

COGSCI

IKW Institut für Kognitionswissenschaft
Institute of Cognitive Science at the University of Osnabrück



••• IKW ••• Institut für
Kognitionswissenschaft

Institute of Cognitive Science
at the University of Osnabrück

Welcome to the IKW

The Institute of Cognitive Science at the University of Osnabrück

... IKW ...

Institut für Kognitionswissenschaft
Institute of Cognitive Science at the University of Osnabrück



The University of Osnabrück is the only institution of higher education in Germany, and one of only a few in Europe, to offer a full range of degree programmes in Cognitive Science, and the Institute of Cognitive Science is one of only a handful of academic institutions in Europe where research is carried out on the full range of cognitive processes including, e.g., vision and attention, reasoning and text comprehension.

Research at the Institute of Cognitive Science involves close interdisciplinary cooperation among researchers from a wide variety of fields. The institute comprises core research groups in

- Artificial Intelligence
- Cognitive Psychology
- Computational Linguistics
- Neurobiopsychology
- Neuroinformatics
- Philosophy of Cognition

and associated research groups in

- Human-Computer Interaction
- Knowledge-Based Systems
- Personality Systems

The University of Osnabrück offers curricular academic programmes leading to BSc, MSc, and Ph.D degrees in Cognitive Science. The undergraduate curriculum is designed to provide a sound foundation in the core areas of Cognitive Science and to introduce students to more advanced topics in their selected areas of study, while graduate training is closely integrated with the research activities of the institute.

In this booklet we give a brief overview of the research conducted at the IKW and of the University of Osnabrück's degree programmes in Cognitive Science.

Further information can be found at www.cogsci.uni-osnabrueck.de.

Cognitive Science is the interdisciplinary study of mind and intelligence, embracing the fields of philosophy, psychology, artificial intelligence, neuroscience, linguistics, and computer science. The intellectual origins of the field were in the mid-1950s when researchers in these disciplines began to develop theories of mind based on complex representations and computational procedures. The central hypothesis of cognitive science is that thought can best be characterized in terms of representational structures and computational procedures that operate on those structures.

Human intelligence – from that exhibited by a chess grandmaster to that displayed by a world-cup soccer champion – is a complex hybrid of skills and techniques. One of the hallmarks of human cognition is the ability to adapt to ever-changing situations, to learn, and to generalize to new problems and situations. Whether this involves comprehending a never-before heard sentence or categorizing a never-before seen object, accounting for the ability to learn and adapt has been central to cognitive science research since its establishment.

In its early years, cognitive science research focused on representational schemes inspired by classical computer architectures involving rule-based symbol manipulation algorithms and addressed “higher” cognitive tasks such as problem-solving, game playing and language understanding. As more has become known about the computational mechanisms of the brain, representational schemes inspired by neural computation have become prevalent and the focus of research has spread to “lower” cognitive tasks such as motor control and object recognition, where pattern-based computation plays a leading role.

A central question for contemporary cognitive science – one which has been a focus for research in Osnabrück – is how rule- and pattern-based processes interact and are integrated. We ask how linguistic symbols are grounded in experience, how discrete symbolic representations might emerge from the continuous flood of perceptual data, and how logical reasoning might evolve in neural networks. Imbuing technical systems with cognitive capabilities represents an important applied dimension for Cognitive Science.

Cognitive Science in Osnabrück

Cognitive Science teaching at the University of Osnabrück began in 1998 with the establishment of an international Bachelor’s degree programme in Cognitive Science, the first of its kind in Germany. In 2001 a two-year Master’s degree programme was added, and in 2002 this was supplemented with a three-year curricular PhD programme. With about eighty Bachelor’s students, twenty Master’s students and up to seven PhD students starting each year, the University of Osnabrück is home to the largest Cognitive Science study programme in Europe, with a unique international focus.

Research on Cognitive Science at the University of Osnabrück is carried out under the auspices of the Institute of Cognitive Science (Institut für Kognitionswissenschaft, IKW). The IKW was founded in 2001 and originally consisted of professorships in Computational Linguistics & Artificial Intelligence, Computational Linguistics & Cognitive Science, Cognitive Psychology, and Theoretical Computer Science. The IKW has grown rapidly, over the past few years, adding five professorships – Philosophy of Cognition, Neuroinformatics, Neurobiopsychology, Artificial Intelligence, and Computational Linguistics – as well as a number of associated groups: Personality Systems, Human Computer Interaction, and Knowledge-based Systems.

Research at the IKW ranges from scientific projects, sponsored by the German Research Foundation, the Volkswagen Foundation, and the European Union, to application-oriented projects with partners from industry. In addition, the IKW plays an active role in the international Cognitive Science community, hosting conferences and workshops and inviting scholars and researchers to visit the institute. In recent years the IKW has organized SuB6 (2001), QITL1 (2002), EuroCogSci 2003, and QITL2 (2006), and played host to over 20 invited scholars per year. Finally, the team of the IKW’s Neuroinformatics group won the finals of the middle-size league at the RoboCup robot soccer world championships 2006 in Bremen!

