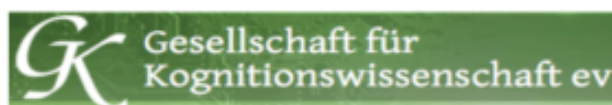


1st GK Doctoral Symposium on Cognitive Science



23-24 JANUARY, 2020.

Tuebingen, Germany



EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN



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Overview

Cognitive science aims at understanding how the mind works. It is an inherently complex topic that requires an interdisciplinary approach. Currently, more than 100 research groups in Germany investigate different aspects of cognition such as memory, learning, language, and event-predictive-encodings.

The German Society for Cognitive Science (Gesellschaft für Kognitionswissenschaft) is funding a yearly meeting for young researchers in cognitive science. The GK Doctoral Symposium invites researchers from all fields connected to cognitive science in order to promote the exchange of knowledge and ideas from different perspectives within the field. It aims at connecting cognitive scientists in Germany and the surrounding area and to promote interdisciplinary collaborations.

The first edition of the GK Doctoral Symposium will be hosted at the University of Tübingen on the 23rd and 24th of January 2020. We will have 24 researchers from 13 different institutions presenting their work on topics such as working memory, consciousness, embedded cognition, computational modelling, neuroscience, and artificial intelligence.

Getting to the venue

The event will be held at the main university building “Neue Aula” room Kleiner Senat / Großer Senat.

From the central train station “Hauptbahnhof”:

- By bus: 10 minutes using bus number 2,3,4,5,6
 - Walking: 20 minutes
-



The Schedule

Day 1: January 23rd

09:00	Registration
09:30	Welcome and opening remarks <i>Francesca Capuano, Gabriela Orellana and Dania Humaidan</i>
09:45	The Experiential Basis of Compatibility Effects in Reading-By-Rotating Paradigms <i>Francesca Capuano</i>
10:00	Psychophysical Color Spaces as Structural Models of Phenomenal Experience <i>Lukas Kob</i>
10:30	The indirect task advantage on low-level sensory input: new insights on unconscious priming <i>Catarina Amado</i>
11:00	Coffee break
11:30	Neural activity in the prefrontal cortex during changes in conscious perception <i>Vishal Kapoor</i>
12:00	What's in a surprise? – Exploring the cognitive determinants of the surprise emotion syndrome <i>Judith Gerten</i>
12:30	Lunch break
14:00	Poster session
15:30	Where do problem spaces come from? On metaphors and representational change <i>Benjamin Angerer</i>
16:00	Do individuals improve in their reasoning performance over time? <i>Hannah Dames</i>
16:30	Reorganizing Spatial Configurations in Visual Working Memory <i>David Timm</i>

The Schedule

Day 2: January 24th

08:30	Morning coffee
09:00	Temporal dynamics of self-association <i>Gabriela Orellana</i>
09:15	Using gated surprise to create and manage event compressions <i>Dania Humaidan</i>
09:30	Embodiment of both spatial concept and spatial exploration affects allocentric spatial representations acquired in a large virtual-reality city <i>Nicolas Kuske</i>
10:00	Identification of Personalised Landmarks <i>Eva Nuhn</i>
10:30	The Navigation-Loop: Human Behavior & Bayesian Framework <i>Charlotte Roy</i>
11:00	Coffee break
11:30	Verbalization of orientation chunks in route instructions <i>Wiebke Schick</i>
12:00	Brain-Computer-Interfaces in Virtual Reality <i>Marius Klug</i>
12:30	Lunch break
14:00	Capacity Limitations of presupposition processing <i>Cosima Schneider</i>
14:30	The Identification of Math and Reading Difficulties in a Multilingual Educational Setting <i>Sophie Martini</i>
15:00	Constraints as Verbal Corrective Feedback - - An Inductive Logic Programming Approach to Generate and Adapt Explanations in Image Classification? <i>Bettina Finzel</i>
15:30	Coffee break
16:00	Heuristics from Resource-Rational Meta-Learning <i>Marcel Binz</i>
16:30	Can Deep Neural Networks Be Good Scientific Models? <i>Hannes Boelsen</i>
17:00	Closing remarks

