously get information –during a classical BAEP recording- on the brainstem auditory pathway and on reflexes mediated through the vestibular nerve and the saccula; (3) the use of extraencephalic references (A1-A2) is able to contaminate the neurophysiological acquisitions of CEPs, such as the P50

or even the latter components, induced by auditory stimulations (i.e. during auditory oddball paradigm). It is therefore possible that due to the filters used for this type of CEPs analysis and because of the seated position commonly chosen for this testing, the CEMP could be a part of the observed early and middle latency CEPs components.

Poster session 7: Speech and language

Wednesday, March 31, 16:00–18:00; Foyer 2nd floor

Symbolic resonance analysis of event-related potentials unveils different cognitive processing demands

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In a language processing experiment, two different types of argument structure violations in German were tested (Frisch, 2000, Experiment 4). As expected, both violations elicited a biphasic N400-P600 response in event-related brain potentials (ERPs) compared to correct sentences (see Friederici & Frisch, 2000). However, the customary voltage averaging technique was unable to reveal a theoretically predicted difference in the N400 component between the two violation conditions. Our analysis rests on a coarse-graining of the ERP epochs by assigning different symbols to samples depending on whether the signal is above or below some threshold. Thus, only polarity and latency information are considered (beim Graben et al., 2000). Here, we employed a three-symbol static encoding with varying thresholds, followed by a spin-flip transformation as a nonlinear filter. Finally we computed an estimator of the signal-to-noise ratio (SNR) for the symbolic dynamics (beim Graben, 2001) measuring the coherence of threshold-crossing events. Hence, we utilized the inherent noise of the EEG for sweeping the underlying ERP components beyond the threshold, i.e. stochastic resonance (beim Graben & Kurths, 2003). Drawing the SNR computed within the time windows of the ERP components against the encoding thresholds yields characteristic resonance curves

for each component. With respect to the present experiment, we found differences in the resonance curves for the two N400 components, thus indicating amplitude differences between the two N400s across single trials. In sum, we have shown that SRA is a promising method complementary to customary averaging analysis since it is more sensitive with respect to experimentally interesting differences which traditional techniques are unable to uncover.

Event related brain potentials for morphological priming on the word-pseudoword pairs

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Word morphology has demonstrated to be important in the lexical retrieval of information from memory. In Spanish, word gender is usually obtained adding to the stem the vowel -O for masculine (e.g., niñ-o [boy]) and the vowel -A for feminine (e.g., niñ-a [girl]). In priming studies, when the prime and the target share their stems and vary only in their gender suffix (niña/niño [girl/boy]), event related brain potentials show an attenuation of N400 (Barber, Domínguez & De Vega, 2002; Domínguez, De Vega & Barber, in press).

The present experiment tries to obtain a similar morphological priming effect using word/pseudoword pairs of stimuli. Three conditions were introduced. First, pairs of orthographically related word-pseudoword stimuli (e.g., pato/poto [duck/durk]. Second, pairs including a pseudoword target wit a morphological structure, composed of an existing stem (ran-) and an existing suffix (-o) (e.g., ran-a/ran-o [frog/rano]). This was a very informative condition, because it allows observing morphological effects at a prelexical processing stage. Finally, an unrelated prime-target condition (e.g., mesa/ruco [table/pucla) served as a base-line.

The results showed, the expected N400 attenuation for morphologically related pairs (differing significantly from the base-line condition). By contrast orthographically related word-pseudoword pairs did not show any significant effect. These differences support a prelexical, morphological (not merely orthographic) interpretation of the overlapping in the critical condition rana/rano.

References

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ERP effects of mismatch in word fragment priming

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Onset fragments of spoken and visual words modulate the processing of subsequently presented visual targets. For example, the string ‘kon’ facilitates responses to a matching target like ‘Konto’ (Engl. account), but not to an unrelated target like ‘Salto’ (Eng. somersault). The behavioral facilitation is accompanied by a reduced amplitude of a left-posterior positive going ERP deflection, named P350, and a reduced N400 component for matching targets. The former effect, peaking at 350 ms, has been related to the activation of modality-independent lexical representations. In contrast, the N400 peaking at 500 ms has been related to strategic mechanisms (Friedrich, Kotz, Friederici & Gunter, Journal of Cognitive Neuroscience, in press). In the present experiment we tested ERP effects of partial mismatch for prime - target pairs like ‘kon’ – ‘Kante’ (Engl. edge), being different in syllable nucleus. Responses to partially mismatching targets were longer than responses to matching targets, but shorter than responses to unrelated targets. However, the amplitude of the P350 was only reduced for matching targets, but not for partially mismatching targets. In contrast, the amplitude of the N400 showed the same pattern as the reaction times. Partially mismatching targets elicited an enhanced amplitude of the N400 as compared to matching targets, but a reduced amplitude of the N400 as compared to unrelated targets. The present results may indicate that lexical representations of partially mismatching targets do not receive activation from the preceding primes. The behavioral facilitation appears to be an artifact of strategic mechanisms underlying the N400 priming effect.

N400 maturation during the second year of life

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In the present study we investigated, whether the mechanisms of integrating word meaning into semantic context as indexed by the N400 are already working during early language acquisition. Using a picture-word-matching design we recorded the ERP response of 12- and 19-month-old infants on slowly spoken basic level words. During the experimental session infants were looking at sequentially presented pictures while being acoustically presented with words which were either congruous or incongruous to the picture content. Infants at an age of 19 month show a broadly distributed long lasting semantic incongruity effect in their ERP when comparing the response on incongruous with that of congruous words. This infant N400 is preceded by an early phonological-lexical priming effect suggesting that infants at that age already create lexical expectations from the picture content. The same effect of facilitating early phonological processing can also be observed in the younger infants. From that we conclude that the semantic content of a picture primes an associated phonological-lexical representation even in 12-month-old infants. Infants at that age, however, do not display a N400-like semantic incongruity effect suggesting that, in one-year-old infants, phonological representations do not activate specific semantic representations sufficient to initiate a N400 response. Maturation of the N400, thus, occurs during the first half of the second year of life.

Focus on focus: The brain's response to focus particles and accents in German

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In linguistic theory, it is assumed that focus particles like "even", "only" and "also" prototypically assign narrow focus, accent and semantic scope to the con-

stituent following the particle. Although this seems to be the default assignment in German, too, the focus particle "sogar" (even) may also be associated with a preceding accentuated constituent. In the present ERP study, we investigated the interaction of the effects induced by the focus particle "sogar" (local prosodic structure) and the effects of global prosodic structure. The global prosodic structure was manipulated via accent on the right adjacent (default reading) or sentence initial word, no (= missing) accent, or double (= superfluous) accent. The results show that, independently of the presence or absence of a preceding accent, the focus particle "sogar" requires the presence of an accent on the right adjacent word (local prosodic structure). These accents evoke a fronto-central negativity around 400 ms which is not modulated by the presence or absence of a preceding accent. Later, however, the ERP is influenced depending on whether the accent was correct, missing, or superfluous (global prosodic structure). Accents on sentence-initial words are processed with delay. This seems to be the result of the relational character of prosodic structure which needs the following word(s) to decide whether the first word bears a narrow focus accent or not. Thus, the data show that global prosodic structure is relational but can locally be overridden by focus particles and their default assignment of focus, accent and scope to the right adjacent constituent.

Processing syntactic ambiguities and the effect of pragmatic context

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Hoeks, Vonk, & Schriefers (2002) showed that pragmatic information determining the topic of the next sentence can eliminate processing difficulty in a locally ambiguous "gardenpath" sentence. To further investigate the use of pragmatic information, an ERP experiment was conducted using temporarily ambiguous sentences which were eventually disambiguated in favor of the PREFERRED syntactic structure. These locally ambiguous sentences were preceded either by a context biasing towards the non-preferred reading or by a neutral context. In addition, to investigate the effect of local ambiguity per se, an unambiguous control

condition was added (preceded by a neutral context). First, the pragmatic context biasing toward the non-preferred reading elicited an early left negativity followed by a late centro-parietal positivity (P600) at the point of disambiguation, suggesting that pragmatic information is used extremely fast in on-line sentence processing, inducing effortful syntactic (re-)processing even in sentences with the "preferred" syntactic structure. Secondly, the comparison of the ambiguous and the unambiguous sentences following a neutral context revealed significant differences at predominantly left frontal electrodes, strongly suggesting a penalty for ambiguous sentences, even when the ambiguity is resolved towards the most preferred reading. This result provides support for the race model of ambiguity resolution (Van Gompel et al., 1998).

Grammatical gender in the sphere of minimal context: An ERP investigation

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The nature of gender information, whether it is more syntactic or semantic, is still in debate. A previous ERP sentence processing study reported a left anterior negativity (LAN) reflecting syntactic processing and a P600 reflecting integration and reanalysis processes for gender violations (Gunter and Friederici, 2000). However, in a word level ERP experiment no LAN, but an N400 effect indicating lexical-semantic processing was observed for gender violations (Hofmann, Friederici & Kotz, 2003). A superordinate analysis revealed a LAN for nouns with phonologically and derivational-morphologically marked endings in contrast to semantically marked words. As gender marked words were presented out of context the question arose, whether syntactic processing is triggered by context only.

The current experiment investigated the influence of visually presented minimal context information (noun phrases) and no context information on gender processing. Additionally nouns were cross-balanced over three gender information categories (phonological, derivational-morphological and semantic) and three gender types (feminine, masculine and neuter).

All three gender information categories elicited an N400 effect for incongruent versus congruent trials. This effect is more pronounced in the context condi-

tion. Also an early frontal effect beginning at around 200 ms post-stimulus onset occurs only in the context condition and is more pronounced for the phonologically marked gender categories (phonological and derivational-morphological). This ERP response might reflect a syntactically driven process followed by a lexical-semantic process as indicated by the N400. Thus, minimal context seems to be a necessary condition to initiate syntactic processing of gender information.

Retrieving words in a second language

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How do speakers retrieve words from their mental lexicon? There is a long-standing debate on the question of whether only words selected for articulation are phonologically activated or whether this is also true for their semantic competitors. Past behavioral and electrophysiological research has addressed this issue by testing whether retrieval of a target word (e.g., cat) affects – or is affected by – the processing of a word that is phonologically related to a semantic coordinate of the target (e.g., log, related to dog). This research has consistently failed to demonstrate such mediated priming effects. Our experiments tested whether this pattern also extends to lexical retrieval in a speaker's second language. Using an ERP paradigm and experimental materials that had previously been employed to study lexical retrieval in speakers' first language (Jescheniak et al., 2002, JoCN, 2003, Cog Brain Res), we now obtained such effects surfacing as a widely distributed negativity starting around 600 ms after stimulus onset. The overall pattern is compatible with the view that increased language experience leads to a fine-tuning of lexical activation during speech planning.

Changes of power and coherence in the EEG during verb and noun processing

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Power and coherence of 124 channels of the electroencephalogram (EEG) were analyzed while 16 subjects read either a verb or a noun which initiated a short meaningful phrase (e.g., "CUTS carpenter wood" or "WOOD carpenter cuts"). Thus, participants were enforced to activate the specific semantic and grammatical features of the respective word category. Short time FFT power and coherence spectra were derived from overlapping Hanning-windowed time epochs covering 1 s after word presentation. Theta-power decreased substantially relative to a prestimulus baseline (fixation period) at left anterior electrode sites for both nouns and verbs. This left frontal power attenuation was more pronounced for verbs compared to nouns. All other frequency bands showed less (alpha, beta) or no effects at all (gamma). Coherence of the theta-band revealed that left anterior electrodes became decoupled from left and right posterior sites, again more for verbs than for nouns. These spectral changes are interpreted as reflecting processing differences due to the grammatical status of the two word categories, i.e., a differential left frontal involvement of verbal working memory resources. In addition to FFT-based analysis spectral effects were also analyzed with wavelets in order to delineate possible similarities and dissimilarities of the two methodological approaches. Both methods provided comparable results.

Morphosyntax in German compounds: Prosody turns plural morphemes into linking elements

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Compounds, i.e. concatenated words, were shown to be decomposed morphologically/morphosyntactically during comprehension. Hence, the morphosyntactic feature (gender) of constituents is processed as part of the morphological repre-

sentation. Number, an important morphosyntactic feature in general, is not specified for initial constituents, but only for the head (in German the final) constituent of a compound. Linking elements between constituents are often phonologically identical with plural morphemes. Whether prosodic cues are used to disambiguate these elements was tested in an event-related potential (ERP) study. Subjects heard acoustically presented critical items that were produced naturally as single nouns or initial compound constituents. These were preceded by a number marked indefinite determiner. Half of the single nouns were singular forms, the other half were plural forms. Half of the compound constituents contained linking elements, the other half did not. Subjects had to detect incongruities between determiners and critical items. Any possible bias of stimuli to be perceived as single nouns or compounds was prevented by appropriate filler items. Single nouns and compound constituents differed in the prosodic parameters duration and pitch (contour). Number violations of single nouns were detected online as indicated by a posterior negativity in the ERP. "Number violations" of compound constituents did not yield any effect until 500 ms past the effect for single nouns; the negativity for incongruent compound constituents showed an anterior scalp distribution. Thus, prosodic cues permit the parser to differentiate phonologically identical plural morphemes and linking elements in order to refrain from irrelevant morphosyntactic operations.

ERP correlates of miniature language learning: What's learnt within five days

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ERPs have been established as a measure of semantic and syntactic processing mechanisms in first and second language (L2) comprehension. In late L2 learners ERPs related to syntactic processing are often more distinct from native speakers than ERPs indicating semantic processing, suggesting a differential susceptibility to critical period effects. Yet some recent experiments using artificial grammars have challenged the critical period hypothesis by eliciting ERPs in trained adults similar to patterns found for native language processing. We studied sentence

processing within a miniature language extracted from Japanese. Thus we assured high proficiency of the learners. Within the miniature language different rule violation conditions were implemented, namely a word category violation, a classifier agreement violation and a case violation. In three auditory ERP experiments we presented correct and incorrect sentences of the miniature grammar to Japanese subjects and to German subjects before and after training. Japanese subjects displayed a P600 for both the word category violation and the case violation. In the word category violation the P600 was preceded by a broadly distributed early negativity with an anterior preponderance, and in the case violation by an N400. The classifier violation resulted in a left anterior negativity only. While the P600 was similar for Japanese natives and trained subjects, the N400 and the anterior negativities were not present in the learner group. The observed differences suggest difficulties in the acquisition of on-line syntactic processes and processes of thematic hierarchizing for the learners despite their high behavioral skills.

Error monitoring during speech production: Evidence from ERPs in tongue twisters

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In the present study we investigated event-related brain potentials (ERPs) related to verbal slips. Tongue twisters where used to reliably induce speech errors.

Two German tongue-twisters and four matched control sentences where first presented in a “karaoke” fashioned display to the subjects, indicating a certain segmentation and pace for the repetitions to follow. While overtly repeating a given sentence, subjects had to fixate a cross on the center of the screen. Subjects where previously trained to time their repetition segment-by-segment to a train of click-tones, also given with the initial display of each sentence. The pace was identical for all sentences and their segments.

ERPs where calculated time locked to click-tones associated with verbal slips and correct vocalizations in tongue-twisters as well as correct vocalizations in control sentences. Average waveforms for error trials where more negative going, than for correct trials.

Results are discussed in relation to the possible neural generators underlying this error negativity as well as in relation to the competing plans hypothesis.

ERPs to prosodic processing in normal and deviant speech

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The paper at hand describes four experiments systematically investigating the brain's response to the perception of sentences containing differing quantities of linguistic information. Spoken language generally provides various levels of information for the interpretation of the incoming speech stream, namely phonemic, syntactic, semantic, and prosodic information. In this paper, we focus on the processing of prosodic phrasing, but especially on its interplay with the other basic sources of linguistic information mentioned above. An EEG paradigm was chosen to record the online responses to processing on single sentence level. For the perception of major prosodic boundaries the Closure Positive Shift (CPS) has been manifested as a reliable and easy to replicate event-related component. It has mainly been shown to correlate to Intonational phrase boundaries (IPh; Selkirk, 1984) in speech. However, to define this component as exclusively relying on the prosodic information in the speech stream it is necessary to systematically vary the linguistic content of the stimulus material. This was done by creating quasi-natural sentence material with decreasing semantic and syntactic information, i.e. jabberwocky sentences (where all content words were replaced by meaningless words), pseudo word sentences (replacement of all function and content words with meaningless words), and delexicalized sentences (hummed intonation contour of a sentence removing all segmental content). In all sentence types a Closure Positive Shift in correlation to the perception of Intonational phrase boundaries has been identified.

Language control: Interlingual homographs and their influence on L2 processing – an ERP study

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The current bilingual study investigated the processing of lexical ambiguity to test L1 influence on L2 processing. A primed lexical decision experiment was conducted in L2 (English) with high and less proficient German speakers. In the experiment, English-German interlingual homograph translations pairs like chef-boss (chef means boss in German) resulted in RT priming for the high proficiency group who had been contextually primed by watching a movie narrated in German prior to the experiment. The low proficiency group showed a similar result only when they had been previously exposed to the same movie narrated in English. The ERP data for the high proficiency group showed significant priming effects in the first half of the experiment, while priming only occurred for the low proficiency group in the second half of the experiment. Taken together, the results support the view that L1 influences L2 lexical processing. In particular, the data imply that L2 learners are not able to consciously suppress L1 influence.

Brain connections of language and actions

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If words are frequently used while actions are being performed, the neurons controlling the actions should frequently fire together with the neurons involved in language processing. Hebbian correlation learning predicts that action- and language-related neurons in motor/premotor cortex and in perisylvian language cortex become mutually linked. This implies different cortical distributions of the cell assemblies that represent and process words such as lick, pick and kick that "mean" face-, arm- and leg-actions, respectively (Somatotopy-Of-Action-Words (SAW) Model, 1–3). Experiments using spoken and written words from 3 languages (English, Finnish, German) carried out with four neuroimaging methods (fMRI, EEG, MEG, TMS) and implementing three different tasks (lexical deci-

sion, silent reading, watching video while ignoring words) indicated that three semantic subtypes of action words (face-, arm- and leg-words) are related to different areas in the fronto-central cortex. The results support the SAW Model (1–3) and demonstrate that semantic processes occur early (~200 ms).

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Evidence of early category-specific semantic processing in the brain: Responses to english action words in auditory odd-ball

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We recorded mismatch negativity (MMN), an index of experience-dependent memory traces, to investigate the processing of action-related words in the human brain. We found that:

1. The topography of the mismatch negativity to the action words showed unusual centro-posterior distribution of the responses suggesting that activity was at least in part generated posterior to usually observed frontal MMNs.