Bachelor's Programme

www.cogsci.uni-osnabrueck.de/BachelorProgramme



The Bachelor's programme is designed to provide a sound foundation in the core areas of Cognitive Science (Artificial Intelligence, Cognitive Psychology, Neuroscience, Robotics, Computational Linguistics, Philosophy of Mind). Particular emphasis is on the methods employed in these fields and on their interdisciplinary relations. Students will acquire empirical skills, analytical skills and also engineering skills. Beyond this, students are introduced to more advanced topics in their selected areas of study.

Mentoring

Every student is assigned to a lecturer who guides the student through the whole period of study, offering the student advice on all questions concerning his/her studies.

Tutorials

Most of the undergraduate courses are supported by tutorials held by senior students under the guidance of the lecturer. This provides assistance to newcomers and promotes cooperation between students.

Bachelor thesis

Bachelor theses may be written in the context of one of our research groups. Topics range from basic theoretical questions to practical applications. Outstanding theses will be published in the IKW's publication series PICS.



Semester abroad

Students of the Bachelor's programme will spend one semester at one of our partner universities. The Osnabrück Cognitive Science programme cooperates with over thirty Cognitive Science programmes all over the world. To name only a few,

- Rutgers University New Jersey, USA
- McGill University Montreal, Canada
- University of Trento/Rovereto, Italy
- University of Edinburgh, Scotland
- University of Bahia, Brasil
- New Bulgarian University, Sofia, Bulgaria
- University of Nancy 2, France
- Lund University, Sweden
- King's College London, Great Britain
- University College Dublin, Ireland

Language courses

We offer German courses for foreign students, and we offer English courses for those who are interested.

Accreditation

The Osnabrück Cognitive Science Bachelor's programme as well as the Master's Programme are accredited by the "Zentrale Evaluations- und Akkreditierungsagentur Hannover" (ZEvA) which is a member of the European Association for Quality Assurance in Higher Education.

Degree: Bachelor of Science (BSc) in Cognitive Science

Duration: 6 semesters, starting in October

Language of instruction: German and English

Admission requirements: Abitur (or equivalent)
good command of German and English

Application: The application procedure is specified in the web

Contact: cogsci-info@cogsci.uni-osnabrueck.de

Master's Programme

www.cogsci.uni-osnabrueck.de/MasterProgramme

Studies in the Cognitive Science Master's Programme cover multiple aspects of cognition, such as perception, attention, memory, learning, problem solving, reasoning, emotions, and language. We are concerned with questions related to how these cognitive abilities are realized in biological or in artificial systems, and how such systems are organized. In addition, complex information processing systems like teaching systems and spoken language dialog systems are treated from a design and implementation perspective, including human-computer interfaces aspects.

Special features of the Osnabrück Cognitive Science Master's programme are

Choice of two major subjects from

- Artificial Intelligence
- Cognitive Psychology
- Linguistics and Computational Linguistics
- Neuroinformatics and Robotics
- Neuroscience
- Philosophy of Mind and Cognition

Integrated graduate programme

Students with outstanding results may be admitted to the Doctorate Programme after their first year in the Master's Programme.

One-year study project

Groups of 5 – 10 students carry out a research project under conditions very much like those of regular research. Project themes cover all cognitive science areas and there is a focus on interdisciplinary cooperation.

Study projects from recent years are:

- *Mind-Reading* and *Social Cognition*
- *ASADO*: Analysis and Structure of Aviation Documents
- *CarDial*: Building a Spoken Language Dialogue System
- *feelSpace*: creating a new sensory modality by stimulation with a vibrotactile device
- *Preference and Reference*: Analysing demonstratives in German
- *MIDI*: Mechanisms in Neuropsychological Issues
- *Higher Level Language Processes in the Brain*
- *MAPA*: Mapping Architecture for People's Associations

Lab rotation

Students participate for at least one week in each of the research labs to get familiar with the every day life in the labs.

Joint Cognitive Science Master's Degree Programme Osnabrück – Trento/Rovereto

Students from Osnabrück and students from Trento have the opportunity to study at the partner university for two semesters. This exchange will result in a joint Master's degree from both universities providing career opportunities in a united Europe.

Degree: Master of Science (MSc) in Cognitive Science.

Duration: 4 semesters, starting in April and October.

Language of instruction: Courses are given primarily in English.

Admission requirements: BA, BSc or equivalent in Cognitive Science or one of its sub-disciplines (at least with grade B).

Application: The application procedure is specified in the web

Contact: master-info@cogsci.uni-osnabrueck.de

PhD Programme

www.cogsci.uni-osnabrueck.de/DoctorateProgramme

The core objective of the Cognitive Science PhD Programme is to enable excellent students to carry out independent research in promising and highly active areas of Cognitive Science. The programme aims at optimal synergy between the dissertation projects and current research at the Osnabrück Institute of Cognitive Science.