The abstracts: Talks

Psychophysical Color Spaces as Structural Models of Phenomenal Experience

Lukas Kob

Otto-von-Guericke Universität Magdeburg

Psychophysicists construct color spaces via the measurement of just noticeable color differences along the dimensions of hue, saturation and brightness. This allows for defining colors by their location within the color space, enabling objective standards in research. Such a so called structural definition is very abstract, as it only captures the second-order relational properties of colors. Nevertheless, knowledge about structures is all we can get from science, as proponents of epistemic structural realism in the philosophy of science argue. The first part of the talk will delve into some philosophical and historical issues in constructing color spaces. In the second part, I will argue that psychophysical research is a paradigmatic example for the structuralist's picture of science. This lays the ground for an argument claiming that phenomenal properties pose no special problem to science. The so-called "hard problem" of phenomenal consciousness is a part of deep metaphysical problems belonging to science in general. Fortunately, such metaphysical issues typically do not pose a threat to scientific progress.

The indirect task advantage on low-level sensory input: new insights on unconscious priming

Catarina Armado
University of Tübingen

The unconscious priming phenomenon states that a masked, unconscious, prime stimulus influences the behavioural and neural responses of a subsequent target stimulus, even though participants are close to chance-level when discriminating the prime. We describe this effect as an “indirect task advantage” (ITA), because on one hand there is a good indirect discrimination of the prime (through the priming effect), while on another hand there is a poor direct prime discrimination. Several papers report an ITA on various processes and on stimuli with high and low-level visual properties (Dehaene et al., 1998; Pessiglione et al., 2007; Morris, Öhman, & Dolan, 1998; ten Brinke, Stimson, & Carney, 2014; Schmidt, 2000; 2002; Barbosa & Kouider, 2018). Importantly, Franz & von Luxburg (2015) demonstrated that the predominant statistical rationale used in such studies is flawed and, therefore, can lead to erroneous conclusions. We tested whether an ITA exists for low-level visual stimuli, namely Gabor patches and investigated the role of periphery on the ITA. We used the simple task of discrimination of orientation on Gabor patches on six different experiments, where we manipulated different factors such as masking technique, periphery levels and location factors. Overall, we found no evidence for an ITA.

Neural activity in the prefrontal cortex during changes in conscious perception

Vishal Kapoor

Max Planck Institute for Biological Cybernetics

Higher order theories of consciousness propose prefrontal cortex as a critical node in mediating conscious perception. However, its involvement has been recently debated because of its concomitant role in mediating task related behavior and motor action. Therefore, the use of no-report paradigms has been proposed so as to disambiguate the functional role of prefrontal cortex in mediating task related behavior from that related to visual awareness. To this end, we performed electrophysiological recordings in the ventrolateral prefrontal cortex of monkeys, while they experienced binocular rivalry elicited with oppositely drifting sinusoidal gratings presented to the two eyes. During this paradigm, perception fluctuates between the two sensory signals, thus disentangling the retinal input from subjective experience. Animals passively viewed the stimuli and their optokinetic nystagmus served as an objective indicator of their ongoing percept in this no-report paradigm. We found that visually selective spiking responses in the prefrontal cortex displayed activity changes contingent to animal's perceptual fluctuations. Further, the magnitude of these perceptual modulations was similar to that, when monocular visual stimuli were presented. Our results indicate that the spiking activity in the prefrontal cortex during a no report binocular rivalry paradigm is robustly modulated in concordance with the animal's subjective perception.

What's in a surprise? – Exploring the cognitive determinants of the surprise emotion syndrome

Judith Gerten
University of Cologne

Theories on the constituting factors of surprise diverge and propose both a priori expectations and post-hoc schema integrability to have an important impact. Merging the assumptions of current surprise accounts, we aimed to shed more light on the cognitive determinants of surprise. In two experiments (total N = 1,257) we investigated the influence of the degree of deviance and expectation constraints on the behavioral, affective, experiential, and cognitive surprise components. To induce an expectation with either high, moderate, or low constraints, participants were told that they would see ten stimuli of a certain type on the screen. Orthogonally to that, we manipulated the degree of deviance of the last stimulus and presented a stimulus that deviated to either no, a medium, or a high degree from the one expected due to the instructions. We measured behavioral response delay and explicit ratings of liking, surprise, and expectancy. Our findings point towards an only low association between the single components and dichotomous response patterns that are sensitive to deviance and non-deviance of an event, but not to different degrees of deviance. The current results further suggest a continual cognitive “fine-tuning” of expectations.