2. MMN responses to the hand-related word stimulus (pick) had a more spread-out lateral distribution, whereas the leg-related stimulus (kick) elicited a more focal dorsal negativity. These differences, remarkably reminiscent of the sensorimotor cortex somatotopy, were confirmed by the source analysis (L2 minimum-norm current estimates).

3. The latency of these word-specific MMN responses was in the range of 140–180 ms and could possibly be related to the recognition of the individual words.

The present results are best explained in terms of distributed neuronal assemblies which function as category-specific memory traces for words and might in-

volve sensorimotor cortical structures for encoding action words. The observed effects occurred early in time suggesting that semantic processing may commence in the brain as early as ~140 ms after the word onset.

Coughing is disturbing: delayed semantic reconstruction of words with obliterated speech sounds

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While listening speech, some of the speech sounds may be obliterated by environmental noise. However, we may not perceive any disturbance in continuous speech. In such cases, the semantic context appears to influence the perceptual synthesis of missing speech sounds. We aimed to study the neuronal correlates underlying the phenomenon of this "phonemic restoration".

We used auditorily presented sentences in which the final word was either highly or little expected given the preceding sentence context. Sentences were presented either with or without a cough replacing its initial part. Thus, altogether four types of sentences were used.

In behavioral experiment, there were main effects showing that mean reaction time was slower for repeating low probability words than high probability words and slower for cough replaced words than normal words. Event related potentials of 27 volunteers were recorded with 64 electrode cap. The results showed negative response for the low cloze probability compared to high cloze probability final words (the N400-effect). Further, a prominent N1-P2 was elicited by the words beginning with cough replacement, reflecting brains automatic reaction to coughs. Usually novel stimuli which catch the attention in a sequence of sounds elicit the P3a-response. However, for the cough-inserted final words during the positive slope there was a negative deflection with double peaks at 330 and 410 ms, which may be considered as N400. Normal P3a was elicited by the sentence beginning words. Thus, the P3a for the coughs may have been attenuated by an overlapping N400-response. Thus, despite of automatic detection of coughs, as indicated by N1-response, the semantic integration of the words with cough-replacement takes place in the time window of N400.

Do readers use prediction in on-line sentence processing?

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Hoeks et al. (submitted) found that an unexpected word following a highly predictive sentence context elicited a significant increase in N400 amplitude, relative to when the target word concluded weakly predictive sentence fragments containing the same content words. This suggests that readers actively predict upcoming words and that this has the effect of making the processing of unexpected words more difficult. In the present experiment we investigated whether this finding can be replicated when participants read the sentence for comprehension, without having to give a plausibility judgment (as in Hoeks et al.). Additionally, we investigated whether the effect of prediction diminishes with increasing sentence length, manipulated by inserting a three-word prepositional phrase before the final word of the short sentences. The results showed no main effect of prediction when participants were asked to read for comprehension. The effect seems to be absent because the non-predictive condition is more negative in terms of N400 amplitude than in the earlier experiment, rather than because the predictive condition was more positive. Nevertheless, planned comparisons showed a small but significant effect of prediction in the longer sentences. Apparently if there is no expectation that sentences may be anomalous, participants may try harder to make sense of an implausible sentence, thereby possibly flooding the effect of prediction. We conclude that readers do use on-line prediction, but that the apparent costs of a mismatch may seem bigger than they actually are when readers have to make plausibility judgments.

Poster session 8: Visual processing and perception

Wednesday, March 31, 16:00–18:00; Foyer 2nd floor

Alpha rhythm of the EEG modulates visual detection

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The effects of changes in frequency spectrum of the EEG on the detection of low-intensity visual stimuli near sensory threshold and on resulting visual event-related potentials (ERPs) were investigated on twelve healthy volunteers. The stimulus intensity, at which each subject could perceive 50% of the presented stimuli, was defined as the sensory threshold for that subject. Single ERP epochs were divided into two groups: epochs during detected and undetected stimuli. The ERPs and power spectra of the 1 s pre-stimulus periods were computed for both conditions, and the P300 amplitudes of the ERPs, and total power and relative band powers of the delta (0.5–4 Hz), theta (4–7.5 Hz), alpha (7.5–13 Hz), beta (13–30 Hz), and gamma (30–70 Hz) frequency bands of the pre-stimulus power spectra were measured. Between the two conditions, a specific difference was observed in the relative power of the alpha band, which was significantly lower in trials with detected stimuli ($p < 0.01$) in line with significantly higher amplitudes of the ERPs ($p < 0.001$). These results suggest that small changes in the brain's excitability state are reflected specifically in the relative alpha power of the EEG, which may explain significant variability in perceptual processes and ERP generation especially around boundary conditions such as sensory threshold.

Recognizing famous faces and famous buildings: An ERP-analysis of repetition priming

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Repetition priming for faces or names of persons induces an early repetition effect (ERE) in the ERP around 250–300 ms. Because the ERE is domain-specific and is more pronounced for famous than for unfamiliar persons, it is interpreted as reflecting the access to stored representations of faces (face recognition units, FRU) and names (Pfütze, Sommer, & Schweinberger, 2002). In order to assess the category-specificity of the ERE we compared faces and buildings, which could be either famous or unfamiliar, in a prime-target-paradigm. For all subjects individual sets of 64 pictures of each, famous faces and famous buildings, were selected and mixed with the same number of unfamiliar stimuli. Effects of pictorial codes on the ERE were attenuated by a patterned mask between prime and target. Subjects had to perform a familiarity-decision task. EEG was recorded from 64 channels.

Analysis concerned the different categories (buildings and faces) and the level of specificity (famous and unfamiliar). Reaction times revealed a reliable priming effect for both categories. Results showed very distinctive EREs. They were much larger for famous than for unfamiliar faces. The EREs of buildings appeared later and indicated differences in the level of specificity too, but not to the same extent as seen for faces. Topographic comparisons suggest the involvement of category- and familiarity-specific brain systems.

Pfütze, E.-M., Sommer, W., & Schweinberger, S.R. (2002). Age-Related Slowing in Face and Name Recognition: Evidence From Event-Related Brain Potentials. *Psychology and Aging, 17*, 140–160.

Cortical areas related to depth perception of natural images: a LORETA analysis.

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Introduction: Normal binocular vision implies fusion of the two retinal inputs and processing of monocular and binocular cues to construct a vivid percept of depth. This seemly effortless task involves a series of neural processes that are yet not well known or localized. The aim of the present DC-EEG study was to determine which cortical areas get activated while perceiving natural images that switch randomly between scrambled, monoscopic and stereoscopic.

Method: DC-EEG was recorded from thirty male subjects. Eye-movement related changes were eliminated using a regression approach. Artifact free single-trials were averaged per condition and further supplied to LORETA (Pascual-Marqui et al., 1999). For the statistical analysis we used the randomization-permutation approach illustrated by Nichols and Holmes (2001).

Results: Significant higher current density values for all stereoscopic conditions were found in the dorsal visual pathway of both hemispheres. This could be explained through the additional information provided by the horizontal disparity information induced in the stereo condition (Taira et al., 2001). Other activated regions involve the left medial frontal cortex and the anterior cingulate of both hemispheres. In these regions an activation increase can be seen for the stereo condition when switching from scrambled images suggesting a strong involvement of these areas in stereopsis (Gulyas et al., 1994). Neither did we find significant differences in the temporal cortex nor a strong right hemisphere dominance which were described by many studies. These findings suggest that the different aspects of stereoscopic natural images are processed by a number of distinct cortical areas.

Differentiating evoked and induced visual alpha activity by exogenous parameters

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We investigated exogenous effects of stimulus size and duration on the visual alpha oscillatory activity in human EEG. EEG was collected from 17 subjects while they performed a simple choice reaction task requiring discrimination of squares and circles. In separate blocks stimulus size and duration was manipulated. EEG was recorded from 64 electrodes. A wavelet transform based on Morlet wavelets was employed for the analysis of individual alpha activity. Size modulatory ERP deflections showed significant increases in the amplitude of P100 for enhanced stimulus size. No such effect was observed for the amplitude of the N170. The evoked alpha showed onset and offset responses, whereas induced activity showed only a single decrease in response to stimulation. As the size of presented stimulus increases, evoked alpha response becomes larger in its amplitude for stimulus onset and offset. In addition, there is a modulation of individual evoked alpha activity by stimulus-shape for onset responses in posterior regions. According to these data, evoked and induced alpha activity show different reaction patterns to exogenous stimulus properties. It probably implies that these two kinds of alpha activity have different underlying mechanisms, which may serve different cognitive functions. Together with results from literature, these exogenous modulations of alpha activity demonstrate that the human alpha rhythm does reflect top-down as well as bottom-up processes.

Observer's perceptual state in binocular rivalry modulates early ERP components

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Presenting dissimilar stimuli to the two eyes of an observer results in perceptual alternations between those stimuli. This phenomenon is called binocular rivalry.

We investigated the influence of the current percept on early components of the human event-related brain potential (ERP) when rivalrous stimulation is changed into non-rivalrous stimulation. Such transitions require the stimulus of one eye to be swapped.

It depends on the prevailing percept whether physically identical changes entail a change in perception (incompatible change) or do not entail a change in perception (compatible change). ERPs to compatible and incompatible changes showed first differences in the P1-range. Compared to percept-incompatible changes, percept-compatible changes elicited an attenuated P1-peak, whereas the P1-amplitude in a non-rivalrous control condition was most pronounced. For the following N1 component the pattern of results differed at parietal sites. Here, percept-incompatible changes and changes in the non-rivalrous control condition showed peaks with similar amplitudes, whilst the amplitude for percept-compatible changes was smaller. The outcomes suggest that in humans the binocular rivalry phenomenon is already (partly) resolved in extrastriate visual areas latest. To further discern related issues these results were compared to modulations of gamma-activity in the appertaining EEG measures.

Intracerebrally recorded ERPs in a frequency range of 5.5–15 Hz in visual oddball paradigm

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In humans as well as in cats, alpha responses (8–15 Hz oscillations) to sensory stimuli returning to baseline 200–300 ms after stimulus were described. Intracerebrally recorded alpha responses in cats were found not only in specific primary sensory areas but also in hippocampus where they were present independently on stimulus modality.

The aim of the present study was to investigate the intracerebral distribution of ERPs in a frequency range of 5.5–15 Hz in humans.

In seven patients with medically intractable epilepsies depth electrodes were implanted to localize the seizure origin prior to surgical treatment. A total of 268 sites were investigated. Visual oddball paradigm was performed. To reject long-latencies cognitive potentials the digital filter of 5.5–15 Hz was used. For each subject, approximately 50 trials to target and 100 trials to frequent stimuli were averaged. The sites with prominent ERPs were investigated.

In 98 contacts (6 patients) where the prominent ERPs were identified they were present always after both target and frequent stimuli, and they were identical in several successive components (range from 1 to 5) with the peak latency range from 45 to 339 ms. They were found in gyrus cinguli, gyrus fusiformis, hippocampus, gyrus parahippocampalis, gyrus temporalis superior, medius and inferior.

Simultaneous occurrence of identical components after target and frequent stimuli in different brain structures probably reflects the basic level of processing visual stimuli through diffusely distributed neuronal networks. The resulting morphology of the ERPs in some contacts seems to be very similar to alpha responses recorded in cats.

Detecting pop-out targets in displays of varying set sizes

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Although efficient visual search and effortless texture segmentation are assumed to rely on preattentive processing, they are considered to be different tasks. We believe that the debate receives new insights from studies on the detection of pop-out targets varying the number of context elements. Previous studies reported a non-monotonic relationship between the number of display elements and detection performance, indicating that processing small display sizes (as usually observed in visual search tasks) may be different to processing in large set sizes (as usually observed in texture segmentation).

Our paradigm allowed a transition from stimulus displays typically used in search tasks to stimulus displays typically used in segmentation paradigms. Stimulus arrays differed in set size, ranging from 2 to 49 elements. Detection performance and ERPs were recorded. We assumed that different processes may underlie the processing of the pop-out stimuli dependent on the number of elements in the stimulus display.

Our experiments showed the expected non-monotonic relationship between set size and detection performance: performance first decreased slightly and then increased again. ERP-effects were as follows: The N2p was increased for blank compared to target trials, however, only for large set sizes. An N2pc was observed for a broader set size range, but not for very large set sizes. P3 was enlarged for target compared to blank trials for all set sizes larger than 4. The data can be regarded as evidence in favor of different processing modes depending on the number of elements within a stimulus display.

Poster session 9: Motor processing

Wednesday, March 31, 16:00–18:00; Foyer 2nd floor

Effects of musical training on response timing, motor related cortical potentials, task related power and coherence in a simple synchronization tapping task

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Musical training provides an ideal model to study how training affects brain plasticity with respect to both perceptual and behavioral tasks. Others have shown that long-term musical training increases representations of salient stimulus features, as evident in ERP (e.g., MMN and Nd) and MEG (e.g., mN1). The crucial ability to play (the right note) in-time can be studied with rhythmic finger-tapping experiments, in which musicians commonly show reduced synchronization error (SE) and timing jitter.

In this study, the performances of professional musicians (n = 11) and untrained subjects (n = 11) were compared in a simple auditory paced synchronization tapping task. In addition to behavioral data, Motor Related Cortical Potentials (MRCP), Task Related Power (TRPow) and Coherence (TRCoh) were obtained from 31 scalp electrodes.

Response Timing showed expected reductions of SE and jitter in musicians. Musicians' MRCP displayed higher amplitudes fronto-centrally in the pre-response negative slope (NS) and the post-response P60 (postMPI), whereas the motor potential (MP) was highly similar between groups. Pre-response musicians' TRPow revealed a globally stronger desynchronized 10–12 Hz (μ-band) with slightly pronounced activity over bilateral central sites. Pre-response TRCoh in the μ-band showed increased coupling strength between fronto-central to left central sites and between left and right central sites in musicians. Post-response TRPow/TRcoh effects were not observed.

In sum, the behavioral and electrophysiological effects observed in a group of highly trained musicians can be interpreted as correlates of adaptive/plastic

changes in midline motor areas (e.g., SMA, CMA) associated with the cortical contribution to the timing of motor processes.

Dynamics of motor cortex activation in response selection: Activation and inhibition following subliminal response priming

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Recent studies of masked response priming have shown that covert response activation, induced by subliminal visual stimuli, can be followed by an inhibition phase. Depending on the delay between priming stimulus and response signal, this activation-inhibition sequence gives rise to reversed priming effects in choice response tasks (Eimer and Schlaghecken, 1998). In movement-related EEG recordings of the lateralized readiness potential (LRP) such a sequence of events is reflected in a rapid alternation between activation states that favor correct and incorrect response alternatives. These rapid shifts in motor cortex activation and response bias were here exploited to investigate the dynamics of motor cortex activation in response choice. High-density recordings of the LRP in a masked priming experiment (participants n = 9) showed a multi-phasic activation-inhibition-activation sequence. Analyses of whole-scalp voltage topography and current density distributions demonstrated that the inhibition phase was exhaustively explained by partial activation of the incorrect response, without recruitment of voluntarily controlled inhibitory mechanisms. Furthermore, activation of correct and incorrect responses were each accompanied by contralateral activation and ipsilateral inhibition. Finally, using dipole source analysis we found that partial activation of a response was adequately accounted for by an equivalent current dipole explaining movement-related activity during response execution. Together, the results reveal the operation of a potent mechanism of reciprocal inhibition, acting at a late motoric stage, that influences response choice at the level of the motor cortex. These findings refine the notion of response conflict.

Differential effects of stimulus discriminability on processing speed at different stages of sensorimotor processing

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It is well known that stimulus characteristics, such as brightness or intensity, effectively influence reaction time (RT). Usually, better discriminability of a response signal results in shorter RTs. Various chronophysiological measures such as N1 latency, P3 latency, stimulus-related (S-LRP) as well as response-related (R-LRP) lateralized readiness potentials, and EMG latency represent important research tools to systematically elucidate which stages of the information processing chain (sensory, cognitive, or motor processes or a combination of them) account for the effects of stimulus discriminability on RT. In the present study, the effect of stimulus discriminability was investigated in 48 participants using a visual two-alternative forced-choice RT task. High-discriminability stimuli were responded to more than 30 ms faster than low-discriminability stimuli. Analysis of event-related potentials revealed reliably shorter N1, P3, and S-LRP latencies, whereas R-LRP latency was not affected by stimulus discriminability. Furthermore, EMG latency, reflecting the time from onset of muscle activation to the onset of the overt motor response, was significantly shorter in the high- than in the low-discriminability condition. The overall pattern of results supports the notion that stimulus characteristics, such as discriminability, exert a major influence on speed of early sensory processing but do not affect speed of central motor processes such as motor preparation and/or response initiation. The differential effect of stimulus discriminability observed for R-LRP and EMG latencies points to the conclusion that peripheral motor processes rather than central ones may have contributed to faster responses obtained under high compared to low stimulus discriminability.

Executed and imagined movement: an EEG study.

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Event Related Potentials (ERP) were recorded using a 32 channel system in a modified 10-20 system. We compared unilateral movements of digits and toe with motor imagery of the same movements in a visually cued task. A distinct biphasic pattern of electrical activity following cue onset was observed. It was composed by a first peak at a latency of 140 ms and a second peak at 240 ms in both the imagined and executed task. The first peak corresponded to the visual evoked potential and was the same in the two conditions. The second peak was significantly large in the executed movement. Source analysis revealed that both peaks could be modelled by a single dipole and revealed no qualitative difference between tasks. These data suggest that imagined movement is not sustained by the contribution of cortical regions different from those responsible of the executed one.

Response-synchronized EEG theta oscillations in sensorimotor tasks

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Power changes in oscillatory EEG activity from several frequency bands (alpha, beta, gamma) have been described during motor behavior. In the present study, a substantial synchronization of theta (4–7 Hz) frequency oscillations was revealed to accompany motor response production in sensorimotor tasks. EEG was recorded during choice-reaction tasks with different complexity, in which targets had to be responded to by button pressing with the left, right, or both hands. Response-related potentials (RRPs) were transformed to current source density (CSD) by applying the spherical Laplace operator, and analyzed to assess the magnitude and phase-locking of theta RRP components. Strongly synchronized theta oscillations occurred during response execution at pre-central, central, and

post-central electrodes. For unimanual responses, theta oscillations were distributed only over the hemisphere contralateral to the responding hand. For bimanual responses, both hemispheres manifested response-locked theta oscillations. Theta RRP components were largest at midline frontal-central electrodes. A phase-reversal was found for pre-central and post-central regions. Single-sweep analyses quantitatively verified that theta oscillations were not only enhanced but also phase-reordered by response production. Theta RRP components depended on the responding effector (middle or index finger) and response probability, but did not depend on stimulus modality (auditory or visual). Results are discussed in the context of the functional role of theta frequency networks for the control and monitoring of response execution.