Specific characteristics of the programme are

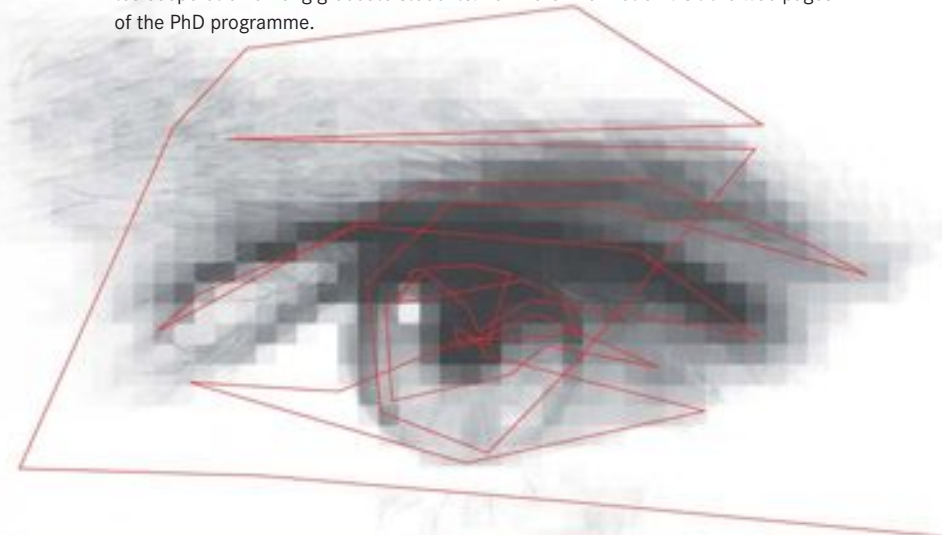
- interdisciplinary research, integrating all Cognitive Science sub-disciplines
- a curriculum comprising seminars, colloquiums and reading groups, systematically supporting the thesis work and enabling students to finish their PhD within three years
- international research environment including, e.g., seminars conducted by renowned guest lecturers, integrating PhD students in his/her international scientific community
- supervision by at least two researchers from different Cognitive Science sub-disciplines. Joint supervision with a researcher from a university abroad is welcomed.
- the opportunity to gain teaching experience by co-teaching a seminar together with an experienced lecturer
- English as the language of instruction; in addition the PhD thesis can be written in either German or English and for the oral examination candidates can also choose between these two languages.
- soft skills courses which provide training on presentation and communication skills, academic writing and publication, grant application, project management, etc.

One of the topics focussed in the PhD programme is

Cognitive Architectures: The Integration of Patterns and Rules

Assuming that human cognition is based on both patterns of experience and categorical rules, one of the highly relevant research questions spanning all Cognitive Science sub-disciplines is the question of how rule-based and pattern-based mechanisms interact in cognitive processes and what kind of architecture has to be assumed for integration.

This question provides an exciting perspective on the individual projects and facilitates cooperation among graduate students. For more information visit the web pages of the PhD programme.



Degree: Ph.D in Cognitive Science (Dr. der Kognitionswissenschaft)

Duration: 6 semesters, starting in April and October.

Language of instruction: English.

Admission requirements: Master's degree (or equivalent) in Cognitive Science or one of its sub-disciplines. Students with excellent results may be admitted to the PhD Programme after their first year in the Master's Programme.

Application: Application documents are specified in the web.

Contact: doctorate-info@cogsci.uni-osnabrueck.de

Artificial Intelligence

Prof. Dr. Kai-Uwe Kühnberger
Dr. habil. Helmar Gust

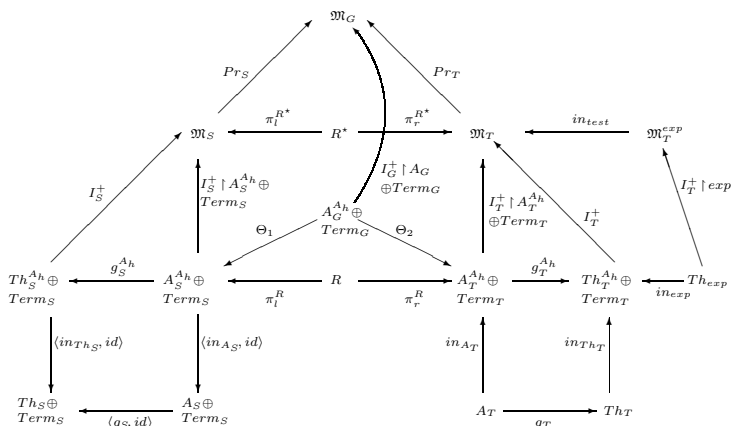
www.cogsci.uni-osnabrueck.de/AI

The artificial intelligence group focuses primarily on the modelling of higher cognitive abilities, for example on (classical and non-classical) reasoning, memory, and learning. The methods used for modelling these abilities include logic-based, algebraic, and co-algebraic approaches, programming paradigms, as well as methods used in neuroscience.

From a more abstract perspective these interests can be embedded into the following questions stressing the cognitive aspect:

- How can we theoretically explain and practically model creativity of humans?
- How can the gap between symbolic and sub-symbolic representations be closed in artificial systems?
- How can machines process information at a semantic level?

Besides these more or less theoretical questions the AI group works on practical realizations in running software applications.



Syntax and semantics of analogies

Main Research Areas of the Artificial Intelligence group:

Analogical Reasoning and Metaphors: Goals of this research area are to develop syntactic, semantic, and algorithmic approaches for models of analogical reasoning and analogical learning. Strongly connected with this line of research is the interpretation of metaphorical expressions.