Where do problem spaces come from? On metaphors and representational change

Benjamin Argerer

Institute of Cognitive Science, University of Osnabrück

The challenges of problem solving often lie not only in how to perform heuristic search, but they begin with how to understand a given task: How to cognitively represent the task domain, its components, and the (sub-)goals an agent tries to achieve can determine how quickly progress towards a solution is being made, or sometimes whether the problem can be solved at all.

By allowing the transfer of knowledge from an unrelated source domain, and amending or even completely re-representing an unfamiliar domain, metaphors can play an important role in solving complex problems. In a series of exploratory case studies, it was investigated how pairs of subjects employ spontaneously generated metaphors when working on an unfamiliar spatial transformation and problem-solving task in the domain of iterated mental paper folding.

In this talk, I will discuss hypothetical extensions made to the theories of problem solving and metaphor production based on the results of case studies. These will mainly focus on (a) heuristic influences on the iterative retrieval of potential source domains, (b) the positive role of flawed metaphors, and (c) the consequential weakening of the notion of static and encapsulated problem spaces.

Do individuals improve in their reasoning performance over time?

Hannah Dames

University of Freiburg, Cognitive Computation Lab

Does an individual's ability to reason logically improve over time? Although this question has been addressed in developmental studies with samples consisting of children or seniors, barely any study has investigated how participants' reasoning performance changes in healthy adults when retaking a syllogistic reasoning test. This study thus examined how the reasoning performance of 74 participants changed over two sessions. Simultaneously, influences of diverse cognitive ability and personality factors were accounted for. There are two main findings: First, participants demonstrated a significant yet very small retest effect. Second, the strength of this retest effect was associated with individual characteristics: While we found ceiling effects in the improvement of reasoning performance for participants with high Need for Cognition as well as fluid intelligence scores, a higher spatial working memory capacity was related with an increased retest effect. These influences differ not only between individuals but also types of syllogisms (e.g., most of the above-mentioned associations were found for valid but not invalid syllogisms) in a complex manner. The study thereby highlights the importance of considering the causes for such individual differences in the retest effect within cognitive models of reasoning.

Reorganizing Spatial Configurations in Visual Working Memory

David Timm

University of Tübingen

Humans process single objects in relation to other simultaneously maintained objects in visual working memory – a spatial configuration. Are humans able to reorganize a global spatial configuration into a relevant partial configuration? We present three experiments investigating this process. Participants encoded objects' locations and performed a change detection task for one object probed at retrieval. This object was displaced in half of the trials. We cued the side of the object probed during maintenance (retro cue), allowing for the reorganization of spatial configurations in visual working memory. At retrieval, either all objects, cued objects only, non-cued objects only or a single object were shown. Furthermore, we investigated the use of the cue and configurations themselves as well as the influence of eye movements. We observed a reliable reorganization when using a retro cue but also found some boundary conditions such as eye movements. Our findings provide evidence for a memory-based reorganization of spatial configurations

Embodiment of both spatial concept and spatial exploration affects allocentric spatial representations acquired in a large virtual-reality city

Nicolas Kuske

Institute of Cognitive Science at Osnabrück University

Recent research highlights the importance of embodied action for cognition. However, navigating large environments relies on knowledge about spatial relations among objects which are not part of the body. Thus, spatial reasoning involving representations of these allocentric relations seems disembodied. To confront this discrepancy, we set up a virtual-reality (VR) city containing 214 houses. Participants explore this city in one of three embodiment conditions: in VR, studying a map of the city, or exploring it in VR while wearing a belt that indicates north. In each of the three experiments, participants explore the city on multiple days. We found that accuracy when judging alignment of housefront and north rises with consecutive experimental sessions, while judging relative house orientations remains constant. Exploration with belt lowers accuracy when aligning houses to north. These findings suggest a difference in allocentric encoding of house orientation and cardinal direction due to different actions associated with the two spatial concepts. Furthermore, pointing from house to house is more accurate after VR training than after map training, relative to the other two tasks. Thus, all three embodiment conditions lead to different spatial representations. We conclude that spatial reasoning does rely on cognitive structures grounded in bodily action.