Symposia

Symposium 1: Recent advances in human memory research

Monday, March 29, 9:00–12:30; HS 17
Chair: Thomas Gruber

Neural correlates of memory encoding

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How the brain supports the storage of information into long-term, episodic memory is an important, yet unresolved, question. This presentation considers findings from recent ERP and fMRI experiments in which episodic encoding is studied via the 'subsequent memory' approach. In this approach, neural activity evoked by information presented to subjects in a study period is classified according to whether the information is remembered or forgotten in a subsequent memory test. Such 'subsequent memory' effects differ qualitatively depending on the type of task subjects perform at study, and the way in which memory is probed. Subsequent memory effects can be seen for transient neural activity associated with processing individual items as well as for neural activity that is sustained throughout a task. It seems that the brain does not support episodic encoding through the same neural system under all circumstances. Rather, there appear to be multiple encoding systems, the employment of which depends on the nature of the proc-

esses engaged by information at initial exposure, those engaged during subsequent retrieval, and the degree of overlap between the two. Moreover, effective encoding seems to rely not only on how individual items are processed, but also on the mental state during which those items are experienced.

The relation between alpha and theta oscillations in memory tasks

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Converging evidence from the human EEG as well as animal research indicates that theta oscillations are associated with working memory processes. We discuss arguments and present data suggesting that alpha oscillations also play an important role during short-term memory retention and retrieval. Three different findings are of importance. First, for the retention period of memory scanning tasks an interesting similarity between the reactivity of theta and upper alpha oscillations with respect to memory load was found. Second, increased evoked upper alpha activity was found over parietal regions during retrieval from short-term memory storage. Third, during attempts to retrieve information from long-term memory, evoked theta oscillations spread from anterior to posterior recording sites and when information actually is retrieved, the direction reverses and theta spreads to frontal sites. Most interestingly, this time point – when direction reverses – varies between subjects to a large extent but is significantly correlated with memory performance and the onset of upper alpha desynchronization. Forth, in a recent experiment we found significant theta : upper alpha phase synchronization during retention and retrieval. These findings suggest that both frequencies play an important role for working memory an that a specific ‘co-activation’ between theta and upper alpha can be observed when information stored in short- or long-term memory is retrieved or processed in working memory. Thereby, upper alpha oscillations may reflect the reactivation of long-term memory codes in working memory.

The role of synchronized gamma activity in declarative memory formation

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Human declarative memory formation crucially depends on processes within the medial temporal lobe (MTL). These processes can be monitored in real-time by recordings from depth electrodes implanted in the MTL of epilepsy patients, which undergo presurgical evaluation. In our studies, patients performed a word memorization task during depth EEG recording. Afterwards, the difference between event-related potentials corresponding to subsequently remembered versus forgotten words was analyzed. These kind of studies revealed that successful memory encoding is characterized by an early process generated by the rhinal cortex within 300 ms following stimulus onset preceding a hippocampal process, which starts about 200 ms later. Direct evidence for a memory related cooperation between both structures, has been found in a study analyzing induced gamma activity around 40 Hz. Here, successful as opposed to unsuccessful memory formation was accompanied by an initial enhancement of rhinal-hippocampal phase synchronization, which was followed by a later desynchronization. Present knowledge about the function of synchronized gamma activity suggests that this phase coupling and decoupling initiates and later terminates communication between both MTL structures. Furthermore, the memory related changes of gamma synchronization were found to be correlated with increases of rhinal-hippocampal coherence in the theta range. This correlation may suggest an interaction of both mechanisms during memory formation. During sleep a general reduction of rhinal-hippocampal EEG coherence compared to waking state was observed, which was most pronounced within the gamma band. The decrease of rhinal-hippocampal EEG coherence may yield an electrophysiological explanation for the sleep related deficiency of declarative memory.

Evoked gamma activity reflects memory representations

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Human brain activity in the gamma frequency range was shown to be a correlate of numerous cognitive functions. However, up to now there is no coherent theory predicting under which experimental conditions gamma activity would arise. One mechanism underlying all of the above cognitive functions is access to memory and may thus explain the phenomenon. We tested the hypothesis that gamma activity is evoked whenever stimuli match memory representations. EEG was recorded from 16 subjects performing a choice reaction task. Visual stimuli were either known real-world objects with a memory representation or novel configurations never seen before. Evoked gamma activity was significantly larger for items which matched memory templates. Therefore, we argue that gamma activity results from the feedback between memory and perception systems. This assumption for the first time integrates the data of many experiments and offers a unifying theory.

Induced gamma activity during various memory tasks in the human EEG

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It has been proposed that learning is accomplished by the formation of cell assemblies and synchronous activity among the neurons of such a network. In a series of studies we have tested the hypothesis that oscillatory activity in the Gamma Band is a signature of different memory processes. In particular, the focus was directed on rapid perceptual learning, recognition memory, and repetition priming. Using multi-channel EEG the following results were found: (1) Retrieval processes in a perceptual learning paradigm led to an increase of Gamma power and phase synchrony. (2) Gamma Band activity is crucial not only during retrieval but also for the establishment of a valid memory trace. (3) Repetition priming of familiar objects resulted in repetition suppression in the Gamma Band, possibly

related to a 'sharpening' in cortical representations. Repetition of unfamiliar objects led to repetition enhancement, which suggests that repetition effects depend on the presence or absence of pre-existing object representations. From this series of studies, it was concluded that memory retrieval/formation is indeed based on networks, which are established by neuronal synchrony amongst their elements. Induced Gamma Band responses and phase synchrony are a signature of activity within such a cell assembly in the human EEG.

Symposium 2: Auditory attention

Monday, March 29, 9:00–12:30; HS 18
Chair: Elyse Sussman

Intermodal selective attention effects in monkey auditory cortex

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We investigated attentional modulation of auditory cortex in monkeys, trained to alternate between auditory and visual discriminations. Laminar event related potential (ERP), current source density (CSD) and multiunit activity (MUA) profiles were obtained by sampling neural activity during penetrations of auditory cortex with linear array multielectrodes. Attention effects were defined by comparing cortical response profiles evoked by tones and more complex stimuli when attended, with the responses to the same stimuli when ignored. Analyses of averaged responses produced 2 findings of general interest. First, attentional modulation begins 20 ms or more after the onset of the local sensory response, and has a clear bias toward the supragranular laminae, with little or no impact on short latency activity in Lamina 4. This pattern of findings is consistent with a "stimulus-driven" feedback model of attention. Second, attention produced a relative negativity in the supragranular ERP at many sites. The CSD profile revealed local contributions to the effect. This may relate to the Processing Negativity observed un-

der similar experimental circumstances in the human scalp ERP. Attentional modulation of oscillatory activity was investigated by analyzing single trial responses using Fast Fourier Transform (FFT) and Wavelet Analysis routines. These analyses revealed attentional modulation across a range of EEG frequencies, including both the lower frequencies in which stimulus/phase-locked activity forms significant contributions to the averaged ERP and higher (gamma) frequencies. There is also an indication of an anticipatory attentional modulation of baseline activity. Local visual responses were detected and appeared to be modulated by attention.

Auditory perception: The interaction between stimulus-driven processes and attentional control

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Typically the sensory information entering our ears is much more than we can deal with. Selective attention limits processing so we can handle the vast amount of information that we encounter daily. Actively selecting a subset of sensory information has been shown to modify the input at an early processing stage, generally seen as an enhancement of the neural activity for the relevant features of the input. In this talk I provide evidence of another type of attention effect on neural activity, affecting the representation of successive sounds in memory. Event-related brain potentials were used to identify the timing of various cognitive processes and, in combination with measures of subject's perception of the sounds, to assess the stage at which attention interacted with sensory input in perception. In one study, attention modified the organization and storage of sound in memory, reflected by the absence or presence of specific ERP components. In another study attention increased accuracy for discriminating stimulus information but did not change the way the information was represented in auditory memory. These data suggest that there is more than one mechanism of auditory attention operating at different processing stages depending on the listener's task, and further, supports the notion that attention interacts with stimulus-driven processes to facilitate behavioral goals.

Stimulus-driven and top-down effects on sound organization

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In one pair of experiments, modeling an unambiguous auditory scene, a repetitive tone sequence including infrequent duration deviants was mixed with tones randomly varying in duration (intervening tones). In the Interference condition, the frequency range of the intervening tones included the frequency of the oddball sequence tones. In the Segregated condition, intervening tone frequencies were set to be distinctly different from the frequency of the oddball sequence tones. Subjects could detect the duration deviants in the Segregated but not in the Integrated condition. Correspondingly duration deviants only elicited MMN in the Segregated condition (while subjects performed a visual primary task).

In another experiment, modeling an ambiguous auditory scene, sequences consisted of a repeating tone triplet (ABA ABA ABA …, the A and B are two tones differed in frequency). Sounds were delivered at a pace at which this sequence could be perceived either as separate high and low streams of sound or as a single stream with a galloping rhythm. Subjects were instructed to maintain hearing the galloping rhythm and to keep a response button depressed when they could do so. ERP responses were analyzed for occasional omissions of the "B" tone. Perception of the galloping rhythm fluctuated within the tone sequences. The elicitation of deviation related ERP responses by the omission deviants was found to correspond to the perception of the galloping rhythm.

Results of these experiments show that stimulus driven and top down effects of sound organization converge on the memory representations reflected by the MMN response.

Relation between pre-attentive deviance detection, involuntary attention, and working memory

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Our auditory system pre-attentively scans the environment for potentially relevant irregularities in an otherwise regular acoustic input. Such irregularities may cause an involuntary attention switch, which, in turn, may disturb ongoing mental operations resulting in impaired task-performance. The protection from distraction and the re-orienting of attention to task-relevant aspects of stimulation belongs to the liability of working memory. We investigated the dependency of ERP and behavioral indicators of processes underlying distraction and the recovery from distraction from the saliency of the perturbating information. More specifically, in a duration discrimination task occasional deviations in the sound's frequency served as distractors. The physical difference between standard an deviant frequency was 1%, 3%, 5% or 10%. Even with the smallest distractor a substantial prolongation in the duration discrimination task was obtained. Separating trials with and without reaction time prolongation revealed MMN to both sub-averages, whereas P3a and RON (indicating an involuntary attention switch and the subsequent re-orienting of attention) were confined to sub-average computed from trials with behavioral distraction. This shows that the mismatch signal elicited by small deviations does not necessarily invoke subsequent distraction. It also supports the model according to which P3a and RON reflect distraction processes of the working memory system, whereas MMN indicates activity of the pre-attentive change-detection system. Moreover, MMN, P3a, RON and reaction time prolongation did also increase with increasing deviancy. Thus the processes involved in distraction including the early pre-attentive deviancy detection, the involuntary switching of attention, and the late re-orienting are modulated in a gradual fashion by the saliency of the distracting information. This strengthens the notion of a close relationship between pre-attentive deviance detection and working memory.

The allocation of attention in the development of speech perception

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Models of the development of speech perception often include the notion that infants learn to automatically focus attention on language-specific relevant cues in speech (e.g., Jusczyk, 1997). Studies using behavioral methods have revealed that infants stop discriminating certain non-native speech contrasts between 6 and 12 months of age. However, behavioral studies with adults show that sensitivity to the cues needed to discriminate these non-native contrasts is not lost (e.g., Logan, et al., 1989). Specifically, if their attention is directed to the relevant cues, they can make use of them. These findings lead to an interesting hypothesis concerning the nature of the speech perception deficits observed in children with specific language impairment (SLI). It is possible that focusing attention on the relevant cues in the native language is not automatic for SLI children. This possibility is supported in a study from our lab in which children with SLI failed to show mismatch negativities to the vowel contrast in “bed” versus “bid”, even though they showed good behavioral discrimination of these vowels. The finding that MMN is reduced or absent to subtle phonetic differences that are not phonemic in a speaker’s language in a number of studies supports the claim that focusing on relevant cues in a native language has become automatic for speakers with typical language. I will discuss how electrophysiological investigations of infant speech perception could help in determining the role of attention in the development of speech perception and in language-learning disorders.

Symposium 3: Perceptual deficits and their remediation in dyslexia

Monday, March 29, 14:00–16:00; HS 20
Chair: Teija Kujala

Brain responses to the matching of score-like visual symbols to sounds indicate a left hemispheric deficit in dyslexia

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Recently, it has been shown by Kujala and colleagues that an audio-visual training requiring the matching of visual and sound patterns has a remediating effect on dyslexia in children. In parallel, the training also altered the neural substrate of sound discrimination, as reflected in enhanced Mismatch Negativity (MMN) component amplitudes of the event-related brain potential (ERP). To shed light on the brain processes involved in the audio-visual training we developed an ERP-paradigm where predictive visual score-like symbols had to be matched to corresponding sounds. If the visual symbol was incongruent to the predicted sound, a brain response was elicited in healthy adults as early as 100 ms resembling the MMN component. It is argued that the auditory system can establish a representation of an expected stimulus on the basis of visual symbolic information which can be compared to the current auditory input at sensory levels of processing. In a subsequent study we examined dyslexic and control first grade Finnish school children with this Symbol-to-Sound matching paradigm. The brain response indicating the detection of an incongruency between the visual symbol and the predicted sound was markedly smaller in dyslexic children compared to control children over left hemisphere areas but not over right hemisphere areas. This is consistent with previous findings that also left hemisphere MMN amplitude is smaller in dyslexics and might indicate a left hemispheric deficit in dyslexia. It may thus be proposed that the audio-visual training helps remediating dyslexia by facilitating especially left-hemispheric functions.

Brain responses in infants and children with and without risk for familial dyslexia: Processing differences and associations with behavioral measures

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Individuals with developmental dyslexia are reported to have problems in auditory and speech processing. Here we review evidence from the Jyväskylä Longitudinal Study of Dyslexia showing that early processing differences, as measured with brain event-related potentials (ERPs), are related to later language related skills in children at risk for familial dyslexia and control children. Preliminary results for school-aged children also show perceptual differences between the groups.

We earlier found that both obligatory and change detection responses differed between at-risk and control newborns in the right hemisphere. Both responses predicted later language and verbal memory skills at 2.5, 3.5 and 5 years. Group differences were also found for 6-month-olds. Associations for later phonological and language skills language differed between the groups between 2.5 and 5 years.

For school-aged children with and without reading problems, both speech and non-speech stimuli were presented in oddball paradigms and a control experiment. Preliminary results for non-speech complex tones show differences in responses to pitch and rise time changes. In control children, MMN was bilateral for pitch change and left lateralized for rise time change. Poor readers had no MMN response to either of the stimuli.

Our findings indicate that enhanced general responsiveness to speech stimuli and atypical change detection processes predict poorer language related skills. The results suggest differences in the organization of the auditory/speech system subserving phonological processing and language functions in at-risk children and poor readers. The results further indicate that ERPs could provide ways to identify children benefiting from early language training.

ERP studies of sound feature and envelop processing in dyslexia and specific language impairment (SLI)

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Speech perception depends on processing of key features in the sound stream and modulations of the sound envelope. These two processing capacities may be reflected in MMN (permanent feature detector) and N1 (transient stimulus detector) components respectively (Naatanen, 1990). Developmental disruption of these processing capacities may result in distinct language disorders.

In a first study of dyslexic adults, a behavioral impairment in pitch discrimination was correlated with a MMN deficit, correlated with phonological skills. In contrast, N1 to tones with short rise times was not impaired, suggesting impaired feature but intact envelope processing in this group.

A second study suggested that processing of both sound features and envelope contribute to behavioral deficits in SLI. Speech MMN magnitude was reduced in SLI and correlated with performance deficits in non-word repetition and listening span. Half of the SLI children also displayed impairments in discriminating speech sounds, correlated with the amplitude of N1 potentials.

A third study examined ERP correlates of sensitivity to sound rise-time, an important cue for speech envelope processing which accounts for a large proportion of variance in children's phonological and reading skills (Goswami et al., 2002). Preliminary data in adults and children suggest that N1 and MMN are also sensitive to sound rise time and might distinguish dyslexics from age-matched controls.

In summary, N1 and MMN are sensitive neural markers for distinct aspects of speech sound processing correlated to phonological skills, and can assist in elucidating the developmental trajectories of their dysfunction in language disorders.

Changes in cortical activity during language processing and effects of affective context

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In an earlier study involving language-impaired children, we observed that improvements in various literacy skills following linguistic training are mirrored in altered magnetic brain activity. One of the questions that emerged from this finding was whether changes in cortical activity are influenced by context properties such as affective or motivational variables. In the current study, we used a classical conditioning paradigm to investigate effects of learned motivational significance in normal adult subjects. Stimuli were syllables of a /ba/-/da/ continuum based on pre-experimental identification-task data of 20 healthy adults (pre-experimental group). In the experimental group, aversive white noise (UCS) was paired with two exemplars of /ba/ stimuli (CS+) near the category boundary of the continuum. Two /da/ stimuli in the vicinity of the category border served as the CS- and signaled absence of white noise. The control group was exposed to the same syllables without presentation of the UCS. In both the experimental and control condition, the electroencephalogram (EEG) was recorded while subjects passively listened to the stimuli. Before and after recordings subjects were asked to identify the syllables in a categorical perception task. Ongoing analyses of the EEG data obtained within the experimental group revealed amplitude modulations as a function of stimulus properties (CS+ vs. CS-). No differential response to the syllables was found for the control group. However, only the control group perceived stimuli near the category boundary differently after than before the EEG session. Our preliminary results point to the role of affective/motivational context in language processing.

Symposium 4: Electrophysiological and hemodynamic correlates of performance monitoring

Monday, March 29, 14:00–16:00; HS 17
Chair: Markus Ullsperger & William J. Gehring

Multiple determinants of the medial frontal negativities related to error processing and feedback

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The studies reported here address two related issues: how the various medial-frontal/anterior cingulate processes observed in electrophysiological and neuro-imaging studies are related, and what the functional roles of these processes are in monitoring and regulating behavior. A variety of medial-frontal negativities are evident in diverse experimental paradigms (e.g., the ERN/Ne, the negativities elicited by error feedback and monetary losses, and the various N2s). One experiment employed time-frequency analysis (using continuous wavelet transforms) to determine whether these negativities arise from the same underlying pattern of brain activity. The response-locked ERN and the ERN-like activity elicited by monetary losses were each apparent as a burst of activity in the 4–7 Hz (theta) range. Variations in the scalp distribution of this theta activity suggest that the two phenomena are not identical, although there may be sources common to both. A second study explored the numerous ways in which a feedback stimulus can be "good or bad" and "expected or unexpected." Here, we examined the feedback-related negativities elicited by feedback stimuli signifying the rewards that were missed or penalties that were avoided because of a prior choice made by the subject. We observed several conditions in which feedback representing a favorable outcome elicited a feedback-related negativity as large as that elicited when the outcome was bad. Our results suggest that theories of medial-frontal function must accommodate the multiple neural sources of the scalp activity and the multiple ways in which a stimulus can deviate from contextually-determined expectancies.