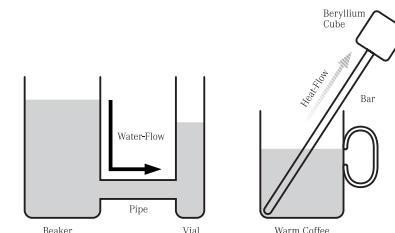
Ontologies: In this research area, the AI group tries to develop a uniform framework for coding ontological and syntactic knowledge. Ontologies – in other words hierarchically structured background knowledge – are useful for a variety of technical applications.

Knowledge Management: The goal is to develop mapping tools for cooperative work and learning scenarios. This area is strongly connected to research in document management.

Algebraic Methods and Logic in Artificial Intelligence: We are interested in applying algebraic methods like category theory, universal algebra, co-algebras etc., as well as non-classical logic accounts and logic programming techniques to reasoning problems in AI.

Symbolic / sub-symbolic representations: This research area attempts to model first-order inferences with neural networks and to extract conceptual knowledge from trained connectionist systems. The overall goal is to bridge the gap between symbolic and sub-symbolic representations.

Learning Environments: This research area includes ICALL systems (Intelligent Computer Assisted Language Learning systems) as well as the whole range of media-based learning environments.



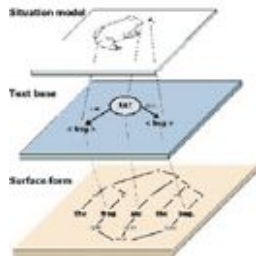
A classical example for analogies: The flow of water and the flow of heat

Cognitive Psychology

Prof. Dr. Franz Schmalhofer

www.cogpsy.uni-osnabrueck.de

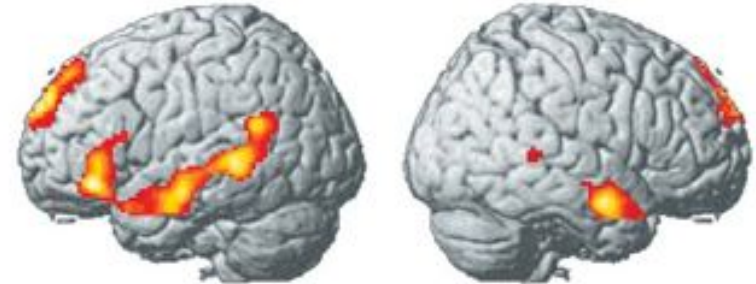
The cognitive psychology group studies human comprehension (i.e. the understanding of words, sentences, texts, pictures, and movies) by investigating the higher level cognitive construction and integration processes that operate upon socially grounded information (e.g. words, sentences or complete texts) in combination with directly perceived stimuli (e.g. pictures, sounds or touches). This experimental and theoretical research applies a three-pronged approach where behavioural indicators of human understanding (remembering, decisions, picture naming, summarizations



of texts, interpersonal communications etc.) from psychological experiments are compared to neural indicators from the human brain as measured by functional magnetic resonance imaging (fMRI) and event related brain potentials (ERPs). The experimental results are then formally described within a unifying computational model. By virtue of the unifying model, our results from basic science can be deployed to various practical problems as they arise in instruction design, human computer interactions and ontology design.

Our results have shown that human comprehension consists of the cognitive formation of a multi-level representation, where the integration of socially grounded information and simultaneous perceptions occurs in a poly-modal situation model that also includes emotional aspects. A situation model is a person's specification of the state of affairs as they are directly perceived from the environment or communicated by language. It is always grounded in the environment of an individual person. Understanding a text is therefore equivalent to the formation of an implicit virtual environment around the person who attempts to understand the state of affairs described by the text.

An application of these results extends to the construction of shared situation models, knowledge mediation and the interactive construction of formal domain ontologies for businesses (including multicultural settings) by dyadic and triadic interactions among human and artificial agents.



Brain areas involved in text comprehension

Some more specific research addresses the following issues:

- Integration of emotions, perceptual structure and object identity information in comprehension.
- How is text information perceptually completed within different visual contexts?
- The role of different comprehension strategies (reading for memory versus reading for understanding) and different perspectives on the time course of generating inferences.
- Integration processes in text comprehension as they are indicated by ERPs and fMRI.
- Unified computational model of coherence formation within a dynamical systems framework
- Human Computer Interaction and the cognitive analysis of increasingly larger organisational contexts
- Netbased knowledge mediation as a component for advanced e-learning
- How personality characteristics may yield an individualized understanding of a text
- How inferences and emotional processes contribute to the understanding of a text.
- The attribution of motivations and emotions in the comprehension of cheating behaviours

Human language cannot function independently of other (lower and higher) cognitive capacities. Hence a full theory of human language requires, in an almost frustrating sense, nearly a full theory of cognition. – The common focus in Cognitive Science at Osnabrück is the big question about relations between higher cognitive processes (such as language or reasoning) and lower cognitive processes (such as vision or motion), and about cognition as a hybrid system that integrates both. In this context the Computational Linguistics Group is interested in two general questions:

- How do symbolic representations and processes interact with non-linguistic cognitive capacities (attention, memory, reasoning, perception)?
- How does linguistic knowledge interact with linguistic and non-linguistic experience?