Identification of Personalized Landmarks

Eva Nuhn

Geoinformatics Group Augsburg

There are a number of studies claiming that personal dimensions influence the identification of landmarks. However, the data collection effort for personal dimensions is high. Therefore, we need to make sure that this effort is justified in relation to the benefits that are achieved through the provision of personalized landmarks. In this work, we investigate the personal dimensions personal interests and prior spatial knowledge keeping in mind that there might be other additional dimensions. We personalize existing models and focus on the weighted sum model, the weighted product model, a decision flow chart, and a decision tree model. We train and implement both, a conventional, non-personalized version and a personalized version of these models. Subsequently, we use the models to identify landmarks selected by participants of a study. The comparison of the results of the models shows that the personalized models do not identify significantly more landmarks than the conventional, non-personalized models. This might be a hint, that the effort to collect data for personal dimensions might not be justified. Thus, it is most likely sufficient to concentrate on the use of existing conventional, non-personalized models in applied pedestrian wayfinding applications.

The Navigation-Loop: Human Behavior & Bayesian Framework

Charlotte Roy

Ulm University

“Humans and other mobile animals move about their environments in order to get to places with food, mates, shelters, margaritas and other resources” (Montello, 2005). This definition explains simply why we navigate every day and how crucial this ability is for humans. Navigation is a fascinating subject of research because it concerns everyone, every day, and it involves research across many scientific disciplines, from psychology and neuroscience to robotics, as well as industrial applications.

The main goal of our research is to gain a better understanding of human navigation in its natural habitat on both the empirical and the modeling levels. We aim to provide a general modeling framework to explain how humans navigate in the world. At a local scale, we investigate how the combination of external and internal sensory information can be viewed as an instance of optimal behavior. At a medium scale, we investigate how the combination of online information and prior knowledge help us to orientate ourselves. And finally, at a larger scale, we strive to investigate how the topography of the world influences the possibilities of locomotion. Our researches deepen our theoretical understanding of human navigation through a unique modelling framework.

Verbalization of orientation chunks in route instructions

Wiebke Schick

Institute for Geoinformatics, University of Münster

Navigation assistance devices often render information as turn-by-turn-instruction, which is problematic both for the acquisition of spatial knowledge and the maintenance of orientation – the knowledge about the environment and one’s own position in it. Our approach “Way to Orientation” aims at providing instructions that support both. Due to the limited capacities of human working memory, the cognitive load has to be considered in the selection of the information that is presented. Abstraction and chunking are ways to reduce the cognitive load. During verbalization, the spatial information, which is two- or three-dimensional, is put into a linear sequence, which is a process of abstraction. The chunking requires further abstraction by identifying the shared features of the chunked elements. The mental spatial representation of the environment derived from the verbal instruction differs from the view of the environment, as due to the abstraction processes, not all details are communicated. In my talk, I’ll introduce our work on how this is can be done verbally in route instructions. I’ll identify those elements apart from landmarks that can provide orientation information, and I’ll show how orientation chunks can be verbalized

Brain-Computer-Interfaces in Virtual Reality

Marius Klug

TU Berlin

Mobile Brain/Body Imaging (MoBI, e.g. Gramann et al., 2011) is an integrative multi-method approach to investigate human brain activity, motor behavior, and other physiological data associated with cognitive processes that involve active behavior. Brain-Computer-Interfaces (BCI), especially passive BCIs (pBCI, e.g. Zander and Kothe, 2011) provide input for cognitive monitoring or neuroadaptive technology for healthy users. Virtual Reality (VR) is a powerful tool to create controlled and modifiable experimental environments that nevertheless support ecologically valid behavior and accompanying natural cognition. The talk will first introduce each concept and subsequently discuss overlaps and complementary opportunities when combining the three to obtain a complete VR-BCI system. An exemplary experiment for investigating the Neuroergonomics of Situational Awareness, as well as a pilot experiment using a VR-BCI system as a modification of the popular game "Skyrim VR" will be shown.