Medial frontal cortex and the regulation of action

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In recent years, the anterior cingulate cortex (ACC) has been shown to be involved in response monitoring, including error and conflict monitoring. However, animal and neurophysiological studies show that the ACC is part of a larger network involved in early stages of learning. Electrophysiological studies show that error monitoring can be indexed in humans and is observed as the error-related negativity (ERN) in the response-locked event related potential (ERP). In this paper, we frame the significance of the ERN within the context of early stage learning such that the construct of ACC function is relevant to both humans and animals.

Error processing, rewards, and motivational context

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Human error processing – a function that is essential for goal-directed behavior – has been proposed to be closely related to reward prediction. Both reward processing and performance monitoring are assumed to reciprocally interact with emotion and motivation. In the talk I will present data from ERP as well as fMRI studies investigating these relationships. In the first part, data from an fMRI study in which feedback informativity was varied during a task involving high response uncertainty will be presented. The results clearly demonstrate the role of the reward system in error processing. The rostral cingulate zone, the putative generator of the error-related negativity, is specifically activated by negative feedback, whereas the ventral striatum reacts to positive feedback. In the second part, ERP as well as fMRI results addressing the modulation of error processing by contextual variables, such as motivation, will be presented. The relevance of errors was modulated by differential instructions and financial incentives. The studies revealed larger ERN amplitudes and higher hemodynamic signal increases in the rostral cingulate zone, when errors were of high relevance to the individual. The

data will be discussed with respect to the reward-based reinforcement learning theory of the ERN proposed by Holroyd and Coles (2002). Furthermore, similarities of the networks involved in the detection of different error types will be discussed.

Conflict and error processing in anterior cingulate cortex

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Anterior cingulate cortex is thought to play a critical role in performance monitoring. In particular, it has been proposed that regions within anterior cingulate are involved in monitoring for response conflict, the simultaneous activation of incompatible responses. This theory, developed in order to account for ACC activity observed in neuroimaging studies, has recently been extended to account for two ERP components, the N2 and the error-related negativity (Ne/ERN). I will discuss ERP evidence consistent with the hypothesis that the N2 and Ne/ERN reflect conflict monitoring in anterior cingulate cortex, and consider the implications of these findings for theories of conflict and error processing.

Symposium 5: Intracerebral generators

Monday, March 29, 14:00–16:00; HS 18
Chair: George Karmos

Laminar analysis of intracortical electrical activity in humans

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The human brain is dominated by the neocortex, a large folded surface, whose cellular and synaptic elements are arranged in layers. Since cortical structure is

relatively constant across its surface, local information processing can be inferred from multiple laminar recordings of its electrical activity along a line perpendicular to its surface. Such recordings need to be spaced close together, and need to be wideband in order to sample both synaptic currents and action potentials. Current source density analysis can identify the synaptic generators of the intracortical field-potentials. Simultaneous multiple- and single-unit activity records lends convergent information to the definition of these processes, and provides insight into local cellular responses to the field-potential being analyzed. Until recently, laminar multiple microelectrode recordings have been performed only in animals. Cognitive event-related potential (ERP) studies are difficult or impossible to be performed adequately in animals because of the complexity of the tasks where they are evoked and manipulated. Furthermore, it is obviously superior to characterize in detail the pathophysiology of an actual human disease – epilepsy – as opposed to an animal model of that disease. Additional information from human studies could help improve diagnostic techniques for the surgical resection of epilepsy by better defining tissue for resection, and regions of eloquent cortex, through increased knowledge of local ERP generators and the represented cognitive function.

Defining the physical mechanisms and physiological significance of ERP components.

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Event-related potentials (ERPs) provide a critical link between the hemodynamic response, as measured by fMRI, and the dynamics of the underlying neuronal activity. Single-trial ERP/EEG recordings capture the oscillatory activity that is hypothesized to underlie both communication between brain regions and amplified processing of behaviorally relevant stimuli. However, precise interpretations of ERPs are precluded by uncertainty about their neural mechanisms. One influential theory holds that averaged sensory ERPs are generated by partial phase resetting of ongoing electroencephalographic oscillations, while another states that ERPs result from stimulus-evoked neural responses. We formulated critical predictions

of each theory and tested these using direct, intracortical analyses of neural activity in monkeys. Based a central assumption of "phase resetting" (pre- to post-stimulus phase concentration without increase in power at the dominant frequency of the ERP), evidence from the monkey studies favors a dominant "evoked response" contribution to early components. In further studies, we investigated the homologies between human and simian ERP components, as well as their neural sources in monkeys. We have tracked several ERP components, including C1, P1, N1, MMN and selection negativity down to underlying brain regions, neuronal populations and cellular processes. In sum our findings support a predominant role for stimulus-evoked activity in sensory ERP generation, and make a series of predictions concerning the contributions of phase-resetting to particular ERP components. We also outline both logic and methodology necessary for differentiating evoked and phase resetting contributions to cognitive and motor ERPs in future studies.

Spatiotemporal dynamics of episodic memory: A combined study with fMRI, MEG and human laminar recordings

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Episodic encoding and retrieval and semantic memory retrieval involve multiple brain areas including prefrontal, and lateral temporal neocortex, as well as the hippocampal formation.

In the present study, 18 healthy rh subjects were investigated with MEG and fMRI using a rapid-presentation event related memory paradigm including trials for episodic encoding, episodic retrieval and semantic retrieval. The same paradigm with a different set of items was used in fMRI and 306-channel MEG. Cortical activation maps were averaged across all subjects and structural and functional MRI were combined with MEG to obtain spatiotemporal maps of cortical activity with high spatiotemporal resolution. Data were compared with results of multi-micro-laminar entorhinal cortex (EC) recordings in one patient with medically intractable temporal lobe epilepsy.

fMRI constrained MEG showed a greater involvement of prefrontal areas for pisodic retrieval vs episodic encoding. Semantic retrieval showed greater ativation of the mesial temporal lobe peaking at ~420–550 ms than episodic retrieval. All conditions show hippocampal involvement in fMRI. Multi-microelectrode recordings in the left entorhinal cortex showed strong current sinks indicating population EPSPs, to all conditions, most strongly in superficial layers to episodic retrieval, with sustained firing in deep layers. Recall evoked strong increases in theta power lasting > 1 s in deep EC layers and phasic wideband increases in superficial EC layers.

This study shows that the medial temporal lobe is strongly active in both semantic and episodic declarative memory tasks, and suggests that there is a sustained contribution of the entorhinal cortex during intentional retrieval processes, in interaction with prefrontal and lateral temporal sites.

Single-trial characterization of evoked responses: Bayesian estimation and differentially variable component analysis

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Brain responses are dynamic, state dependent, and change over time. In acknowledging this, it is becoming increasingly more important to characterize single trial responses. Using Bayesian probability theory, I demonstrate how a more complex signal model that accounts for amplitude and latency variability in the single trial allows one to characterize and examine single trial responses. Furthermore, the fact that different neural ensembles exhibit differential variability patterns allows one to tease apart these mixed signals and isolate signals generated from different neural ensembles. This new technique, called differentially Variable Component Analysis (dVCA) allows one to separate, identify, and characterize single trial responses from simultaneously active sources. Interactions among the ensembles can be studied by examining their single trial properties. I will demonstrate the technique using simulations as well as intracortical field potentials recorded from a linear multi-electrode array in a macaque experiencing visual stimulation.

Symposium 6: News about P3: The integrative component

Tuesday, March 30, 9:00–12:30; HS 18
Chair: Rolf Verleger

Cortical and subcortical generators of P3

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The localization of brain generators of cognitive potentials can provide insight into the composition and function of neuronal networks underlying various cognitive functions. An indirect indication of the importance of brain regions on scalp recorded P300 can be provided by the recordings in patients with circumscribed brain lesions. The activity of the temporo-parietal junction, and in some cases also the activity of the hippocampus, the dorsolateral prefrontal cortex, and the thalamus, and possibly even of some other regions, modulates the activity that provides the basis for the scalp recorded potentials. The source locations can be directly studied using intracerebral recording. In the human brain, a widespread distribution of P3-like potential generators in multiple cortical and subcortical regions has been observed. The participation of widespread areas of the frontal, temporal and parietal cortex, in addition to the cingulate and mesial temporal regions and the basal ganglia and thalamus, has been shown. Intracerebrally, in addition to the multiple task-nonspecific P3 generators, other task-specific P3-like potential generators have been recorded. A variable and task-dependent internal organization of cortico-subcortical systems generating the P300 is probable.

The source of scalp-recorded P300 remains a subject of ongoing discussion. The contribution of individual cortical areas generating P3 potentials remains unclear. We strongly suspect that scalp-recorded P300 represents a summation of potentials that are generated simultaneously in several cortical as well as in several subcortical structures.

P3 integrates stimulus- and response-related processing

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In virtually all tasks used in experimental psychology, stimuli evoke a P3 component when EEG is recorded. Therefore, understanding this component might promote understanding about how human brains generally organize behavior control in such tasks. In intracranial recordings, correlates of scalp-recorded P3 have been found at various locations, both at subcortical (hippocampus, thalamus, basal ganglia) and cortical sites (superior parietal and frontal lobe). Therefore, P3 might have some integrative function.

The present study tests whether P3 reflects the link between perceptual processing and response preparation. If indeed equally related to both processes, P3 should not be smaller in response-locked than in stimulus-locked averages. To this end, data were analyzed from two different tasks and evoked by visual and auditory stimuli.

Parietal P3 amplitudes were indeed not smaller in response-locked than in stimulus-locked averages, in some instances even larger. For comparison, peak amplitudes both of lateralized readiness potentials and of response-force were larger when response-locked (as could be expected) and fronto-central P3 with auditory stimuli was larger when stimulus-locked (as could be generally expected for P3 if it were stimulus-related only).

Thus, parietal P3 seems unique in being equally related to stimulus and response. It might reflect fast-track decision, based on prepared S-R links. The modules needed for this process are described and are mapped to neurophysiological evidence about P3.

Target-to-target interval versus probability effects on P300

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There are currently a number of theories relating to the psychological correlates of the P300. Many of these have been derived from complex relations that have been observed between P300 attributes and such stimulus parameters as target probability, number of preceding non-targets, and inter-stimulus interval (within oddball-type paradigms). However, recent evidence suggests that a number of these relations may be more economically explained by the varying target-to-target intervals employed in those studies, which in turn may have significant theoretical and clinical implications including a re-examination of the relative importance of the P300's potential physiological and cognitive determinants. This presentation will describe some of the research in support of the target-to-target interval explanation of the P300, including data from both auditory and visual paradigms, as well as some preliminary data from pharmacological manipulations within non-clinical samples.

Multiple functional subcomponents of P300: evidence from the time-frequency domain

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One way to understand better the P300 component of the event-related potential (ERP) is to study its heterogeneous nature. In the classical averaged waveforms, P300 sub-components remain obscure but they can be revealed by analysis in the time-frequency (TF) domain. A TF decomposition can extract neuroelectric events with different duration that may occur simultaneously during P300. In the current study, P300 was elicited in several conditions manipulating stimulus probability, discrimination, and motor task-relevance. Event-related potentials were spatially enhanced by means of current source density and decomposed in the TF domain. Wavelet analysis found that multiple TF components from the sub-delta

(< 1 Hz), delta (1.5–3.5 Hz), theta (4–7 Hz), and faster frequency bands were phase-locked with stimulus and co-existed during the classical oddball P300. Importantly, each of these TF components manifested a specific pattern of scalp distribution: parietal for the sub-delta, frontal-central for the delta, and frontal-parietal for the theta TF component, thus contributing differentially to the posterior and anterior portions of the oddball P300. Subsequent analyses revealed that each TF component manifested a specific reactivity to experimental variables at specific scalp locations. Thus, the isolation of TF sub-components of P300 demonstrates the integrative nature of this ERP component. It is also suggested that time-frequency-spatial (TFS) patterns may be regarded as more refined electrophysiological correlates of the neural processes during P300. Additional analyses of response-locked averages indicated that P300 elicited in sensorimotor tasks may contain motor-related activity in the delta and theta frequency bands.

Overview of P3a and P3b: Towards an integrative theory

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The relationship between the P3a and P3b event-related brain potentials (ERPs) will be reviewed by outlining the empirical background of the distinction between these subcomponents. Recent results suggest that the key factors for eliciting P3a in a three-stimulus oddball task are salience rather than novelty of the distracter stimulus and how target/standard discrimination difficulty modulates task processing. Although the exact neural loci of P3a and P3b generation are still unclear, discriminating a target from a standard stimulus appears to initiate frontal engagement as a consequence of the focal attention engaged by task demands. When this attentional focus is disrupted, P300 generation may then originate from an interaction between frontal lobe (P3a) and hippocampal/temporal-parietal (P3b) activity. This overall approach removes the involvement of novelty as a requirement for P3a production and opens the door for a more direct P300 theory.

Symposium 7: Episodic memory and the mesiotemporal lobes

Tuesday, March 30, 9:00–12:30; HS 17
Chair: Bertram Opitz & Ken Paller

How does conscious recollection differ from priming?: Insights from amnesic patients and brain potentials

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Patterns of memory impairment in patients with amnesia suggest that memory for facts and episodes depends on a process of "cross-cortical storage" that is not required for other forms of memory. This neuropsychological evidence provides a theoretical foundation for understanding memory phenomena like recollection (the conscious experience of remembering facts and events) and priming (an instance of item-specific implicit memory). Building on this foundation, electrophysiological measures of brain activity can provide additional evidence relevant for understanding the processes responsible for these fundamentally different types of memory. In particular, distinct brain potentials have been associated with recollection of episodic memories and with certain types of priming. This approach is thus useful for exploring the neurocognitive events that make remembering with awareness so different from remembering without awareness.

A selective impairment of recollection following medial-temporal lobe damage: behavioural and electrophysiological data

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Patient (KN), a 44 year old man, suffered 50% bilateral shrinkage of the hippocampus and amygdala following meningitis. In contrast to his preserved IQ (WAIS PIQ 116, VIQ 136) he shows a severe, persistent loss of episodic memory.

This is demonstrated by his failure to recall prose passages, word lists, and complex figures, so that on the WMSr he has an Attention Concentration Index of 123, yet a General Memory Index of 88, and Delayed Recall Index of 50 (at floor). Likewise, on the recall components of the Doors and People Test he performs extremely poorly (name recall 1%ile, shape recall 5%ile). In contrast, KN appears more normal on tests of recognition memory (e.g., Warrington Recognition Memory test, words 48/50, 75%ile; Doors and People Test, name recognition 25%ile). Consistent with this he performs at normal levels on the Calev recognition task (20/24) but is very impaired on the Calev recall task (7/24). Performance scores on these tasks are expected to be comparable.

Evidence from two different sources indicates that KN is able to perform recognition memory tasks on the basis of familiarity. First, while scalp-recorded event-related potentials (ERPs) differentiated correctly identified old and new test items, the ERP signature of recollection did not form part of this differentiation. Second, estimates of familiarity and recollection derived from an ROC analysis reveal a strong bias toward using familiarity. These findings accord with dual-process models of recognition memory in which familiarity and recollection are distinct components. The former may depend on the parahippocampal region while the latter depends on the hippocampus.

Electromagnetic indices of memory-related theta oscillations and of theta-gamma covariance

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Theta oscillations and covariance of theta and gamma oscillations are important physiological indices of memory processes in the hippocampus. We show, using whole-head magnetoencephalography, that during the recognition of repeated words from episodic memory, theta oscillations over left temporal sensors have higher amplitudes and show a greater degree of phase alignment than correct rejections of new words. Over similar regions, there are also differences in gamma amplitudes between recognized and correctly rejected words. Remarkably, recognized and new words also differ with respect to the degree to which gamma changes are locked to certain phases of theta. In patients with temporal lobe epi-

lepsy who have unilateral hippocampal sclerosis, both theta oscillations and the theta-gamma phase-coupling are affected over temporal sensors.

From oscillations to single-unit activity: the neurophysiology of human spatial navigation

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The place cells of the rodent hippocampus, and the 4–10 Hz hippocampal theta rhythm, constitute two of the most striking examples of correlations between neuronal activity and complex behavior in mammals. Using human intracranial recordings, which can be ethically obtained as part of standard neurosurgical evaluations, we examine the neurophysiological basis of human spatial cognition. Field recordings from intracranial electrodes while subjects actively explored a virtual town revealed increased theta activity associated with movement and when searching for objects whose locations were not known. Single cell recordings from hippocampal, parahippocampal and frontal regions reveal cells in the hippocampus that respond at specific spatial locations and cells in parahippocampal region responding to views of landmarks. These data suggest that the hippocampus is specialized for spatial processing while the parahippocampal region is specialized for coding spatial views. Cells also responded to the subject's navigational goals and to conjunctions of place, goal and view.

Differential neuronal correlates for familiarity and recollection during memory retrieval

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It has been proposed that one can recognize a previously studied item based on the recollection of specific details of the study episode or based on a non-specific and context free sense of familiarity. Human lesion studies, single unit recordings in animals and brain imaging studies add to the converging evidence that both as-

pects of recognition memory are mediated by two medial temporal lobe systems: The perirhinal cortex and the hippocampus. In this talk it will be shown that familiarity-based and recollection-based recognition can be mapped onto spatially and temporally distinct parts of the ERP old/new effect. Familiarity-based recognition judgments are associated with a mid frontal old/new effect that onsets earlier and demonstrates a different scalp distribution than a parietal old/new effect that is associated with recollection-based recognition. It will be shown that this ERP dissociation holds for a variety of operational definitions of familiarity and recollection. However, a critical case for the generation of a familiarity signal appears to be the assessment of the global similarity between the first and second occurrence of an item. Whereas recollection presupposes the retrieval of associational, inter-item information. Results from recent ERP studies suggest that recognition memory for biologically relevant (emotional) events is characterized by different contributions of familiarity-based and recollection-based judgments as compared to recognition memory for neutral events. Implications of these findings for models of episodic memory as well as for the functional architecture of the medial temporal lobes will be outlined.