These questions lead to our ongoing research and teaching in areas like the following:

- Context-dependence and the semantics-pragmatics interface
- Anaphora: Syntax, semantics, and discourse properties of pronouns and anaphors; Algorithms for annotation and resolution
- Information structure and discourse structure: Focus in complex NPs, specificity, definiteness, focus & contrast, and connectives

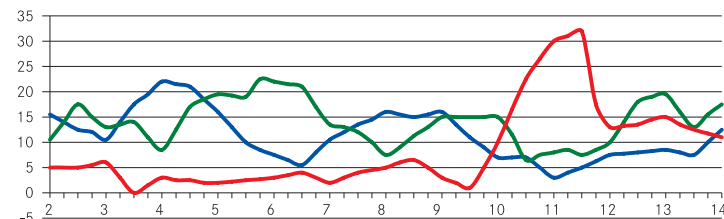
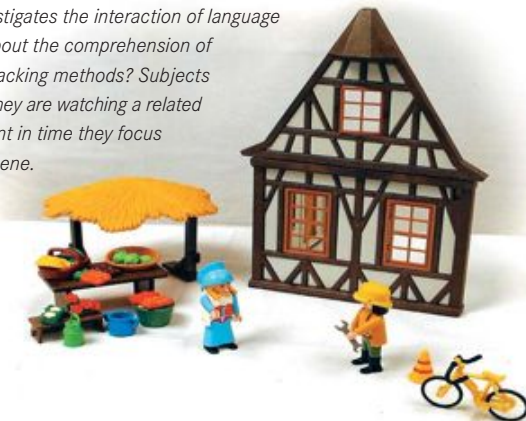
Current work on the frequency distributions of linguistic expressions is revealing statistical patterns that might be exploited by the human brain for efficient language production and perception. The insights and new mathematical models resulting from this line of research are also relevant for theoretical linguistics as well as for applications in computational linguistics and lexicography.

- Temporal semantics and event semantics: Semantics and discourse behaviour of temporal information and reference to events
- Computational lexicography and lexical semantics: Interaction of lexical meaning with conceptual information, world knowledge, and frequency; Disambiguation of lexical meaning; Lexical resources and corpora; Collocations; Corpus-based lexicon development
- Human language processing: Theoretical and experimental psycholinguistic work
- Quantitative Linguistics: Statistical research on distribution in morphology and lexicology; Collocations and idioms

One of our current projects investigates the interaction of language and vision: What can we learn about the comprehension of referential expressions by eye-tracking methods? Subjects listen to a brief discourse while they are watching a related scene. We measure at which point in time they focus on which of the objects in the scene.

For instance:

*Heute ist Markt im Dorf.
Die Marktfrau streitet sich mit dem Arbeiter. Sie sagt jetzt gerade, daß er ihr nun das neue Fahrrad zurückgeben soll, das er sich geliehen hat.*



Die Marktfrau ... mit dem Arbeiter. Sie ... er ihr ... das neue Fahrrad ...

We wish to learn about and to understand human cognition and behaviour. Starting with visual processing we study cross modal interaction and sensorimotor coupling under natural conditions.

To achieve this, we believe it is necessary to apply in combination methods from psychology on the one hand and neurobiology on the other. In this we apply a wide range of methods: statistics of natural stimuli, measurements of eye movements, micro-electrode recordings, electroencephalography (EEG), simulations of hierarchical neural networks, navigation of autonomous agents implemented on mini-robots, advanced data analysis techniques, and in collaboration high-temporal resolution imaging with voltage sensitive dyes, laser range scanning and fMRI.

In this context the Neurobiopsychology Group is interested in the following questions:

- How do top-down signals pertaining to the behavioural context interact with stimulus driven bottom-up information?
- Which stimulus properties drive overt attention?
- How is information originating in different sensory modalities combined?
- What are the neuronal response properties in sensory cortices under natural conditions? Can these be described by unsupervised learning of natural stimulus statistics?
- What is the role of oscillatory processes and synchronization of neuronal activity in sensory processing?
- Is the quality of perceptual awareness determined by a specific neuronal substrate or by sensorimotor contingencies?

Examples of current projects

The influence of colour on human overt attention:
We measure eye movements and neuronal activity of human subjects viewing natural and manipulated natural stimuli. Applying information theoretic analysis we arrive at model integrating bottom-up and top-down information.



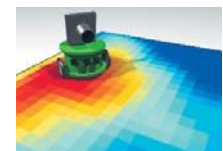
feelSpace: Can a new sensory modality be learned?
Subjects wear a belt equipped with a set of vibrators controlled by an electronic compass. That way, the person wearing the belt gets permanent input about his heading relative to the earth's magnetic field.



Neuronal dynamics during cross-modal interaction:
We employ bimodal visual-auditory stimuli of natural scenes with animals and measure neuronal activity by EEG during congruent and incongruent lateralization. This allows high temporal resolution to reveal synchronization effects between different cortical regions.