Capacity Limitations of presupposition processing

Cosima Schneider

Department of Psychology - Group: Cognition and Action

Definite determiners trigger existence- and uniqueness- presuppositions, that is, the speaker assumes that it is taken for granted that there exists exactly one of the mentioned objects in the relevant discourse. Indefinite determiners are associated with anti-uniqueness, that is, that there are several of the mentioned object. Applying the Maximize Presupposition principle, this additional meaning component arises as an anti-presupposition and involves first considering the definite determiner's uniqueness-presupposition and then negate it. We here investigate processing of the two determiners in more detail and ask whether this processing is automatic or requires limited central capacities. We employed the Psychological Refractory Period approach and the locus of slack-logic and combined a tone discrimination with a sentence evaluation task. We observed more difficult processing for the indefinite compared to the definite determiner as would be expected if the anti-uniqueness inference arises from a negation of the uniqueness-presupposition of the definite determiner. Further, the data revealed more difficult processing with infelicitous compared to felicitous sentences. The whole pattern is in line with the idea of immediate but capacity-limited processing of presuppositions. These results support the Maximize Processing principle and are an important step forward toward understanding cognitive processing in presupposition processing.

The Identification of Math and Reading Difficulties in a Multilingual Educational Setting

Sophie Martini

University of Luxembourg

Little research has investigated the impact of instruction language proficiency and home language on the identification of math (MD) and/or reading difficulties (RD). Diagnostic tests or assessments are mostly carried out in the instruction language. Currently, there is no consensus on cut-offs for identifying learning difficulties for multilingual populations. As the number of students who do not speak the instruction language at home is growing, adequate identification of difficulties in these students is paramount. In Luxembourg, students acquire literacy in German from grade one onwards, but most pupils speak other languages at home, e.g. Luxembourgish, French, Portuguese or a South Slavic language. Using population data from national standardised tests, we investigate the impact of three different ways of setting cut-offs to identify MD and/or RD in relation to third graders' (N = 5111) characteristics (non-verbal IQ, home language, SES, and gender). First results show that depending on the cut-off used, home language and SES play an important yet different role in the identification of MD and/or RD. However, the choice of the cut-off impacts the identification and therefore potentially subsequent intervention. The implications of the different cut-offs are discussed (e.g. over or under-representation of different home language groups).

Constraints as Verbal Corrective Feedback - - An Inductive Logic Programming Approach to Generate and Adapt Explanations in Image Classification

Bettina Finzel

Cognitive Systems, University of Bamberg

Interpretable machine learning (ML) models, like Inductive Logic Programming (ILP), produce comprehensible output, which can be directly analysed by human experts. However, sometimes the reasons why given examples were assigned by a classifier with a particular label are not correct. One cause may be noisy data. We present a solution that allows experts to correct faulty explanations produced by a classifier. We implemented a template-based constraint generation approach on top of an inverse entailment algorithm to integrate corrective feedback into the process of explanation. In this talk, we first introduce the foundations of inverse entailment. We explain how ILP is applied to generate and adapt global (model-level) and local (example-level) verbal explanations for classification tasks. Second, we present use cases taken from our current research project Transparent Medical Expert Companion and show how verbal feedback can be integrated into the process of medical image classification. Our results show that global and local explanations can be successfully adapted through constraint-based corrections if certain conditions are met. We illustrate that our approach can identify and explain noise. Finally, we discuss new opportunities for model re-training and transparent ML that emerge by state-of-the-art efforts to integrating ILP and interaction into Deep Learning-based classification.

Heuristics from Resource-Rational Meta-Learning

Marcel Binz

Philipps-University Marburg

Individuals often rely on simple heuristics when making complex decisions. The origins of such heuristics are still under dispute, with major theories arguing for their computational efficiency and their effectiveness in naturalistic situations. In this work we investigate the conditions under which heuristics emerge in artificial learning systems. We train deep neural networks using standard meta-learning techniques, so that they can solve new learning tasks from just a few samples. We find, that the characteristics of discovered strategies crucially depend on both the resource limitations of the learning system as well as on the distribution of tasks it has to solve. In addition to the emergence of strategies resembling heuristics, our method provides a natural mechanism for explaining why a specific strategy should be preferred over another.

Can Deep Neural Networks Be Good Scientific Models?