Symposium 8: Pre-attentive speech perception

Tuesday, March 30, 9:00–12:30; HS 20
Chair: Thomas Jacobsen & István Winkler

Magnetoencephalography is feasible for infant assessment of auditory discrimination

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Magnetoencephalography (MEG) detects the brain's magnetic fields as generated by intra-cellular currents during synchronized neuronal activity. It is noninvasive, has excellent temporal resolution, and it can localize neuronal activity with good precision. For these reasons many scientists interested in the localization of brain functions, such as auditory processing, have turned to MEG. The technique, how-

ever, is not without its drawbacks. Those reluctant to employ it cite its time-consuming data analysis as well as its relative awkwardness among pediatric populations owing to the fact that MEG requires subjects to be fairly still during experiments. Due to these methodological challenges, infant MEG studies are not commonly pursued. In our study MEG was employed to study auditory discrimination in infants. We had two goals: first, to determine whether reliable results could be obtained from infants despite their movements; and second, to improve MEG data analysis methods. In order to get more reliable results from infants we employed novel hardware and software solutions to better deal with noise and movement. With these solutions, the location and orientation of the head can be tracked in real time and the external magnetic disturbances can be eliminated, such as that due to heart beat and limb movement. In the present study these new methods were used to study the biomagnetic equivalents of event-related potentials (ERPs) in response to changes in auditory stimuli in healthy, full-term infants. Our findings indicate that with the use of these new analysis routines, MEG will prove to be a very useful and more accessible experimental technique among pediatric populations. Nonetheless, several problems remain. Adult-sized helmets are too large to acquire reliable infant data from both hemispheres at the same time. Although results are much better now that we are able to track head movements real-time, disturbances due to the heart and limbs remain a problem in some infants. Finally, data analysis continues to be time-consuming and requires considerable expertise.

Sensitivity to phonetic contrasts is pre-attentively modulated by the phonological system

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If the sensitivity to phonetic contrasts is dominated by acoustic/phonetic characteristics of the input signal one would expect the same sensitivity for the same contrast in two groups of subjects speaking different languages containing identical phonetic categories. However, if there is a top-down influence of the language-specific phonological system implemented in the speaker's mental lexicon, one would expect a differential sensitivity for identical phonetic contrasts when

contrastive phonological features are different. Here we use the differential assignment of the phonological feature LOW in Bengali and German to some of the vowels varying along the LOW-HIGH dimension (from [a] to [u]). The contrast sensitivity was examined by means of the mismatch negativity (MMN). Vowel pairs were presented to groups of Bengali and German subjects as standard and deviant and had therefore the same phonetic contrast for both groups. In some experimental blocks, standard and deviant contained conflicting phonological features for Bengali speakers but non-conflicting features for speakers of German. Only in these blocks a differential MMN between the two groups was observed. In control conditions, where standard and deviant formed a conflicting LOW-HIGH contrast for both groups, MMNs were not different. This study provides neurobiological evidence for a top-down influence of the language-specific phonological system on the perception of phonetic contrasts.

MMN to suprasegmental cues

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Changes of the Mismatch Negativity (MMN) component of ERPs elicited by sub- and suprasegmental speech contrasts were investigated in adults, school children of developmental language deficit and in infants.

The MMN to different acoustic cues, phonetic contrast and word stress, both playing an important role in language comprehension was investigated. Voice onset time (VOT) and stress pattern changes of bisyllabic Hungarian words were used in passive oddball paradigm.

Our results show that the MMN latency is time locked both to the stressed and to the unstressed syllables though occurs with larger amplitude to the second syllable changed from unstressed to stressed. The MMN to the violated first syllable occured somewhat later than that to the VOT contrast both in adults and normally developing school-children. Moreover, both types of the MMN could be recorded in all 3–10 months old infants including preterm infants but the low birth weight pathological ones.

Our MMN data acquired in children of developmental language deficit (SLI)have proven the assumptions that both sub- and suprasegmental cues are abnormally processed in this particular group of children.

Speech and language in the auditory odd-ball: Mismatch Negativity (MMN) studies

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The mismatch negativity (MMN), a well-known index of automatic acoustic change detection, was recently found to be a sensitive indicator of long-term memory traces for native language sounds. When comparing MMNs to words and meaningless pseudowords of Finnish and English using EEG and MEG, we found larger MMN amplitudes for words than meaningless items. This effect was independent of the grammatical status of the standard stimulus. We have also demonstrated that, using MMN, it is possible to register differences in the brain response to individual words, suggesting that the cortical memory networks of individual lexical items can be revealed by the MMN. In more recent studies, we found additional evidence that the mismatch negativity reflects automatic syntactic processing commencing as early as ~100 ms after the relevant information becomes available in acoustic input. The findings will be discussed using a distributed neuronal network approach. In summary, neurophysiological imaging of the mismatch negativity response provides a unique opportunity to see subtle spatio-temporal dynamics of the language processing in the human cortex.

Pre-attentive categorization of vowel formant structure in synthesized vowels and complex tones

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The present study tested whether even complex tones that were constructed based on F0, F1 and F2 vowel frequencies to resemble the defining features of speech

sounds, but were not speech, are categorized pre-attentively according to vowel space information. The Mismatch Negativity brain response was elicited by infrequent tokens of the complex tones, showing that the auditory system can pre-attentively categorize speech information on the basis of the minimal, defining auditory features. The human mind extracts the language-relevant information from complex tones despite the non-relevant variation in the sound input.

Symposium 9: What can ERPs tell us about cognitive aging?

Tuesday, March 30, 14:00–16:00; HS 18
Chair: David Friedman

Temporal integration and aging: ERP studies

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Integration time is an important feature for perceptual efficiency. An increase in the integration period can reduce perceptual acuity, but a decrease in the integration period can reduce perceptual sensitivity resulting in perceptual deficits. In older people, decreased auditory acuity may contribute to problems in speech and music perception. The mismatch negativity (MMN), an event-related potential (ERPs) component, is a useful tool for assessing the duration of perceptual integration. We compared groups of older and younger participants in two experiments. In the first experiment an omission paradigm was used. When a stimulus within the temporal window of integration was omitted, MMN-like activity emerged. The longest SOA for which we were able to identify an MMN appeared to be longer for the elderly (150–200 ms for the younger and 250–300 ms for the older group, respectively). In the second experiment, two consecutive deviants were presented within the sequences of standards. Duration of perceptual integration is defined as the shortest SOA where the second deviant elicits an MMN. Like the first experiment, results indicated a longer duration period for the elderly.

ERPs reveal age-related changes in the inhibitory and updating sub-processes of working memory

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Event-related potentials (ERPs) and performance measures were recorded from younger and older adults during two working memory tasks. In both tasks, digits were presented in strings that varied in length from 4–11 numbers. In one task, participants were instructed to remember the last four digits (Updating Task, UT) and in the other task the first four digits (delayed-matching-to-sample task, DMST) for a subsequent memory test. For both age groups, performance for the DMST was better than for the UT, but younger adults performed better than the older adults on the UT. Three major findings were observed in the ERP data. First, under DMST conditions, ERP indices of inhibition for task-irrelevant stimuli were greater for younger than older adults, even though performance did not differ between the age groups. Second, under UT conditions, ERP indices of proactive interference were observed for younger but not older adults. Therefore, when task demands were constrained, older adults were still able to maintain performance even in the face of reduced inhibition of task-irrelevant stimuli. Third, for both age groups, a positive component (peak latency ~500 ms) of maximum amplitude was elicited by the 5th study digit under UT conditions, and the 4th digit under DMST conditions. Current source density maps showed a stronger frontal focus for the older than the younger adults under the UT conditions. These findings suggest that the positive ERP component reflects processing of salient task events rather than updating per se, and that older adults rely more on frontal lobe processes.

Behavioral and ERP aging effects during encoding and retrieval: Initial age-related recognition deficits are ameliorated by practice

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Neurocognitive processes that may underlie the age-related decline in memory performance, supplemented by relevant experimental results, will be discussed to summarize current knowledge and highlight unsolved questions. Thereafter, the focus will be on the results of an intentional old/new recognition study designed to test the hypothesis that impaired supervisory processes may cause age-related differences during encoding and subsequent episodic memory. In the study phase, young and elderly participants selected specific semantic information in a HIGH selection (HS) condition, or gave a general judgment about the meaning of a word in a LOW selection (LS) condition. Preliminary results indicate a late (starting around 800 ms) left frontal negativity for HS words for both age groups during encoding, possibly reflecting activation of left inferior pre-frontal cortex. In the first test phase, the elderly showed lower hit rates than the young. This was especially pronounced in the HS condition. For the young, more positive going waveforms for hits relative to correct rejections were recorded at parietal locations (parietal Episodic Memory or EM effect). However, these waveforms were small or absent for the elderly. A repetition of the study-test cycle elicited similar ERP encoding effects. However, recognition performance for the elderly improved greatly to almost the level of the young and was accompanied by diminished ERP differences between the age groups. Demanding supervisory processes (HS) seem to complicate the first encoding phase, resulting in poor old/new recognition performance and small EM effects in the elderly. However, a second exposure to the items almost equalized behavioral and ERP recognition effects between the age groups.

Distraction and re-orientation of attention in elderly people

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An important pre-requisite of adaptive behaviour is a balance of involuntary and voluntary attention in order to be able to react on unexpected changes in the environment even when focusing on task demands. The coordination of distractibility and focusing is essential during the lifespan and, therefore, should be preserved even with older age. This was tested in the present study: Young (18–27 years), middle-aged (39–45 years), and elderly (59–66 years) participants, all without any known cognitive or neurological impairments, performed an auditory duration discrimination task. Interestingly, performance was highly accurate and reaction times were similar for all groups, indicating no differences in auditory duration processing. Task-irrelevant, rare frequency changes were introduced to check whether the participants could detect changes in the environment while focusing on the task-relevant information, and, then could re-focus on the relevant task after distraction. The results showed that the elderly participants had a distraction effect twice the size of the middle-aged group. The event-related brain potentials showed that the mismatch-negativity, P3a, and re-orienting negativity elicited by deviants were present, but later and smaller in elderly participants. These results can be interpreted in terms of central executive processes. While elderly participants are still distractible by changes in the environment when focusing on the task at hand, distractibility is markedly increased. This suggests slower processing of attentional re-allocation towards task relevant information maintained by the working memory system. Noteworthy, is that increased distractibility did not result in a loss of accuracy, suggesting that the processes underpinning attentional allocation are, in general, unimpaired by normal aging.

Symposium 10: Movement planning and control: Structure, function, and temporal organisation

Tuesday, March 30, 14:00–16:00; HS 17
Chair: Hartmut Leuthold

Visuomotor preparation of discrete finger responses

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Human skilled behavior requires preparatory processes that selectively make sensory and motor systems more efficient for perceiving the upcoming stimulus and performing the correct action. I review the literature concerning these preparatory processes as studied by response-cuing paradigm, and propose a model that accounts for the major findings. According to the Grouping Model (Adam, Hommel, & Umilta, 2003), advance or precue information directs a dynamic process of subgroup making—that is, a process of stimulus- and response-set reconfiguration—whereby the internal representation of the task is simplified. The Grouping Model assigns a critical role to the unit of selection, with Gestalt factors and inter-response dependencies mediating the formation and strength of stimulus and response subgroups. Moreover, the Grouping Model assigns a critical role to the mode of selection by distinguishing between fast, automatic subgroup selection and slow, effortful subgroup creation. I present the results of several experiments that manipulated perceptual and motoric grouping factors. Also, I present the results of an fMRI study that investigated the neural activation patterns associated with the rapid visuomotor preparation of discrete finger responses. Our imaging results revealed a large-scale distributed network of neural areas involved in fast visuomotor preparation, including specific areas in the frontal cortex (middle frontal gyrus, premotor and supplementary motor cortex), the parietal cortex (intra-parietal sulcus, inferior and superior parietal lobe) and the basal ganglia.

Neuroimaging of movement representations: from blobs to content

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I will address the issue of neural correlates of motor representations, in the context of interactions between action and perception. First I will review studies in which instructed delay tasks have been used to isolate neural activity related to motor preparation, temporally independent from instructions and responses. I will then move onto discussing a series of potential confounds implicit in that approach, touching on the context-dependent features of delay-related neural activity. I will conclude by addressing the issue of neural interactions between sensory- and motor-related responses.

The basal ganglia and inhibitory mechanisms in response selection: Subliminal priming of motor responses in Parkinson's disease

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Interference or conflict tasks are commonly used to investigate frontal lobe based mechanisms for interference control and resolution of response conflict. However, increased susceptibility to interference, as in Parkinson's disease, may be significantly influenced by inhibitory dysfunction at a sensorimotor level. Evidence to support this view was obtained with masked response priming in an investigation with Parkinson patients (n = 12), age- matched controls (n = 12) and young controls (n = 10). Using backward masking, covert activation of left or right hand responses was induced without subjects consciously perceiving the stimuli (right or left pointing arrows). The masked priming stimuli were followed by visible arrow stimuli, instructing for a left or right hand response, at a delay (ISI) of 0 or 100 ms. In young subjects, prime-target (in)compatibility effect had regular priming effects at ISI = 0 ms, but priming effects were reversed with ISI = 100 ms,

consistent with an automatically invoked inhibition of prime-induced response activation (Eimer & Schlaghecken, 1998). The negative compatibility effect in young subjects (at ISI 100 ms), turned into a positive compatibility effect in Parkinson patients, while age-matched controls produced intermediate values. LRP recordings allowed a separation of age-related changes in performance and an inhibitory deficit in Parkinson's disease.

Preparation for action, motor programs, and the brain

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The mental processes underlying action preparation are not directly observable. To infer the hidden mechanisms underlying action preparation, psychologists and neuroscientists have been using the response precuing technique. The present paper reviews movement-related brain potential (MRP) correlates of action preparation and its consequences on information processing in the response precuing paradigm. Two aspects of action preparation are considered: (1) The covert processes going on during the preparatory interval before the imperative response signal and (2) the chronometric effects of such preparation on the processes following the imperative response signal. Firstly, MRPs provide access to at least some of the action preparation processes going on during the preparatory period. Precuing effects in MRPs are by and large consistent with a dual-process model of motor preparation that incorporates abstract and effector-specific programming levels. Accordingly, higher-level motor areas perform abstract programming, whereas effector-specific processes implement motor acts through activation at a lower level muscle-specific level. In this model specification processes of both higher and lower programming levels appear to benefit from advance information and also when temporal uncertainty is reduced. However, motor programming at the muscle-specific level is subject to specific boundary conditions. Secondly, using a chronopsychophysiological approach that combines measurement of reaction time and of the onset of the lateralized readiness potential (LRP), preparation has been found to shorten both premotoric and motoric processing time, depending on the specific movement parameters involved. Implications for current models of action preparation are discussed.

Symposium 11: 15 years after: Cortical induced gamma band rhythms and higher cognitive function

Wednesday, March 31, 9:00–12:30; HS 18
Chair: Matthias Müller

The role of neuronal synchronization in cognitive processing

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Processing of information in the cerebral cortex is characterized by cooperative interactions within distributed neuronal assemblies. Synchronization of neuronal responses with a precision of a few milliseconds is thought to organize the respective neuronal assemblies (i) by enhancing the visibility and impact of the spatio-temporal activity patterns of synchronously firing groups of neurons within the nervous system, and (ii) by enhancing and structuring the functional connectivity for the computations just needed. Often such synchronous discharges appear in oscillatory patterns within the gamma frequency range. Cognitive processes depend on the highly flexible selection and combination of information and are therefore expected to make particular extensive use of a dynamic processing architecture. Recording of neuronal activity in the cerebral cortex of macaque monkeys performing well defined cognitive tasks provide a unique opportunity to test this hypothesis. For a spatial selective attention task which requires to detect a change in speed, neurons in area MT with overlapping receptive fields showed more synchronous oscillatory firing in response to a moving bar stimulus that was a target of attention than to the same bar being a distracter. In area V4 a strong increase of synchronous oscillatory activity occurred when monkeys attended a morphing shape in the contralateral hemifield instead of a similar morphing shape in the ipsilateral hemifield. Synchronization between distant sites in the temporal cortex was observed to depend on correct performance of a memory task, indicating the importance of the synchronization mechanism in structuring the computational architecture. These results indicate that highly specific patterns of synchro-

nization within well defined sets of neurons represent a basic mechanism for cognitive processing in the cerebral cortex.

Modulations of auditory induced gamma/beta oscillations in human intracranial recordings

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Neural oscillatory synchronization has been proposed as a dynamic link between the different brain areas engaged into the same perceptual or cognitive process. This hypothesis has mainly been supported by studies in the visual modality, either at the unit level in animals or at a macroscopic level from human scalp EEG/MEG. In this latter case, induced gamma oscillations have been proved to be strongly associated with perception and rehearsal of coherent objects and to be modulated by attentional top-down processes. Similar oscillations have been observed in other sensory modalities but have been much less studied.

We studied the temporo-spatial characteristics and the attentional modulation of induced beta/gamma oscillations in the auditory system. For that purpose, we recorded intracranial EEG in the temporal cortex of epileptic patients in several situations, including passive listening and active discrimination tasks. Focal sources of gamma oscillations have been found in the 20–90 Hz range, between 150 and 350 ms after stimulus onset: one in the primary auditory cortex and another one in higher level areas (superior temporal gyrus, most lateral part of planum temporale). These gamma sources showed differential modulations by attention. With similar timing, stimulus induced decrease of on-going beta activity (15–20 Hz) was also observed at different focal location of the supra-temporal cortex. The respective time-courses of these beta/gamma oscillatory activities and their modulation by attention are described and discussed.

Modulation of gamma band activity by attention during a verbal short-term memory task in human intracranial recordings

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We have used depth electrodes to record intracranial EEG from several epileptic patients performing two kinds of short term memory tasks. Both tasks followed the same procedure: a series of visual stimulus was presented, half of which had to be remembered by the patients. In one task, the stimuli were letters while in the second task, they were geometric configurations. We quantified the gamma activity induced by the presentation of those visual stimuli and found clear differences between the stimuli to be remembered vs. those that didn't have to be remembered. Those differences were particularly strong in the insula.

Neural dynamics during acquisition of motivational significance

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Perception and evaluation of emotionally arousing scenes is essential for the organization and regulation of an organism's behavior. Recent work in the field of the cognitive neuroscience of emotions has provided a dimensional framework for emotional perception being based on the two dimensions of valence (appetitive versus defensive/aversive system) and arousal (amount of activation in either system or degree of co-activation of both systems). This work is based on network approaches to the organization of emotional perception and memory. Affective modulation of visual processing, for instance, may be effected by afferent projections to visual cortices, resulting in a facilitation of the neural tissue in cases where perceptual content is emotionally arousing. While interactions and overlaps between emotional arousal systems and attentional systems have recently been studied extensively, the dynamics of acquisition of affective dispositions remain largely unclear. The present talk presents a series of experiments using large-scale high-frequency and low-frequency oscillations as measured using Electro- and Magnetoencephalography, examining the time course of learning aversive reac-

tions to conditioned stimuli. Using measures of within-site and between-site phase-locking, the functional organization of various subsystems was examined that act to bind together the activity of the distributed areas and finally establish emotional perception. Both induced and evoked (driven) oscillations showed time-dependent sensitivity to classical conditioning, with phase-locking and amplitude being increased as a function of (i) duration and (ii) motivational significance of a given stimulus.