Unsupervised learning in autonomous agents: We investigate whether the optimization of stable sensory representations can generate a hierarchy of cortical like processing stages. The model visual hierarchy is implemented on a mobile robot exploring a complex real-world environment.



Neuroinformatics

Prof. Dr. Martin Riedmiller

www.ni.uos.de

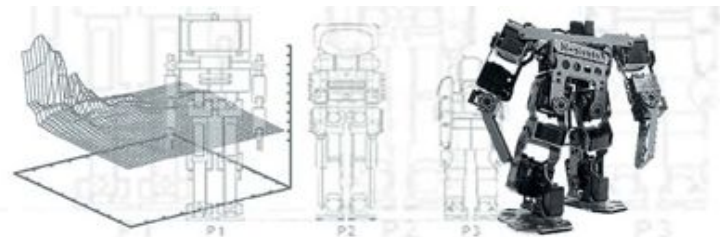
Future computer programs will contain a growing part of intelligent software modules that are not conventionally programmed, but instead are learned either from data provided by the user or from data that the program autonomously collects during its use.

In this spirit, the Neuroinformatics Group deals with the research on Machine Learning techniques and the integration of learning modules into larger software systems, aiming at their effective application in complex real-world problems. Application areas are robotics, control, forecasting and disposition systems, scheduling and related fields. Main techniques that we use are artificial neural networks and reinforcement learning.

Among others, two research projects exemplify this research target:

We have been participating in the RoboCup championships of autonomous soccer playing robots for some years now. In contrast to other teams we use learning techniques to optimize skills and movements of the robots like moving on the field, intercepting and dribbling the ball, and acting cooperatively. We were able to verify the strength of these learning approaches winning the world championship in 2005 with one team and the German Open competition with all three teams.

In cooperation with the Axel-Springer-Verlag we are developing a system for sales rate prediction of the BILD-Zeitung. It can be used to predict the daily sales rates of each of the 110 000 retail traders of the BILD-Zeitung one week in advance. The special feature of this system is that it is able to individually adapt to the characteristic of each of the retail traders using efficient learning techniques.



Philosophy of Cognition

Prof. Dr. Achim Stephan
 Prof. Dr. Wolfgang Lenzen (associated)
www.cogsci.uni-osnabrueck.de/philo

Main research topics:

- *Emotions*: Affective intentionality, emotional motivation, interplay of emotion and cognition, phenomenal aspects of emotions, moods, sensations, values and evaluations, appraisals.
- *Mind Reading*: Theory of mind, imitation, joint attention, developing theories of intention, executive functions in children, mirror neurons, autism, false belief test.
- *Emergence*: strong and weak versions of emergentism, reductive explanation, mechanisms, mind-body problem, self-organization.
- *Phenomenal Consciousness*: qualia, explanatory gap, state consciousness, access consciousness.
- *Free Will*: determinism, indeterminism, the impact of neuroscientific experiments, incompatibilism, compatibilism, moral responsibility.
- *Philosophy of Psychoanalysis*: manifest phenomena, free associations and their meaning, symbolizations, cognitive science approaches to psychoanalysis.

Western philosophers have characterized man as the rational animal and by that distinguished him from all other animals. Although this seems to be appropriate in many respects, it nevertheless neglects a crucial aspect of mankind: human beings are emotional creatures. Emotions are characteristic features of our experiences. Moreover, they are not only constitutive components of evaluations and decisions but also of their concrete realization in action processes. The aim of our current research project *animal emotionale* funded by the VolkswagenStiftung is to study human emotion from an interdisciplinary perspective combining philosophy and affective neuroscience.

In this context we are, for example interested in the following questions:

- How do emotional processes relate to other cognitive processes such as evaluating, reasoning, action planning, and acting?
- How do emotional processes relate to social interactions?

The second task relates to our research on mind reading: Facial expressions of emotions or accompanying bodily postures are major signs and signals furthering the understanding of what's going on in the "mind" of each other.

- What role do the phenomenal qualities of conscious feelings play in emotional processes?

The third task relates to our research on phenomenal consciousness, which in turn is connected to questions like the ones Colin McGinn once inimitably raised: How can Technicolor phenomenology arise from soggy gray matter? How could the aggregation of millions of individually insentient neurons generate subjective awareness?

These questions refer to the good old mind-body problem, which in current terminology asks for an answer to how mental properties could be accounted for by the physical properties of their bearers.



Human-Computer Interaction

Human-Computer Interaction (HCI) is an interdisciplinary area of research concerned with the design of usable interactive computing systems. The disciplines involved in this area are: computer science, human factors, engineering psychology, cognitive science, ergonomics and industrial design. Usability refers to the extent to which a product can be used by users to achieve their goals with effectiveness, efficiency and satisfaction. At the University of Osnabrück, HCI is one of the main research topics in the department of work and organizational psychology. Our research in this field deals with theories about cognitive and emotional processes and their application to the design of interactive products on the one hand and the corresponding engineering process on the other hand. This usability engineering process is based on the following principles: requirements analysis, user participation, prototyping and evaluation including the empirical analysis of user behaviour.