Hannes Boelsen

Otto von Guericke University Magdeburg

Over the past few years, deep learning (DL) has become one of the most promising approaches to artificial intelligence (AI). This machine learning method allows deep neural networks (DNNs) to learn representations of data with multiple levels of abstraction. DL thus enables DNNs to efficiently capture very complex functions, which leads to an impressively versatile AI performance, ranging from image recognition to mastering the game of GO. Considering that, it is surprising that DNNs have received only little attention from philosophers so far. This talk wants to change the status quo by setting the ground for answering the question whether DNNs in the brain/cognitive sciences can be good scientific models (and if so, under what conditions). More specifically, it is argued that the interpretability of DNNs is a necessary condition for answering this question. Why is that so? First, models are often seen as interpreted structures. Second, DNNs are frequently described as black boxes, which (to some extent) lack interpretability. Consequently, some DNNs cannot be regarded as models at all and thus cannot be assessed as such. It is then argued that recently developed analytical techniques in explainable AI (e.g., diagnostic classification, feature-detector identification, input heatmapping) can aid these shortcomings.

The abstracts: Posters

Monoaural and Binaural Sound Source Localization in the Median Plane

Timo Oess

Universität Ulm

To localize the vertical elevation of a sound source, the auditory system compares the spectrum of a perceived sound with a previously learned map of elevation spectra. Whether this process is separately initiated for the signal of the left and right ear, respectively, or if it is already binaural at the stage of map formation is yet unresolved. We present a model of localizing the sound source elevation. CIPIC database HRTFs are used to generate a binaural data set of various sound types and elevations. Based on such data an averaged map of sound spectra is constructed by filtering and integrating the binaural input signals. Monoaural and binaural input signals can then be localized by searching for the elevation with maximum correlation between input and map. Experiments with binaural inputs show that our model accurately localizes sound types of different spectra. In the case of monoaural signals the localization fails for unfamiliar inputs. However, if a priori information of a sound type specific spectral mean augments the monoaural signals, localization performance is restored. We suggest that vertical sound source localization is fundamentally binaural but can cope with monoaural inputs if sound model information generated from previous perceptions is added.

Effects of number priming on task performance: No evidence for preserved unconscious processing

Iris Zerweck

University of Tübingen

It is often argued that humans can discriminate stimuli outside consciousness. In a typical paradigm, participants classify a masked 'prime'-stimulus in a 'direct' task. Thereby, they perform close to chance, suggesting no conscious awareness of the prime. In an 'indirect' task, participants discriminate a 'target' stimulus following the prime. Here, the prime has congruency effects on reaction times (participants are faster if prime and target belong to the same category). This is seen as evidence for better discrimination in the indirect task and preserved unconscious processing. However, this reasoning is only correct if the congruency effect is converted to an appropriate discrimination performance (Franz & Luxburg, Psychological Science, 2015). Because this is rarely done, the literature on priming effects needs reconsideration. We performed three studies replicating and extending well established effects. In all three studies we found a congruency effect of 11 ms ($p < 0.001$) in the indirect task, replicating the literature. However, the discrimination performance in the indirect task did not exceed the direct task performance in neither case. Our results indicate that, contrary to previous assumptions, there is no preserved unconscious processing of the numerical value of digits in cases where conscious discrimination is close to chance.

Assessment of Social Understanding in Adolescents: Introducing the EmpaToM-Y

Christina Breil

Julius-Maximilians-Universität Würzburg

Empathy and Theory of Mind (ToM) are two core components of social understanding. The EmpaToM (Kanske et al., 2015) is a validated social video task that allows for independent manipulation of the two capacities in adults. First applications revealed that empathy and ToM are clearly dissociable constructs on a neuronal as well as on a behavioral level. As the EmpaToM has been designed for the assessment of social understanding in adults, it has a high degree of complexity and comprises issues that are inadequate for minors. Here, we present a new version of the EmpaToM that is especially suited to measure empathy and ToM in youths. We validated the EmpaToM-Y on the original EmpaToM in an adult sample (N = 62), revealing less difficulty of the new version while maintaining high correlations of empathic responding and ToM performance between the two paradigms. Thus, the EmpaToM-Y may be an appropriate instrument to assess social understanding in adolescent samples.