Induced gamma band responses in the human EEG and selective stimulus processing

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In everyday life, the brain is confronted with an enormous amount of visual input at any given moment. To guarantee coherent and adaptive behaviour, selective attention is needed to focus the limited processing resources on the relevant part of the available information while ignoring the rest. It is generally appreciated that selective visual information processing is performed in multiple cortical areas. Synchronized neural activity in the gamma frequency range (> 20 Hz) has been proposed as being the key to the question of how information processed in different cortical areas is bound together to form a percept. We present a series of experiments in which we demonstrated that induced GBRs are modulated by selective attention. From these experiments we conclude that synchronized neuronal activity might serve as a powerful mechanism to increase the signal of the attended stimulus from the background “noise”.

Symposium 12: Processing words and sentences: ERP evidence from patients

Wednesday, March 31, 9:00–12:30; HS 17
Chair: Sonja Kotz

Picture naming in developmental dyslexia: evidence from event-related brain potentials

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We studied the time-course of conceptual and phonological feature activation during tacit picture naming in adult developmental dyslexic readers and a normally reading control group. Participants viewed a series of pictures (with the instruction to covertly name the depicted item), and made dual choice Go/noGo decisions based on each item's conceptual (whether the item was an animal or an object) and phonological features (whether the item's German name started with a vowel or a consonant). During picture naming, the N200 component (related to response inhibition) indicated that conceptual processing preceded phonological processing by about 140 ms in dyslexic as well as in normal readers. Moreover, conceptual and phonological feature activation was delayed in adult dyslexic readers indicating that access to the semantic lexicon as well as to phonological features is impaired in this group. These findings are discussed with respect to current theories of developmental dyslexia.

Sentence-picture matching electrified

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A classical task in the neuropsychology of language is sentence-picture matching. In this task subjects are required to select a picture from a set of alternatives that matches an auditorily presented sentence. We developed an on-line version of this task, by showing a picture and presenting a sentence while recording the patients' ERP. Sentences differed in complexity, and ranged from simple active semantically irreversible sentences ("The young lady reads the exciting book") to passive, semantically reversible sentences ("The woman is pushed by the tall man"). The sentence either matched the picture or mismatched the visual information depicted. Both elderly control subjects and patients with Broca's aphasia were tested with this paradigm. Elderly controls showed on-line sensitivity to the mismatch as soon as the verb was heard, and thereby the thematic role information was made available. The aphasic patients did not show an on-line ERP effect. However, they showed an off-line behavioral sensitivity to the mismatch between sentence and picture. The patients' dissociation between on-line and off-line sensitivity will be discussed in relation to the nature of the underlying language deficit in the aphasic patients.

Word-evoked potentials as a reflection of recovery from aphasia?

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Starting about 200 ms after stimulus onset, words and pseudowords elicit differential cortical activation in normal healthy individuals. This early index of lexicality appears to be altered in stroke patients who have recovered from an aphasia. The talk discusses the possibility that word and pseudoword evoked potentials might indicate the restitution of language functions after stroke.

The role of the anterior temporal lobe in semantic processing: ERP patient evidence

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A renewed debate on the role of the left anterior temporal lobe in speech perception has revealed a diverse functional engagement of this brain region such as in speech intelligibility (Scott et al., 2000), in lexico-semantic processing (Kotz et al., 2002, 2003a; Scott et al., 2003), in local syntactic processing (Donkers et al., 1994; Kotz et al., 2003b; Meyer et al., 2000; Friederici et al., 2003) as well as in semantic integration (e.g., Stowe et al., 2000). To further investigate lexico-semantic processing (Experiment 1) and semantic integration (Experiment 2) we tested a group of patients with left anterior temporal lesions (Exp.1, N = 11; Exp.2, N = 6) and as a control group patients with extended right anterior temporal lesions (Exp.1, N = 8; Exp.2, N = 5) in an auditory word list lexical primed decision task (LDT; Exp.1) and an auditory semantic correctness judgment task (Exp.2). Patients with left anterior temporal lobe lesions showed no lexical N400 effect, but a delayed and reduced N400 semantic priming effect in the LDT, while patients with right anterior temporal lobe lesions showed a lexical N400 effect, but a strongly reduced N400 priming effect. Both patient groups showed a delayed N400 effect comparing semantically correct and incorrect sentences. These results indicate that the left anterior temporal lobe may play a role in mapping initial phonetic information to lexical representation during word recognition, but only indirectly in semantic priming and semantic integration (see also McNellis & Blumstein, 2001).

Functions of the human hippocampal formation: episodic memory or more?

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The importance of the human hippocampal formation for episodic and declarative memory has been known for a long time. Using ERP recordings from depth electrodes in epilepsy patients undergoing presurgical evaluation we could show that this medial temporal lobe structure contributes to the detection of associative (situational) novelty thus mediating encoding for declarative memory. This hippocampal function depends on NMDA-receptors and seems to be related to hippocampal synaptic plasticity (long-term potentiation). However, we also found that the anterior parahippocampal region is also sensitive for word repetitions that are not consciously recognized. Second, we found that syntactically incorrect sentences elicited pronounced negative ERP responses peaking between 500 and 600 ms within the hippocampus proper. And third, we recently recorded depths ERPs within the hippocampus proper (but not the anterior parahippocampal region) that reliably differentiated between meaningful and meaningless visual objects thus indicating that the human hippocampus also contributes to semantic visual object processing. In sum, we take our data to suggest that the human hippocampal formation is not only involved in encoding for and recalling from episodic memory but may also contribute to other cognitive processes that depend on implicit or explicit knowledge.

Symposium 13: Emotional Perception

Wednesday, March 31, 14:00–16:00; HS 22
Chair: Annette Schirmer

Facilitative and inhibitive components of same-expression priming

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Facial expressions do not show repetition priming using the standard paradigm in which primes and targets are presented in separate blocks of the experiment (Ellis et al., 1992; QJEP, 42A(3)). Using the self-priming paradigm (Calder et al., 1996; QJEP, 49A(4)), I investigated whether a short-term benefit of same expression priming could be found when primes and targets are separated by a short interval with no intervening items. In all experiments, primes and targets were computer-manipulated images; primes were 50% caricatures of expressions and targets were morphed images containing 50% neutral and 50% expression. An initial experiment compared two prime-target conditions prepared from happy and sad expressions. Examples of the two condition types were as follows: same condition (e.g., prime = 50% happy caricature, target = 50% neutral-happy morph) and unrelated condition (e.g., prime = 50% sad caricature, target = 50% neutral-happy morph). Contrary to initial expectations, the results showed that same expression primes produced slower RTs to categorize the target expression relative to unrelated primes.

Additional experiments addressed whether the results of the first experiment had a perceptual basis by examining whether the position of prime had an effect on performance. The format of these experiments was similar to the first, except that the central single prime was replaced with two identical ‘flanker’ primes positioned on either side of the central target position. Contrary to the results of Experiment 1, the same flanker primes produced facilitation relative to unrelated primes. The results will be discussed in terms of different components of facial expression priming – perceptual versus conceptual.

Neurophysiological correlates of facial emotional discrimination in anxious and depressive people

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Many discussions about the existence of cognitive and affective bias in anxiety or depressive disorders can be found in current literature.

For instance, an affective bias can impair emotional expression decoding, but actually, we don't know if this bias would belong to the negative cognitive set described by Beck, suggesting an attraction for negative stimuli, or if it would correspond to an absence of attraction for positive stimuli. Moreover, research failed to determine the attentional or decisional locus of this kind of bias.

To answer these questions, emotional oddball paradigm was analyzed in 32-channels averaged event-related potentials (ERPs) recorded from twelve subjects with depressive tendencies and paired subjects while seeing frequent stimuli as neutral emotional face and having to detect as quickly as possible rare stimuli with happy or sad expression. Significant effects of emotional content were found on the attentional N200 component in subjects with depressive tendencies, as evidenced by a delayed N200 peak for rare sad as compared with rare happy stimuli. On P300, subjects with depressive tendencies showed longer latency onset as compared with normal controls.

These results can be interpreted as a "negative attentional bias" towards sad stimuli. The same design was also applied to anxious people, and significant differences on attentional N200 component were also described.

We suggest that ERPs could give us the opportunity to define the exact locus of action (attentional or decisional) of the emotional deficits observed in many psychiatric populations.

Emotional speech processing: Effects of gender and culture

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Speakers can express emotions both verbally and prosodically. Emotional prosodic expression refers to modulations of acoustic parameters such as loudness, speech melody and tempo and is known to help listeners to interpret the emotional message conveyed verbally. Moreover, recent ERP findings suggest that emotional prosody can establish contextual information that influences word processing in a similar way as semantic context. Words that are incongruous with emotional prosody (e.g., positive words spoken with a negative prosody) elicit a larger N400 as compared to congruous words (e.g., negative words spoken with a negative prosody). Interestingly, however, this emotional-prosodic context effect depends on experimental variables such as the time lag between prosodic information and the onset of the critical word, the instruction to ignore or to attend to prosody, and the listener's sex and cultural background. My talk will focus on the effects of these variables as revealed by a series of ERP studies that investigated emotional speech processing in German and Cantonese listeners.

Neural mechanisms and time-course of emotional attention

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Emotional information can influence the processing of visual stimuli, especially based on their fear-related significance. Behavioral and functional neuroimaging studies in healthy subjects and brain-damaged patients converge to demonstrate that attention is preferentially biased towards fearful rather than neutral faces. Such effects appear to be mediated by rapid enhancement of sensory responses in fusiform and earlier visual cortical areas, through modulatory influences from amygdala that are partly independent of voluntary mechanisms of attention. Emotional responses in amygdala can be elicited rapidly by coarse cues based on low spatial frequency information in faces, whereas cortical fusiform areas involved in

conscious face perception might operate more slowly, tuned to extract finer visual features. Evoked potentials and source localization techniques also show an early modulation of extrastriate areas in response to fearful faces, with a similar time-course and substrate as other exogenous effects in spatial attention. Thus, face perception involves a dynamic interplay between distant brain regions exerting reciprocal modulatory influences on each other, and mechanisms of emotional attention may influence sensory processing in ways that are similar but partly independent of other mechanisms of spatial attention.

Symposium 14: ERPs and fatigue

Wednesday, March 31, 14:00–16:00; HS 20
Chair: Monique Lorist & Michael Falkenstein

EEG, sleepiness and mental fatigue

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The relation between electrical brain activity, fatigue and sleepiness is complex and not well understood. Fatigue and sleepiness are based on two different psychological constructs. A model that distinguishes between both constructs is outlined. According to this model it is possible to predict fatigue as well as sleepiness for human operators.

While it seems extremely difficult to define a scientific approach for the investigation of fatigue through EEG measurements, sleepiness is clearly related to changes in electrical brain activity.

A standard physiological method to assess sleepiness is the so-called polysomnographic recording that includes EEG. In particular, the assessment of micro-sleep events, the so-called MSLT (Multiple Sleep Latency Test) that has also clinical relevance, and the determination of sleep onset latencies are related to the concept of sleepiness and are based on EEG measures.

EEG signs of fatigue: Temporal aspects and relationship with oculomotor activity

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Our studies of mental fatigue utilize tasks entailing continuous (50–60 min) demands for memory, anticipation and judgment processes, under conditions in which active eye movement patterns are required. Our review of these studies will emphasize two key aspects. One is that an important component of fatigue is the increased incidence of momentary lapses of attention or alertness, in the context of otherwise satisfactory performance. Such lapses may be infrequent but, if occurring at inopportune times, can have catastrophic consequences. Our research has included efforts to identify EEG and ERP signs during such lapses, and as well as premonitory signs of impending lapses. Of particular promise appears to be the appearance of transient EEG features which are customarily thought to accompany sleep onset under eyes-closed conditions (Santamaria and Chiappa, 1987). We show that such transients can be detected in the waking EEG even with eyes open and during active task performance, and that some are associated with impaired performance. The second key aspect is that oculomotor activities are a sensitive convergent measure of mental fatigue. The majority of performance lapses during continuous tasks are within context of some demonstrable oculomotor indicator of fatigue. Since the oculomotor activities are continuous measures, they serve to identify momentary lapses on a finer-grained time scale than is afforded by typical task performance-based measures. Their utility within this context is reinforced by our findings that impaired oculomotor performance is accompanied by local EEG signs of fatigue (preponderance of energy at slow frequencies, increased incidence of transients).

Electrophysiological markers of mental fatigue

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Mental fatigue can be defined either semantically, or though the consideration of an operational setting. For the purposes of this paper, a working operational definition of mental fatigue has been chosen and reflects changes in performance, which are attributed to time-on-task. A consideration of the effects of fatigue on different human information processing stages will be considered, through an examination of sensory, detection, and motor related ERP components. Data recorded during two studies will be reported. In the first of these studies subjects performed a visual oddball procedure for a period of 2 hours. Increases in response times were accompanied by changes in both stimulus locked and response locked activity. These effects were greatest over frontal scalp. In the second study subjects performed a simulated train-driving task, over a period of 4 hours. A 10 minute break was taken at the midpoint. ERPs associated with control interactions, and responses to warning tones will be presented and discussed within an overall model of mental fatigue.

This work was funded by the Human Science Domain of the UK Ministry of Defence Scientific Research Programme.

Mental fatigue and cognition: what is going on?

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Fatigue is a serious problem. The rising amount of people suffering from mental overload urges to gain more knowledge on the mechanisms underlying fatigue. This knowledge is essential in order to be able to cope effectively with fatigue, and more important to be able to prevent humans from becoming, for instance, work disabled due to mental overload. At the subjective level, fatigue manifests itself in reduced motivation and in negative emotions. With respect to performance, the picture is less clear. In general, fatigue is related to a deterioration of

cognitive functions. An important question, however, is which cognitive processes underlie the performance changes observed under conditions of mental fatigue elicited by prolonged task performance. Recent research suggests that when people become fatigued, the flexibility that characterizes normal human behavior seems to disappear: behavior becomes less dynamic and more rigid. Cognitive control mechanisms lie at the heart of dynamic behavior, and play an important role in novel and complex task situations, conditions under which fatigued humans have most pronounced performance difficulties. We found, for example, that with increasing mental fatigue humans failed to use available information to prepare and guide performance in order to function efficiently and to cope with complex situations. These results appear to bear out that the locus of behavioral control shifts from internal to external factors, under conditions of fatigue.

Changes of error-related ERP components with time-on-task

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To assess possible changes of error processing with mental fatigue, error-related brain potentials were recorded from young and older adults while they performed various cognitive tasks during several hours with normal breaks between task blocks. The EEG was recorded at 64 electrodes, and response-related ERPs were computed. Data from two tasks will be reported, a four-alternative choice task (4-CR) and a distractor task (flanker). Behavior was unaffected by time-on-task. The error negativity (Ne or ERN) a correlate of early mismatch resp. error detection, was slightly reduced with time-on-task, but only for the young subjects, and mainly so in the 4-CR task. Ne latency was prolonged with time-on-task, but only for the elderly, and only in the flanker task. The latency of the error positivity (Pe), which depends on conscious error recognition, was prolonged with time-on-task for all subjects, but only in the flanker task. The reduction of the Ne is in line with data from sleep deprivation (Scheffers et al., 1999) and studies with prolonged uninterrupted work (Lorist et al., 2003). In sum, the present results suggest an impairment of different aspects of error processing with mental fatigue. Further work should assess the preconditions for such impairments.

Symposium 15: Brain mechanisms of consciousness

Wednesday, March 31, 14:00–16:00; HS 17
Chair: Claude Tomberg

Physiology and phylogeny of consciousness

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Consciousness represents for the neurosciences a major challenge which cannot be resolved by molecular biology, but requires novel research designs targeted at intrinsic physiological brain processes. Conscious brain mechanisms emerging many millenia ago enabled choice between alternative behavioral scenarios, thereby endowing organisms such as early mammals with decisive flexibilities in hostile environments. Consciousness did not appear by any magic stroke as a non-biological mind, and is not an epiphenomenon (as viewed in black-box functionalism). Conscious physiological mechanisms have survival value and evolved through natural selection. The fairly continuous consciousness in waking includes affective processes and items or events that can be in the focus or at the periphery of attention.

Brain mechanisms of consciousness and cognitive unconscious in real time: kinetics of 40 Hz prefrontal binding

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Scalp-recorded brain mapping can reveal sequences of distinct event-related potentials with high resolution (milliseconds). The high versatility of brain conscious electrogeneses requires analyses of the brain mapping data in real time, thus excluding electronic averaging which obliterates response variations along time and from trial to trial. For somatosensory (fingers) evoked responses, several cognitive cortical generators, namely P40, P100, N140 and P300 were identified

in single trials through their characteristic brain mapping profiles in spite of the noise. The kinetics of 40 Hz gamma waves and their transient prefrontal-parietal synchronization were found to be critically associated with perceptual functions. Presence or absence and variations of single cognitive neurogeneses and 40 Hz binding documented the brain flexibility between the different trials. These were a.o. correlated to attention focusing and to cognitive resources allocations in the cognitive strategies.

Representation of the self and neglect

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The representation of the self is an important constituent of human self-consciousness which depends on the correct integration of mental and bodily states as one's one mental and bodily states. This involves first versus third person perspective taking as well as centring one's own multimodal experiential space upon one's own body thus operating in an egocentric frame of reference. The brain regions crucially implicated in representation of the self comprise frontal and parietal cortex as evidenced by both functional imaging and lesion-based neuropsychological data. In my lecture I will review some recent functional imaging data which focuses on our understanding of neglect. In particular, I will enlarge on what can be learned conceptually from combining lesion-based neuropsychological studies and functional imaging and what crucial discrepancies need further investigations.

Conscious brain mechanisms in patients recovering from vegetative state

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Traditionally, vegetative state is conceived as a syndrome in which only autonomous, i.e. vegetative functions are preserved. Cognitive functions and other mental competencies are thought to be absent including consciousness and self-representation. In the paper presented, new data are presented which contradict the traditional view and demonstrate that components of the mental/cognitive processing devices are still active in patients in VS and recovering from VS. Consequences for ethical and legal considerations are deduced from the new scientific findings.