The Usability Lab (U-Lab) of the university (www.ulab.uni-osnabrueck.de) provides an excellent infrastructure for HCI related research. The Lab comprises two test rooms and one observation room. It supports the application of different usability testing methods such as eye-tracking or video based behaviour observation.



Apl. Prof. Kai-Christoph Hamborg

www.psycho.uni-osnabrueck.de/fach/aopsych/

Our current research topics in HCI are:

- Visual perception of websites: Eye movements and fixations are investigated to understand the initial perception of and visual orientation on web pages.
- Design and evaluation of voice user interfaces: Development of voice dialog systems considering limitations of voice user interfaces in contrast to graphical user interfaces. Design topics are for example: system prompts, wording and menu structure.
- Usability of eLearning applications: requirements analysis and usability testing to support the development of usable eLearning tools.
- Development and validation of usability engineering methods, especially methods for requirements analysis and evaluation like thinking-aloud technique, cognitive walkthroughs etc.



Knowledge-Based Systems

Prof. Dr. Joachim Hertzberg (associated)

www.inf.uos.de/kbs

Research in knowledge-based systems has traditionally focused on smart software systems. The symbolic knowledge that is necessary for their advanced reasoning is typically provided by human knowledge engineers, who acquire it from other humans or from primary experience, possibly using sophisticated methods or tools for knowledge acquisition and elicitation. Our approach is different in that we mainly consider the case of autonomous acquisition and maintenance of symbolic world knowledge by autonomous embedded agents, that is, robots. Their knowledge sources differ wildly, including accessible prior knowledge bases provided by humans, and, in particular, the data from physical sensors, such as cameras or range finders. The challenge is to turn these data into symbols on-line on-board the robots so that their reasoning may use all the prior and recent knowledge that is out there.

Typical forms of symbolic reasoning useful for autonomous robots include action planning for optimizing and making more robust their own courses of action, and question answering for providing information in a compact, abstract form for humans and for fellow robots.

Within this long-term perspective, we currently focus on acquiring semantic environment maps autonomously. State-of-the-art robot maps today mainly hold 2D or 3D geometry information that is needed for navigation. We add to that the automatic interpretation of building structures (walls, floor, ceiling etc.) and the segmentation and classification of instances of known, i.e., trained object classes.

Rendering of a 3D point model of a corridor with classified building components. The red-colored structures in the back by the window are correctly classified as a rubber plant and a printer resting on a rack.

ceiling
door
wall
wall
floor



Our main sensor in use is a 3D laser scanner, yielding information about the 3D geometry in the form of a point cloud of selectable resolution. This information needs to be fused with other sensor data, such as camera images or odometry readings. We test our methods and algorithms in challenging environments by participating regularly in international contests of the RoboCup Rescue Real Robot League. Moreover, we consider outdoor environments.

Our current research in ongoing and planned projects comprises the following specific topics:

- Detecting humans in cluttered environments
- Extracting drivable surfaces in cluttered or natural environments
- Mapping changing environments
- Planning for mobile manipulation
- Planning optimal next sensing poses

The Kurt3D robot mapping the Botanical Garden.



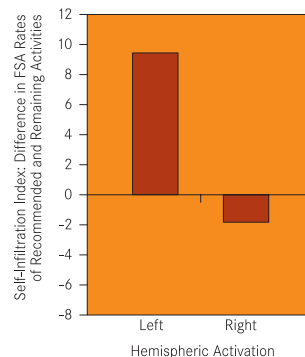
Personality Systems

The Personality Systems Group at Osnabrück is pursuing a functional-design approach to motivation and self-regulation. The interaction between high-level volitional control and low-level cognitive and emotional processing is at the core of our research program. We are interested in the functional profile of an implicit self-representational system, which – according to recent findings in neuro-imaging – seems to be supported by the prefrontal cortex of the right hemisphere.

Specifically, our projects focus on

- the effect that positive vs. negative affect has on different modes of cognitive processing (e.g., holistic vs. analytic, high-level vs. low-level),
- the interaction of conscious and unconscious cognitive processes (using chronometric and psycho-physiological methods, such as EEG, ERP, slow potentials),
- mechanisms of volitional facilitation and inhibition (using a modified version of the Stroop task),
- inhibited self-access and self-infiltration as predictors of alienation and psychosomatic illness,
- incongruence between explicit goals and implicit needs or motives,
- the functional significance of left- vs. right-hemispheric activation for the processing of goal- and need-relevant information,
- explicit and implicit forms of coping with negative affect and stress.

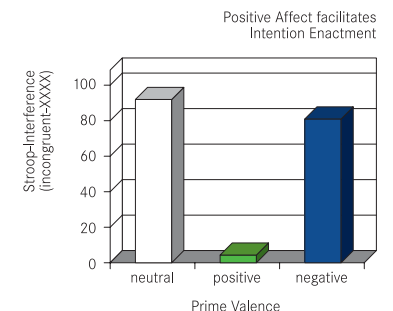
According to our theory of Personality Systems Interactions (PSI theory), access to implicit and holistic self-representations is inhibited when excessive amounts of negative affect cannot be downregulated. This results in an impairment of all top-down executive control processing based on self-access.