The influence of visual and haptic cues of object density on digit placement

Sina Mehraeen
University of Ulm

Previous research has shown that when the individuals lift objects made out of a single material, with a homogeneous density distribution, they tend to grasp it near or at the center of mass to minimize torque; this exemplifies the role of vision in digit placement. To better understand the roles of vision and touch when manipulating objects with an asymmetric density distribution, we asked participants to lift cylinders made of varying combinations of PVC and metal piping. These combinations were designed in such a way that the center of mass would shift in gradual steps away from the center of the object, while providing visual cues of how the density is distributed. In experiment 1, the metal piping had a higher density than that of the PVC. We found that participants were able to identify the center of mass quite easily and therefore, perceptual learning did not occur. In experiment 2, we manipulated the objects by inverting the densities so as to force perceptual learning. Our findings demonstrate differences in spatial modulation dependent on visual and haptic cues of material properties.

Semi-Supervised Categorisation: The Need for Feedback is Determined by Input Representations

Franziska Broeker

MPI for Biological Cybernetics

Behaving systematically towards different classes of input is fundamental to a successful interaction with the world and acquired through the learning of categories. Semi-supervised categorisation is concerned with contexts where explicit feedback on the target response is only partially available. Many natural learning problems that humans encounter are more accurately reflected by this than either supervised or unsupervised conditions alone. Despite its relevance, research on the topic is surprisingly sparse and inconclusive. We present a behavioural experiment aiming to explain the source of incoherence across experiments. We hypothesise that the a priori match between task and mental representations of the inputs determines whether feedback is necessary to acquire a novel categorization and compare psychological and machine learning models against the data.

More than nothing: Neuronal correlates of numerosity zero in the avian endbrain

Maximilian Kirschhock

Animal Physiology, Institute for Neurobiology, University of
Tübingen

Numerical competence is ubiquitous across the animal kingdom, yet, few species seem to possess a quantitative understanding of empty sets. Besides, neurophysiological investigations thereof have only been conducted in nonhuman primates. Carrion crows (*Corvus corone*) exhibit numerical abilities comparable to higher primates despite lacking a layered neocortex. Instead, the avian endbrain area nidopallium caudolaterale (NCL) was repeatedly shown to be implicated in numerical cognition. We asked whether carrion crows would treat empty sets as having null value and, if so, how the NCL gives rise to this behaviour. To this end, we trained two crows on a delayed match-to-numerosity task with numerosities 0-4. Along with high task performance, the behaviour of the crows indicates handling of empty sets as part of the numerical continuum. Electrophysiological recordings revealed that empty set preferring single units are the most abundant class of numerosity-tuned neurons in the NCL, with both, categorical and numerical response profiles. On a population level, numerosities are encoded in a behaviourally relevant manner. These results mark the first account of neuronal correlates of numerosity zero outside the mammalian taxon. They thus underline the central role of the avian NCL not only in numerical cognition, but also cognition in general.

A Theoretical Perspective on the Allocation of Processing Resources in the Visual System

Sascha Meyen
University of Tübingen

Visual processing in artificial systems requires optimal allocation of limited resources. Much work has been done to achieve good classification performance when identifying an object from multiple images. However, in these classification tasks, there is a lack of fundamental theoretical consideration regarding the optimal allocation of limited resources. How can limited processing resources to individual images be allocated such that the overall classification is optimal? To approach this topic, we consider the framework of confidence weighted majority voting (CWMV). In this framework, a system classifies each individual image with only a limited amount of processing resources. Specifically, we assume a limitation on Shannon's information measure because this measure reflects a naturally occurring constraint. We derive optimal confidence distributions under such information theoretic constraints that correspond to a theoretically optimal way for allocating limited processing resources. These results (a) provide direction to the construction of artificial visual systems; (b) raise the question whether the visual systems in animals follow such optimal distributions and therefore give specific hypothesis to test for in future research; and (c) generalize to any system that can be modeled as CWMV, for example expert group discussions in medical diagnostics.

About GK

The German Society for Cognitive Science (GK) was founded in 1994 with the goal to support the scientific progress in Cognitive Science research and to create an over-arching institutional frame for cooperation between the participating disciplines. Within this frame, synergy effects between the different scientific approaches towards the same phenomena shall be advanced effectively. It is thereby the aspiration of GK to further Cognitive Science comprehensively, from academic teaching to research projects to the identification of its benefits for practical use and job prospects.

Contact Us

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If you are interested in hosting the Doctoral Symposium in 2021 please contact:

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