Sessions

Session 1: Perception and cognition I: Vision

Monday, March 29, 9:00–12:30; HS 20
Chair: Jochen Kaiser

Excitability changes induced in the human primary visual cortex by transcranial direct current stimulation: an electrophysiological evidence

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Transcranial direct current stimulation (tDCS) has been shown to modify the perception threshold of phosphenes elicited by transcranial magnetic stimulation (TMS). Here we examine whether tDCS applied over the occipital cortex is also able to affect visual evoked potentials (VEP), which characterize occipital activation in response to visual stimulation, in a polarity-specific way. For this purpose, VEPs evoked by sinusoidal luminance grating in an on/off mode were recorded before, immediately after and 10, 20, 30 minutes after the end of 5, 10, or 15 minutes of anodal or cathodal tDCS of the primary visual cortex.

Significant effects were only observed when low contrast visual stimuli were applied. Cathodal stimulation decreased while anodal stimulation increased the

amplitude of the N70 component. The effect of cathodal stimulation was significant immediately after and 10 minutes after the end of stimulation, if the stimulation duration was sufficiently long, i.e. 10–15 minutes. An increase of N70 amplitude by anodal stimulation was significant only 10 minutes after the end of the 15 minutes tDCS. Cathodal stimulation tended to affect also the amplitude of the P100 component, however, here the effect of stimulation was inverse: the amplitude increased immediately after the end of cathodal stimulation. In contrast, anodal stimulation did not affect the P100. The latencies of the N70 and the P100 were not affected by tDCS. tDCS appears to be a suitable method of inducing reversible excitability changes in a polarity-specific way, not only in the motor but also in the primary visual cortex. The duration of the induced after-effects depends not only on stimulation duration but also on stimulation polarity. Cathodal stimulation seems to be more effective, in line with previous reports on the motor cortex.

Schizophrenia and communication between the hemispheres

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EEG differences are often reported in schizophrenia research, with reductions of P2/P3 amplitudes, hemispheric topographic deviations, laterality differences, and abnormalities of ERPs obtained from linguistic stimuli most commonly cited. Recent research suggests that individuals with schizophrenia have a deficit in the transfer of verbal information from the right to the left hemisphere (Endrass et al., 2002). We used a basic visuospatial task to assess information transfer in individuals with schizophrenia (n = 10) and age matched controls (n = 10) using the evoked potentials (EPs) method. EEG was recorded from 128 electrodes while participants underwent 200 trials in which they were required to make a recognition response to the presentation of a basic stimulus (a circle) which appeared briefly in either the left visual field (LVF), right visual field (RVF), or bilaterally (BVF). Interhemispheric transfer time was assessed using the N1-latency difference between the hemispheres ipsilateral and contralateral to stimulation. The schizophrenia group were characterized by differences in both functional laterality and information transfer between the hemispheres. The results will be discussed

with reference to symptoms characteristic of schizophrenia and the role of the corpus callosum in information transfer.

Magnetoencephalographic gamma-band responses to illusory triangles in humans

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Increased induced gamma-band activity to illusory triangles has been reported in EEG (Tallon-Baudry et al., J. Neurosci. 1996) where the activity was both spectrally and topographically widespread, i.e. it could not be attributed to specific cortical areas. While this is a typical feature of gamma-band responses in EEG, in MEG we have consistently found highly focal increases of activity in the higher gamma-band (50–90 Hz) during different types of auditory processing, suggesting that MEG may be more sensitive to local network synchronization. Here we present a replication of the study by Tallon-Baudry et al. in MEG. N = 16 subjects had to respond to two consecutive presentations of a curved illusory triangle (targets) in sequences containing also straight illusory (Kanizsa) triangles, real triangles and no-triangle stimuli (with rotated inducer disks) at equal probabilities. Three blocks of 200 stimuli were presented (duration: 0.7 s, variable interstimulus interval between 2–3 s). Induced oscillatory responses were compared between Kanizsa and no-triangle stimuli and between Kanizsa and real triangles using a statistical probability mapping. Kanizsa triangles were distinguished from no-triangles by increased activity around 70 Hz over medial occipital cortex peaking at 240 ms and over bilateral lateral occipital areas at 430 ms after stimulus onset. Kanizsa stimuli differed from real triangles by increased spectral amplitudes at 90 Hz over parieto-occipital cortex between 100–450 ms after stimulus onset. These findings suggest that illusory triangles are encoded by networks both along the visual ventral and dorsal streams. Supported by DFG (SFB 550/C1).

Comparative analysis of event related potentials during Go-Nogo, CPT and Stroop tests: Decomposition of electrophysiological markers of response inhibition, sustained attention and resistance to interference

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Neuropsychological tests are designed to target specific cognitive functions and used for cognitive evaluation in disorders such as dementias, psychoses; however, numerous cognitive subcomponents are involved in each test. We wanted to decompose the cognitive components by recording event related potentials (ERPs) during administration of computerized versions of three frontal executive function tests, go-nogo, continuous performance task (CPT) and Stroop. Through the choice of three tests targeting complementary cognitive domains we aimed to define the ERP correlates of response inhibition, sustained attention and resistance to interference in the same subject population. 32 channel-EEG was recorded continuously from 24 subjects. ERPs were averaged and N100, P100, N200, P300 peak amplitudes and latencies were measured. For Stroop, 550 ms–950 ms time period was divided into 100 ms intervals and mean amplitudes were measured. N200 was pronounced and the P300 had a central maximum in the nogo trials in go-nogo and CPT. All amplitudes were larger in CPT compared to go-nogo. In Stroop, a left lateralized negativity around 400 ms and a parietoccipital negative difference in the 650–750 ms time window were observed in incongruent trials. Our results show that go-nogo and CPT have similar P3 topographies probably reflecting the common response inhibition component and the observation of a general increase in amplitudes in CPT might be reflecting the additional sustained attention component of this test. Although Stroop seems to include a similar response inhibition effect, the characteristics of the ERPs show that the resistance to interference effect in Stroop involves a more complex, lateralized activation pattern than the simpler response inhibition tasks.

The Necker cube is disambiguated in early visual processing – evidence from a novel ERP-paradigm

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Introduction. Prolonged viewing of ambiguous stimuli (e.g., the Necker Cube) induces spontaneous changes in perception. Previous EEG studies investigating perceptual reversals used subjects' response as time reference for averaging. This, however, entails marked latency jitter. We introduced a new paradigm as follows: Spontaneous reversals were entrained to specific time instances by onset/offset presentation. Further a comparison condition was added, containing depth-shaded, non-ambiguous stimuli, which reversed externally.

Methods. Subjects viewed a "Necker lattice" as ambiguous stimulus for spontaneous reversal (Exp. 2) and a nonambiguous version for externally induced reversal (Exp. 1). Stimuli were presented intermittently and subjects indicated during the inter-stimulus-intervals (ISI) whether they had perceived a reversal compared to the preceding orientation.

Results. (1) Externally induced reversals: The ERP-difference-traces (reversing vs. non-reversing condition) showed a series of three components beginning with a negativity at occipital and parietal locations, 200 ms after onset. (2) Spontaneous reversal: The difference traces showed a series of four components, beginning with a positivity restricted to the occipital locations 100 ms after onset. The subsequent three components had the same succession, polarities and scalp locations as those in (1) but consistently appeard about 60 ms later.

Conclusions. Disambiguation of the visual input seems to be accomplished by structures early in the visual stream, indicated by the occipital positivity at 100 ms. In case of ambiguous stimuli, the "normal" perceptual processes, as taking place with unambiguous stimuli, seem to be delayed by the preceding neural disambiguation activity.

Faces and non-face objects of expertise recruit overlapping visual processes indexed by the N170

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Previous ERP studies have shown that human faces lead to a larger occipito-temporal visual component, the N170, compared to other object categories (e.g., Rossion et al., 2000). This N170 difference has been interpreted as evidence for the occurrence of early face-specific processes (Bentin et al., 1996). However, visual expertise with non-face objects increases the N170 (e.g., Tanaka & Curran, 2001), suggesting that faces and objects of expertise share visual processes taking place at this processing stage. Here we used a competition paradigm in ERPs to provide further evidence in favor of the latter hypothesis. In two studies, the N170 in response to lateralized faces was recorded while subjects were processing a non-face object presented centrally. Subjects simply reported the side of the face presentation. In the first study, the N170 in response to faces was substantially decreased when preceded by a novel object (Greeble) remaining on the screen. This decrease of the face-evoked N170 was observed only after subjects had been trained extensively with the object category. In the second study, a substantial reduction of the face-evoked N170 was found in car experts processing pictures of cars. The effect was not found for car novices, and was not due to low-level visual features of car pictures. Together, these results show that faces and non-face objects in a domain of expertise compete for overlapping visual processes reflected by the N170. More generally, they indicate that early face categorization processes can be tuned by visual experience in adults.

Session 2: Methods and analysis

Monday, March 29, 14:00–16:00; HS 22
Chair: Valéria Csépe

Single-trial evoked potentials with wavelet denoising

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We show the application of a denoising implementation for visualizing single-trial evoked potentials. Its performance is shown in simulated data as well as in human evoked potentials. For the simulated data, the method gives a significantly better reconstruction of the single-trial responses in comparison with the original data and also in comparison with a reconstruction based on conventional Wiener filtering. For the real data, the method clearly improves the visualization of the single-trial responses. This allows the study of the variability between trials, which can be linked to processes such as habituation, sensitization, learning, attention, etc. Since the method is fast and parameter free, it could complement the conventional analysis of event-related potentials.

Advances in statistical source analysis of visual evoked potentials

Böcker, K. B. E.[1], Bijma, F.[2], Waldorp, L. J.[3], Grasman, R. P. P. P.[3], Kenemans, J. L.[1], de Munck, J. C.[2], and Huizenga, H. M.[3]

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Grating onsets generate electrical brain responses with spatial distributions that indicate activation of the striate and extrastriate cortex for high and low spatial frequencies respectively (instantaneous electrical source analysis; Kenemans et al., 2000). To decrease overlap between electrical potentials originating from one or more ipsilateral and contralateral sources we studied the effect of hemifield stimulus presentation, next to full-field. Checkerboard stimuli with spatial frequencies of 0.53 (low), 1.06 (middle) and 4.25 (high) cycles per degree were pre-

sented to 10 participants. Spatiotemporal source analysis of checkerboard evoked responses indicated that regardless of spatial frequency first the contralateral extrastriate cortex was activated, next the contralateral striate and finally the ipsilateral striate cortex. With full-field stimulation bilateral extrastriate activity was followed by bilateral striate activity. Furthermore, we extended the latency-of-best-fit test procedure (Kenemans et al., 2002) from instantaneous to spatiotemporal dipole models. This procedure involves the estimation of individual spatial and temporal source parameters, starting from the grand average dipole solution. In a next step these parameters are statistically analyzed by (M)ANOVA. Preliminary results of such analyses confirm the above conclusions, that were based on visual inspection. We will elaborate these by a detailed statistical analysis of both spatial and temporal source parameters of full-field and hemifield visual evoked potentials for checkerboards of low, intermediate and high spatial frequency. We will inspect these for an explanation of the apparent discrepancies between these and earlier dipole solutions for grating onsets. (Supported by Netherlands Organization for Scientific Research, NWO, grant 575-25-015).

Impact of the resting brain DC potential and task preceding slow potential shifts on response time and ERPs

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Based on the hierarchical activation model (Haider et al., 1982) the impact of brain DC potentials on performance and ERPs analyzed. Twenty-two persons participated in a 40 min lasting cognitive task. Performance was determined on the basis of response times of four 10 min epochs and persons were grouped as quick and slow responders by cluster analysis. The resting DC potential was more negative in persons with a quick response time than in slow responders independent of location indicating some evidence of the impact of a general energetic level (activation) on performance. The slow positive component (SPC) of the event-related potential (ERP) was enhanced in quick responders which was interpreted as a sign of motivation and/or attention. While cognitive information processing, as indicated by SPC, was not affected by task preceding slow potential shifts (pSPS) in quick responders, slow responders showed a prolonged information processing

time after specific pSPS indicating an unsteadiness or irregularity of information processing depending on phasic activation changes. Results suggest that cognitive performance is related to the resting DC potential as well as to the impact of pSPS on the SPC which may be seen as an electrophysiological sign of some energetic aspects of information processing often discussed in terms of attention and motivation.

The effects of MAO A gene polymorphism on N100 potential

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MAO A enzyme, a form of MAO, plays a critical role in the regulation of catecholamines and indolamines (especially in norepinephrine and serotonin) neurotransmission. There are a number of studies in brain electrophysiology literature searching for relations between evoked potentials and platelet MAO activity and/or several psychiatric traits mentioned to be affected by MAO. A variable number of tandem repeats (VNTR) polymorphism was found in the promoter region of this gene associated with MAO A transcriptional activity. In our study, we investigated the effects of MAO A gene polymorphism on N1 component of event-related potentials obtained by auditory oddball and auditory novelty paradigms. Allele 1 and allele 3 were common alleles for this gene in our population (%98). The amplitude and latency differences of N100 wave between these allelic groups were analyzed by an ANOVA design with the between subject factor, genotype, and within-subject factor, topographic distribution. There were significant overall differences between the two allelic groups in N100 latency, which reached a statistically significant level in N100 potentials evoked by the target stimuli of the oddball and the standard stimuli of the novelty paradigm ($p = 0.035$ and $p = 0.01$, respectively). The N100 latencies of allele 3 group were longer than those of allele 1 group. Because of the high serotonergic innervation of the primary auditory cortex, MAO A gene could affect N100 potential via serotonin level regulation. These results suggest that MAO A gene could be a neurobiological substrate for the interindividual variance of auditory N100 potential in several conditions.

Amplification of Long-Latency-Reflexes (LLR) by trains of stimuli

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Long-Latency-Reflexes (LLR) are indirect, sensorymotor evoked potentials. Methods: LLR were registered over the slightly activated M. biceps brachii (BB) und M. abductor digiti minimi (ADM) on either side simultaneously with unilateral supramaximal 1/s-stimuli over the N. radialis superficialis at the wrist (8 males, 20 to 42 yr.). 60 responses were averaged and reproduced once; 400 ms time window. Trains of 3 (3S) und 5 stimuli (5S) (inter-stimulus intervals: 3 ms) were compared with single stimuli (1S). Results: The ipsilateral BB showed at least 2 reproducible responses M1 ($n = 7$) und M2 ($n = 8$). Further 1 to 3 responses were facultatively observed ($n = 3$). Amplitudes were: M1, 1S, 78 ± 47 μV (mean ± SD); 3S, 122 ± 46 μV ($p < 0.005$); 5S, 155 ± 91 μV ($p < 0.05$). M2, 72 ± 56 μV (1S); 134 ± 85 μV (3S; $p < 0.01$), 197 ± 112 μV (5S; $p < 0.01$). Onset-latencies were not significantly different (mean M1, 50 ms; M2, 85 ms). Over the ipsilateral ADM M1 and M2 were seen in 3 (1S) or 7 cases (5S). Over the contralateral muscles responses were less frequent ($n = 2$ for the BB, $n = 0$ for the ADM; 1S), ($n = 4$ for the BB, $n = 3$ for the ADM; 5S), in part only M1, in part M1 and M2. Discussion: Amplification of LLR by trains of stimuli infers increasing numbers of recruited supraspinal motoneurones by subsequent stimuli. Responses contralateral to the stimulus may be due to the known ipsilateral projections of the motor cortex. The repetitive discharges (usually 2, in single cases up to 5) may reflect characteristics of central motor neurons, that have not yet been seen after direct stimulation over the motor cortex. The frequency of the subsequent responses lies within the beta-band. At present we investigate whether the frequency of LLR-discharges is coherent with somatosensory evoked potential responses or with beta-frequencies in EEG power spectral analysis.

Session 3: Speech and language

Tuesday, March 30, 14:00–16:00; HS 20
Chair: Thomas Gunter

MEG evidence for early decomposition of compound words

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The psychological reality of the morphological difference between compounds (teacup) and single words (crescent) is controversial. Decomposition accounts vary regarding time-course (early vs. late) and presence of constraints such as novelty and length. We investigated decomposition in compounds using magnetoencephalography (MEG) in a visual lexical decision paradigm comparing compounds (CW) and single words (SW).

Monolingual English speakers responded to 60 disyllabic noun-noun CW, 60 pairwise-matched SW, and 120 nonwords including 12 word-nonword foils (boxshep) while a 160-channel whole-head MEG system (Kanazawa Institute of Technology, Japan) recorded brain signals.

Response time (RT) reflects both early and late processes, whereas the MEG component around 350 ms post-onset (M350) reflects lexical activation. While the CW and SW were pairwise-matched for overall frequency (mean log-frequency 0.455) and letter-length (mean 7.8 letters), the first and second CW constituents had higher log-frequency (mean log-frequency 1.96, both for first and for second constituents) and shorter letter-length (first constituent mean letter-length 3.82, second constituent mean letter-length 4.0). Consequently, early decomposition predicts earlier M350 and faster RT, reflecting constituent over whole-word properties. Late decomposition predicts faster RT but not earlier M350. Given lexicalized CW with short constituents, lexicalization/length constraints predict neither RT nor M350 differences. Whole-word-only accounts likewise predict no differences.

Faster M350 latency (341 ms vs. 375 ms) and RT (682 ms vs. 740 ms) for CW vs. SW supported early decomposition. Comparison of the lowest-frequency CW

vs. SW items showed faster M350 for CW (340 ms vs. 387 ms), but not faster RT (761 ms vs. 755 ms), predicted by reduced post-access facilitation from constituents. Among the highest-frequency items, however, both M350 (344 ms vs. 364 ms) and RT (635 ms vs. 663 ms) were faster. M350 patterned with overall frequency only within SW, and constituent frequency within CW.

Processing syntax with two hemispheres

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In the present experiment we investigate the processing of category and morphosyntactic violations, using sentences such as (1) and (2).

1) Category Violation: Het brood werd door de bakkers in gebakken. (lit. The bread was by the bakers in baked)

2) Morphosyntactic Violation: Het brood werd door de bakkers bakte. (lit. The bread was by the bakers baked (past tense))

Final words of these sentences were briefly presented in either the right visual field (directly connected to Left Hemisphere = LH) or the left visual field (connected to Right Hemisphere = RH), while ERPs were recorded. We were especially interested to find out how the RH copes with ungrammaticality.

Morphosyntactic violations presented to the LH elicited a LAN (Left Anterior Negativity) and a P600, which have been commonly reported in the literature for this sort of violation. When presented to the RH morphosyntactic violations elicited a “RAN” which was so broadly distributed (and especially large at parietal sites) that it looked more like an N400 effect; the P600 was evident in the RH too, though it started later.

The results for category violations were rather unexpected. For stimuli initially presented to the LH, a highly lateralized frontal positivity was apparent – starting as early as 175 ms post onset – which was largest at RIGHT frontal electrodes; no P600 was observed. For the RH, the early positivity was largest at left frontal electrodes. Again, no P600 was observed.

Implications for theories of sentence processing will be discussed.