In one of our projects, access to implicit self-representations is measured in terms of self-infiltration, which is assessed in terms of false self-ascriptions of external goals or ideas (Kuhl & Kazén, 1994: Journal of Personality and Social Psychology). High amounts of self-infiltration were observed for state-oriented participants, i.e., participants who cannot easily downregulate negative affect or stress, especially when they are exposed to task-alienating conditions or external pressure, or when experiencing negative moods. Under those conditions access to their self-system seems to be impaired, including access to integrated representations of personal preferences.

The second side of Personality Systems Interactions involves the control of action through high-level explicit representations of goals and intentions. According to PSI theory, difficult or complex intentions lead to an abstract, high-level representation in intention memory and inhibitions of the pathway between intention memory and its output system are relaxed by positive affect (see Kuhl & Kazén, Journal of Experimental Psychology: General, 1999). This can be seen for instance in the classic Stroop task, where participants have to name incongruent colours in which colour words are presented (e.g. the word “red” presented in a green font). It was predicted and found that carrying out such difficult intentions would be facilitated when positive affect was aroused just prior to exposure to the task.

Additional experiments show that this effect can help reduce procrastination in everyday life: Participants carry out a greater proportion of their intentions after a pre-treatment that involves alternation between an activation of positive affect, such as anticipating the positive feeling of accomplishment, and focusing on the difficult or unpleasant steps to be performed. We are currently investigating brain activities accompanying volitional facilitation.



The University of Osnabrück

Founded in 1974, this young and modern university is a dynamic centre of study and research in north-western Germany that supports active international exchange and interdisciplinary initiatives. The University, with its open and friendly atmosphere, offers an academic education to 10,600 full-time students and 600 PhD candidates. Students can choose from over 80 degree programmes in the Humanities, Social Sciences, Natural Sciences, Law and Business Studies. With its well-equipped laboratories, workshops, classrooms and libraries, the University offers scientists and students excellent working conditions.

In striving towards internationalising its educational and research activities, the University has introduced internationally recognised degrees. Various modularised programmes, following the Bachelor and Master scheme, are offered, while the European Credit Transfer System (ECTS) is also applied. Furthermore, the university has exchange programmes with more than 200 institutes of higher education and connections to over 500 academic institutions in more than 60 countries.

The University places special emphasis on supporting the development of graduate students. Evidence of this are six graduate colleges and the Cognitive Science und Advanced Materials structured PhD programmes. The University is also home to a number of world-renowned interdisciplinary research groups and to five interdisciplinary institutes for Migration Research, Cognitive Science, Environmental Systems Research, Early Modern Era Research and European Studies.

With its innovative study and research concepts, aimed at promoting international and interdisciplinary co-operation, the University of Osnabrück offers an academic environment that fits the times and that opens up new professional perspectives for its students by preparing them for the job market of the future.



Osnabrück – the City of Peace

www.osnabrueck.de



Lying between the Teutoburger Wald and the Wiehengebirge, in the midst of a landscape of low mountains and extensive deciduous forests, Osnabrück is a modern university city with a population of about 170,000. Being the third-largest city in Lower Saxony, Osnabrück is an important service centre in north-western Germany. Osnabrück's status as a city of the future was reaffirmed when it became the seat of the Federal German Environmental Foundation.

The city also prides itself on its colourful past. Osnabrück is very close to the historic site where in 9 AD Hermann the Cheruscan stopped the Roman Army under Quintilius Varus in the Battle of the Teutoburger Wald. Earliest records of a settlement date back to 780 AD when Charlemagne founded a mission here, which became a diocese in 800 AD. Osnabrück received the privileges of a city from Emperor Barbarossa in 1171.

One of Osnabrück's finest hours came in 1648 when the Peace of Münster and Osnabrück, which ended the Thirty Year's War between Protestants and Catholics, was negotiated here. Until today, Osnabrück holds the title "Friedensstadt" – City of Peace and is still involved in efforts to find peaceful solutions to conflicts. The city is the seat of the German Foundation for Peace Research, and the Osnabrück Peace Dialogues – sponsored by the University of Osnabrück – provide an academic forum for lectures and discussions that examine current political, social and cultural conflicts.



The University and City of Osnabrück also sponsor the Erich Maria Remarque Peace Centre, which does research about the life and work of the Osnabrück-born author, famous for his anti-war novel "All quiet on the Western Front" (1929). Felix Nussbaum, the "painter of the holocaust" who fell himself victim to Nazi terror, is another internationally-known artist who was born in Osnabrück. The Felix-Nussbaum-Haus, designed by the renowned architect Daniel Libeskind, is both a showroom for Nussbaum's paintings and a work of art in its own right.

With its Romanic and Gothic buildings and romantic half-timbered houses, Osnabrück's beautiful old centre also has something to offer for those interested in architecture. Tasteful villas and a number of green parks complete the city's unique urban landscape, which is the backdrop for a buzzing cultural and social scene. In addition to housing numerous museums and theatres, the city presents a variety of cultural festivals and with almost 600 pubs, wine bars, restaurants and cafés, Osnabrück has something for each culinary preference. On the other hand, for those who every now and then like to escape from the hustle and bustle of city life, the surrounding hills and forests offer ample opportunity for relaxing excursions and hikes.



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