Automatic processing of grammar: Insights from a Mismatch Negativity (MMN) study

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The Mismatch Negativity (MMN) has recently been found to be sensitive to lexical and grammatical properties. In particular, abstract linguistic categories like phonemes and morphemes seem to be represented in the low level auditory system. We hypothesize a top-down flow of information, that we have called 'language-specific tuning effect', to explain the sum of data found in different MMN investigations. Our goal is to examine these early effects even for abstract grammatical categories of verbs. In our study we presented German verbal stimuli in a passive oddball paradigm to elicit a MMN in healthy adults (n = 10). In condition 1, we used meaningful word stems (imperative) as standards of strong verbs (e.g., /geh/, /sitz/, /lies/) and as deviants the same strong verbs but in the past tense form (e.g., /ging/, /saß/, /las/). In condition 2, the standards were the same as in condition 1 but as deviants we presented different meaningful word stems with the 3rd person singular ending (e.g., /geht/, /sitzt/, /liest/). Preliminary results of the healthy adults will be presented. The long-term aim of the study is to investigate the top-down effect in clinical groups such as children with Specific Language Impairment. These children are assumed to have central-auditory processing deficits that behaviorally manifest themselves in the incorrect use and understanding of grammatical categories.

Semantic illusions during sentence comprehension

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Recent ERP studies have uncovered a phenomenon we will call the "semantic illusion" effect: Words that make a sentence semantically anomalous do not cause an increase in N400 amplitude, as if the implausible sentence is temporarily taken

as plausible. For instance, in "The javelin has the athletes thrown" (literal translation from Dutch) the thematic role assignment prescribed by the syntax – "javelin" is AGENT (who does the throwing) and "athletes" are PATIENT (who are thrown) – seems to be temporarily overcome by the preferred role assignment of the entities involved. Instead of an N400, a P600 is seen. Hoeks et al. (submitted) suggested that the effect might disappear if the processor were given more time to resolve the thematic processing difficulty. To test this hypothesis, we conducted an experiment in which sentence length was manipulated by inserting three-word prepositional phrases (e.g., "in the morning") before the final word, to permit timely construction of the correct semantic representation. The results show, however, that this manipulation did not prevent the semantic illusion effect from occurring: The implausible sentence caused little or no N400 effect as compared to a plausible control and the P600 was still apparent. Thus, the semantic illusion effect seems rather robust, as the thematic processing difficulty may be too great to be resolved in a relatively short time. The length manipulation did produce additional significant main effects in both the N400 and the P600 time-windows, the implications of which will be discussed.

Session 4: Perception and cognition II: Audition

Wednesday, March 31, 9:00–12:30; HS 20

Chair: Eero Pekkonen

Attention capture by significant stimuli: semantic analysis follows attention switching

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Event-related potentials (ERPs) were recorded from the human scalp to resolve an old controversy in auditory attention research, namely, when the "breakthrough of the unattended" takes place in the human brain. Nine subjects classified visual

stimuli occurring after task-irrelevant standard tones (p = 0.8) or "novel" environmental sounds (p = 0.2) into odd/even categories. After the recordings, subjects scored the novel sounds as to whether they had any particular meaning to them (identifiable) or were perceived just as a short burst of noise (non-identifiable), and performance and ERPs were analyzed according to this classification. Results yielded identical N1 activity for the two types of novel sounds, indicating that attention switching was similarly triggered after these two types of unexpected sounds. However, there was a larger orienting of attention towards identifiable novels, as indicated both by larger behavioral distraction and enhanced novelty-P3 amplitude to these sounds. Moreover, this larger orienting of attention was due to the sounds being contingent with the visual stimuli, as no increase in novelty-P3 to identifiable novels was observed in a control condition, in which the sounds occurred non-contingently with the task-relevant visual stimuli. Therefore, the present results show that involuntary orienting of attention towards significant stimuli, such as our own name, occurs only after a transitory attention switch towards the eliciting stimuli.

Right-hemisphere dominance of phase-locked auditory evoked field components in response to periodic signals

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Psychoacoustic experiments in humans as well as various animal studies using intracranial recording procedures indicate phase-locked cortical activity to be an important aspect of complex pitch processing. In order to further elucidate the time course and hemispheric lateralization of this mechanism, human brain responses to periodic acoustic signals (repeated FM-sweeps, 2000–500 Hz; fundamental frequency F0 = 13, 22, 40, 67, or 111 Hz, duration = 300 ms) were recorded by means of whole-head magnetoencephalography (MEG) while subjects had to perform a stimulus identification task. Left- and right-hemisphere response curves were derived based on M100 dipole analysis. In accordance with previous studies, the latency of the M100 field was inversely related to F0. Furthermore, the 40-Hz stimulus elicited the smallest M100 amplitude but, in contrast, the

strongest phase-locked periodic MEG activity. The phase angle of the F0 component was quite consistent across subjects in case of the three highest F0 values, indicating active synchronizing mechanisms. Phase-locked activity was significantly stronger within the right as compared to the left hemisphere. These data indicate right-hemisphere dominance of an auditory pre-processing mechanism of periodic signals, providing a framework for subsequent pitch- or event-synchronous spectral evaluation.

The auditory evoked P3 and the omission evoked potential decrease with predictability: a single-trial analysis with wavelet denoising reveals individual learning curves

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Within the oddball paradigm, participants commonly respond to infrequently occurring targets. Thus evoked potentials (EPs) contain a large positive potential, the P3. It is well known that when target-probability increases, P3 amplitude decreases. Some have proposed that this is mainly due to a decrease in target-to-target interval. In this study we propose that the ability to predict target occurrence (which increases when probability is high) also decreases the P3.

In a first experiment targets (n = 96) with a 12.5% probability, interspersed within a train of backgrounds (ISI 800 ms), were presented. Targets were either deviant stimuli (session A) or omitted stimuli (session B). Within one session, blocks of 8 consecutive targets were alternately presented at either a random or fixed position. Thus, targets presented within fixed cycles became predictable after a couple of presentations. In a second experiment the same paradigm was presented, but expanded by adding either a fixed or random distractor stimulus (probability 12.5%). Single-trial analysis by means of wavelet denoising was applied in order to investigate trial-to-trial variation.

In response to targets presented in fixed cycles, P3 amplitudes rapidly diminished (after 2–3 presentations), resulting in a steep learning curve. No such de-

crease was observed when targets were presented in random cycles. Preliminary results show that distractor stimuli might flatten these learning curves

By applying this "learning oddball paradigm" individual learning curves can be determined when using single-trial wavelet denoising. In addition, susceptibility towards distraction might be additionally assessed. Therefore, this paradigm could lead to a clinical useful tool.

Wavelet components of auditory event related potentials (ERPs) in relation with signal discrimination, motor response, response inhibition and updating of working memory

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ERPs are generated by parallel and sequential activation of different neuronal groups in the brain during cognitive processes. Time-frequency analysis is a powerful method to investigate both consecutive and temporally overlapping signals with distinct frequency characteristics. Assuming that distinct neuronal structures responsible for specific subprocesses of a cognitive operation may operate in different frequency bands, this study aims to decompose auditory ERPs into specific signal components that reflect signal discrimination, motor response, response inhibition, and updating of working memory. Data obtained from 16 healthy volunteers using single-stimulus, oddball, go/no-go, and three-stimulus paradigms were decomposed by wavelet transform into six sets of coefficients. Alpha, theta, and delta band coefficients in the post-stimulus periods were evaluated in parallel with the conventional P200 and P300 peak measurements. Time-domain analyses reveal that discrimination process decreases the P200 amplitude, and motor response, response inhibition and updating of working memory processes increase the P300 amplitudes. Time-frequency analysis refined these results by showing that a prominent alpha oscillation between 0 and 500 ms occurred with a central maximum only in non-discrimination conditions, whereas it was strongly suppressed and two bitemporal alpha foci remained between 125 and 312 ms in discrimination conditions. Furthermore, in 250–375 ms interval a right temporal theta component in relation with discrimination and working memory update, and

a parietal delta component that was diminished by signal discrimination and motor response were distinguished. Thus, signal components and topographies related more specifically to different subprocesses of stimulus processing could be obtained by decomposing ERPs using wavelet transform.

Cortical evoked auditory responses are abnormal in Down syndrome: an MEG-study

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Introduction. Patients with Down syndrome (DS) usually have an extra copy of chromosome 21, accompanied by later mental retardation. Brain pathology in DS have similar features than that of Alzheimer's disease (AD); accumulation of senile plaques and neurofibrillary tangles, accompanied by destruction of ascending cholinergic neurons. Existing event-related potential (ERP) studies in DS have shown accelerated signal processing at the level of brainstem, with delay of later cortical responses N1 and P3. Studies with magnetoencephalography (MEG) indicate that patients with AD have impaired parallel auditory processing between the hemispheres. It has not been studied with MEG, whether patients with DS have similar functional abnormalities of auditory processing as observed in AD.

Material and methods. Whole-head MEG-measurements were performed to six patients with DS, and six age-matched healthy controls. Monaural auditory tones were presented to all subjects with stimulus interval of 1 s, and auditory evoked fields (AEF) were measured with 306-channel MEG-system.

Results. Magnetic P50 response was significantly delayed, but not attenuated in the DS group. The subsequent N100m was significantly attenuated contralaterally in the patient group, whereas the latency difference of N100m was not significant.

Discussion. This is the first MEG-study in patients with Down syndrome suggesting that parallel auditory processing between the hemispheres is impaired in DS. In addition, our preliminary results suggest that P50m and N100m generators

have different sensitivity to Down pathology. An abnormal auditory processing might be linked to cholinergic deficiency observed in DS.

Session 5: Audio-visual processing

Wednesday, March 31, 11:00–12:30; HS 22
Chair: Marie-Helene Giard

Neural dynamics of auditory-visual speech fusion

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How does the nervous system fuse two separate streams of sensory information, for which timing and spatial location may be the only source of redundancy? Multisensory fusion is classically accounted for by neural convergence onto multisensory integration sites, where spatio-temporal coincidence of auditory-visual (AV) events provides a sufficient constraint for the integration process.

Why then, does an audio [pa] dubbed onto a place-of-articulation [ka] results in perceiving [ta] (i.e. a unified percept) while an audio [ka] dubbed onto a visual [pa] does not (McGurk and McDonald, 1976)? Here, we take an information-theoric perspective and provide evidence for the necessity of an abstract (and modality-independent) representation of speech.

First, electrophysiological (EEG) recordings show that in natural AV syllables, visual information facilitates the neural processing of auditory speech such that the more salient visual inputs are, the faster the auditory processing of speech is. In bimodal condition, the shortened latency of auditory-evoked potentials (tens of milliseconds) was accompanied by an amplitude decrease (~200 ms), suggesting that neural computations in the gamma (~40 Hz) and theta (4–7 Hz) range are crucial for the processing of AV speech.

Second, EEG recordings using desynchronized AV speech stimuli shows that cognitive demands (i.e. identifying vs. judging the synchrony of AV stimuli) are associated with two different global cortical states of activation in the gamma and theta range, suggesting implicit modulation of information extraction in AV speech.

Furthermore, it is in the interaction gamma/theta, that hemispheric-specific computations could be dissociated. For instance, interactions in the right hemisphere correlated with the perception of temporal order.

Our results strongly suggest the 'analysis-by-synthesis' nature of AV speech integration. A forward model of AV speech fusion is proposed to account for the results and will be discussed in the context of current multisensory neural convergence and feedback models of multisensory integration.

Does the McGurk effect always fool the brain?

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The key role played by visual speech information in our subjective perception of auditory speech input is clearly illustrated by the audiovisual speech illusion known as the McGurk effect. Typically, subjects do not notice the lack of congruence between the acoustic and visual input and this illusion is known to be quasi-irrepressible. However, the question of a possible non-conscious detection of this existing incongruence is still open. Here we show that while subjects mainly identified the McGurk stimuli according to the illusory percept they are supposed to yield, the event-related brain potential responses recorded for these stimuli resulted in larger amplitudes for a late positive component, namely the P600, as compared to those elicited by congruent audiovisual speech stimuli with the same auditory information. When the task consisted in explicitly detecting the incongruence between the bimodal speech inputs, however, this modulation in the P600 amplitude no longer occurred, although again the McGurk stimuli were mainly categorized as a coherent percept. These results are in accordance with recent

findings showing that the P600 reflects cerebral repair and reanalysis processes. Moreover, the results indicate that this brain response, which may be reflecting a non-conscious detection of the non-coherence between the bimodal speech inputs for McGurk stimuli, seems to depend on the focus of attentional resources.

Is visual information represented in auditory sensory memory?

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Mismatch Negativity is elicited when incoming sounds are detected as deviating from a neural representation of acoustic regularities in auditory cortex and can thus be used as a probe to study the representation of sounds in transient auditory sensory memory (ASM). However, several studies have shown that auditory MMN may be sensitive to visual information: an auditory-like MMN can be elicited by an illusory auditory phonetic deviation due to infrequent mismatching lip movements (McGurk effect), even though the physical auditory signal does not differ between deviants and standards.

The question then arises whether this visual influence on auditory representation in ASM is speech-specific, or may be observed with non-speech audio-visual events as well. Indeed there is growing evidence for the existence of cross-modal interactions at early sensory processing stages, suggesting that auditory-visual information may be at least partially integrated before the MMN process occurs.

To test this hypothesis, we compared the MMNs (amplitude, latency and topography) elicited by stimuli deviating from audio-visual AV standards on visual (AV') or auditory (A'V) or both (A'V') dimensions. Auditory-only (A) and visual-only (V) oddball paradigms were conducted as additional controls.

The main hypothesis is that if the ASM trace includes visual information of a bimodal stimulus, 1) an AV'-MMN should exist and 2) A'V'-MMN and A'V-MMN should have different characteristics. Further comparisons between the different audiovisual and sensory-specific MMNs should allow characterizing the possible bimodal nature of the neural representations stored in ASM and involved in the MMN process.

Session 6: Prosody and music

Wednesday, March 31, 14:00–16:00; HS 18
Chair: Mari Tervaniemi

About the nature of the Closure Positive Shift (CPS)

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As previous studies of normal subjects and different age groups have shown, the perception of intonational phrase boundaries (IPHs) induces a positive shift (CPS) in the ERP. The question about the nature of the CPS is still a matter of debate. IPh boundaries are characterized by a set of prosodic cues, e.g., preboundary lengthening, pause, boundary tone. Perceptual studies have shown, that the CPS is also measurable in filtered and hummed speech, where the fundamental frequency plays a crucial role. Nevertheless, if sentence material was presented with a flattened pitch contour, the CPS occurred at each IPh boundary. Hearers are able to aware an IPh boundary without perceiving the full set of prosodic cues in the speech signal.

Moreover, to evaluate the perception of the IPh boundaries in dependence of brain functions, sentences were presented to unilateral left and right lesioned patients. Both groups showed differences in processing of IPh boundaries in comparison to healty controls. The RH group clearly displays the processing in an extended time window, whereas the LH group might have problems to integrate linguistic based prosodic features into speech within an appropriate time. The results of the studies lead to an interpretation of the CPS as a component which reflects the segmentation of the speech input.

Is prosody a good predictor of up-coming information? ERPs evidence from spoken German sentences

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The question of whether prosody is exploited by the parser for predicting up-coming information has been addressed in the present study. We approached this issue by investigating the auditory processing of complex German verbs that do take a particle (e. g., an-laecheln [to smile-at]). Precisely, our goal was to determine whether the prosodic information of the inflected verb stem helps the parser to predict the occurrence of a split particle at a later position in the sentence. Event-related brain potentials (ERPs) were recorded while twenty German listeners were processing morpho-lexically and/or prosodically correct or incorrect German sentences. The critical item was either the split particle or the preposition. Participants performed an off-line probe detection task (PDT). ERP data indicate that prosodic information of the verb stems is consulted on-line by the parser in order to predict the occurrence of a split particle. An N400-effect was found for the processing of split particles following verb stems which do not take a particle, but only if the prosodic contour of the verb stem specifically marks the presence of a split particle. We argue that the N400 component reflects the higher costs associated with the (unsuccessful) reaccess to the lexicon. Furthermore, as a general reflection of prosodic processes, a closure positive shift (CPS) was found at intonational phrase boundaries. Taken together, the present findings provide strong evidence for the notion that prosody is a good predictor of up-coming information during the auditory processing of German sentences.

Neurocognition of speech vs. music sound processing: An ERP and fMRI study

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Sound frequency, duration, and intensity are key elements in carrying prosodic and musical information. Our aims were to compare the neurocognition of speech and music sounds and to determine the relative importance of the above mentioned features.

The subjects were presented with pseudowords and music sound patterns of matched duration, intensity, and fundamental frequency. As rarely occurring "deviants", pseudowords and music patterns with acoustically matched pitch, duration, and intensity changes were employed. In addition, all additive combinations of those changes were included (ERP study). The subjects watched a silent video (ERP: Ignore), performed a target detection task (ERP: Attend), or categorized the sounds as speech or music (fMRI).

The change-specific MMN component was modulated by the deviating sound parameter, the number of deviated parameters, and the sound type (music vs. speech). Moreover, N2b was influenced by the subjects' musical expertise, deviated sound parameter, and marginally also by the sound type. Up to some extent, fMRI dissociated the brain areas involved in speech vs. music processing. Taken together, these results support the existence of (at least partially) modular music- and speech-specific systems in neurocognition of auditory information.

An electrophysiological marker for phrasing in music

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Sequential information in music as well as language does not form uniform streams, but can be subdivided into phrases of several levels. Prosodic phrase boundary markers (e.g., pauses) support a speedy and accurate processing. For auditory speech, a recent study gives direct electrophysiological evidence for the immediate use of prosodic markers for the resolution of syntactic ambiguities (Steinhauer et al., 1999). Each phrase boundary was indicated by a positive shift with a centro-parietal distribution, called Closure Positive Shift (CPS). The question arises whether a similar component can be found indicating the detection of phrase boundaries in music. We present evidence that this is indeed the case. In two experiments, musicians listened to unknown piano sequences consisting of 1, 2 or 3 phrases. ERP was measured at 64 or 32 electrodes and revealed a significant positive component in response to the phrase boundary with a peak latency of 550 ms after phrase boundary offset, an amplitude of about 2 mV, and a centro-parietal distribution. Moreover, parallel measurements with a whole head MEG system were used to gain insight into the underlying generator configurations. Further exploration showed that the presence of the component is influenced by various parameters concerning the structure of the music (phrase lengths, symmetry) and the interpretation (emphasis of phrasing, reflected by pre-final slowing and lengths of pauses). This finding indicates that the CPS might reflect a universal segmentation process which applies to musical perception as well.

Reference: Steinhauer K., Alter K., & Friederici A. D. (1999). *Nature Neuroscience 2(2),* 191–196.

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