NEUROCOG 2016
How methods shape the brain of cognitive neuroscientists

November 28th-29th, 2016

Leuven

Practical Information

Location
The Leuven Institute for Ireland in Europe (Irish College - Iers College)
Janseniusstraat 1, 3000 Leuven, België.

Social dinner
The conference dinner on Monday November 28 will be held at the Faculty Club. The dinner has an additional charge of 70€ per person. The Faculty Club is located in the restored Grand Beguinage of Leuven, which has been recognized as UNESCO world heritage (http://www.facultyclub.be/en/). It is located within walking distance of the conference venue and hotels.

For further information
https://ppw.kuleuven.be/home/english/research/neurocog

Keynote talks
Each talk is 45 minutes followed by 15 minutes of discussion.

Oral presentations
Each talk is 15 minutes followed by 5 minutes of discussion. To test the presentation, arrive at the conference auditorium at least 20 minutes before the start of your session. Presentations can be made from your Mac or PC laptop.

Poster sessions
The size of your poster should be A0 (84.1cm by 118.9cm) in portrait orientation. Each poster should stay on the all day.

Each abstract is assigned a 3 digit number (e.g., 1.12). The first digit is the poster session number. The digits after the period indicate the board number. Numbers can be found on the board.

Poster session 1: Monday, 28th November, 13:15-14:45
Poster session 2: Tuesday, 29th November, 13:00-14:30

Neurocog 2016 Awards
1) **Poster award.** Two posters (one on each day) will be awarded by the Neurocog jury.
2) **Audience award**. An award to the most inspiring contribution (oral presentations and posters, excluding keynotes) will be voted by the audience.

Organising committee
- Hans Op de Beeck, KU Leuven
- Cees Van Leeuwen, KU Leuven
- Stefania Bracci, KU Leuven
- Valérie Goffaux, Université Catholique de Louvain-La-Neuve
- Eva Van den Bussche, Vrije Universiteit Brussel
- Felipe Pegado, KU Leuven

Programme

Monday, November 28th
9:15-9:45   Registration and coffee
9:45-10:00   Welcome
10:00-11:00   **Olivier Collignon:** Building the brain in the dark.
11:00-11:15   Coffee break
11:15-12:15   **Birte Forstmann:** Towards a mechanistic understanding of the human subcortex.
12:15-13:15   Lunch
13:15-14:45   **Poster session 1**
14:45-16:45   **Oral presentations:**

Jacques Jonas: Beyond the face network defined in fMRI: intracerebral stimulation of the anterior fusiform gyrus elicits transient inability to recognize faces.

Max C. Keuken: Effects of aging on T_1, T_{2*}, and QSM values in the subcortex using 7T MRI.

Mohamed Rezk: The impact of blindness onset on the connectivity profile of the occipital cortex.

Chie Nakatani: Cross-frequency coupling: implications and applications in cognitive neuroscience.

David Wisniewski: Using MVPA to identify the functional organization of the cognitive control network.

Milena Dzhelyova: Automatic categorization of brief changes of facial expression with fast periodic visual stimulation in EEG.

16:45-17:00   Coffee break
17:00-18:00   **Samuel Nastase & Jim Haxby:** Constructing a representational atlas for human cerebral cortex**.**
19:00   Conference dinner

Tuesday, November 29th
9:00-9:30   Coffee
9:30-10:30   **Sam Schwarzkopf:** Measuring perceptual experience and its neural signature.
10:30-11:00   Coffee break
11:00-12:00   **Radoslaw Cichy:** Gaining a spatio-temporally resolved and algorithmically explicit account of visual cognition through method integration.
12:00-13:00   Lunch
13:00-14:30   **Poster session 2**
14:30-15:30   **Oral presentations**

Massimo Silvetti: Meta-learning foundations of cognitive control: A neuro-computational model.

Marjolein Verly: Widespread functional underconnectivity of the language network in children with developmental dysphasia.

Henryk Bukowski: Coordinates-based meta-analyses of neuroimaging studies: A critical overview.

15:30-16:00   Coffee break
16:00-17:00   **Philippe Schyns:** Brain algorithmics: reverse engineering dynamic information processing in brain networks from EEG/MEG time series.
17:00-17:30   Neurocog 2016 Awards and concluding remarks.

Keynotes Lectures

Monday, November 28th

10:00-11:00 – Chair: Stefania Bracci

Building the brain in the dark
Olivier Collignon

1. Institute of Psychology (IPSY) and Institute of Neuroscience (IONS), University of Louvain-la- Neuve, Belgium; 2. Center for Mind/Brain Sciences (CIMEC), University of Trento, Italy.

How does sensory experience shapes the development of the brain? Since the dawn of neuroscience, the study of the consequences of sensory deprivation has served as one of the most compelling model system to address such fundamental question. Recent researches involving early blind or deaf individuals have shed new lights on the old 'nature versus nurture' debate regarding brain development: whereas the recruitment of the deprived regions by ectopic inputs highlights how experience shapes brain development (nurture's influence), the observation of specialized functional units in these deprived regions, similar to those observed in hearing and seeing people, highlights the intrinsic constraints imposed to such crossmodal plasticity (nature's influence). I will illustrate how, by using a plurality of methods (psychophysic, EEG/MEG, stereotactic-EEG, TMS, fMRI) and analyses (eg, multivariate, RSA, functional and effective connectivity), we aim to rely on the respective advantages of each of them to progressively build a comprehensive understanding of how the brain develops and (re)organize after sensory deprivation.

11:15-12:15 – Chair: Cees van Leeuwen

Towards a mechanistic understanding of the human subcortex.
Birte Forstmann

1. Amsterdam Brain and Cognition Center, University of Amsterdam, The Netherland; 2. Institute for Neuroscience, an Institute of the Royal Netherlands Academy of Arts and Sciences, Amsterdam, The Netherland; 3. Cognitive Psychology Unit, Institute of Psychology and Leiden Institute for Brain and Cognition, Leiden University, The Netherland.

Today only seven percent of the subcortical structures listed by the Federative Community on Anatomical Terminology (FCAT, 1998) are depicted in available standard MRI-atlases (Alkemade, Keuken, & Forstmann, 2013). As a consequence, the remaining 423 subcortical structures cannot be studied using automated analysis protocols available for MRI and therefore require trained anatomists for the study of subcortical brain areas: The human subcortex is notoriously difficult to visualize and analyze with functional magnetic resonance imaging. In this talk, exciting technical advances are presented that allow charting terra incognita; the human subcortex. Closing the knowledge-gap of the human subcortex has already resulted in the re-evaluation of prominent models in the cognitive neurosciences such as the functional role of cortico-basal ganglia loops in decision-making. I will discuss the emerging possibilities of novel human neuroanatomical approaches and directions for the incorporation of these data within the field of model-based cognitive neuroscience.

17:00-18:00 – Chair: Hans Op de Beeck

Constructing a representational atlas for human cerebral cortex.
Samuel Nastase & Jim Haxby

Department of Psychological and Brain Sciences, Dartmouth College, Hanover, NH, USA

Human cerebral cortex encodes rich perceptual and semantic information in high-dimensional neural representational spaces. However, fine-grained functional topographies vary across individual brains. We describe several critical steps toward constructing a representational atlas for human cerebral cortex. A representational atlas characterizes cortical fields in terms of what information they explicitly encode—i.e., their representational geometry. Correspondingly, a representational template can be constructed by registering individual brains according to local representational geometry rather than anatomy. Current data-driven approaches, collectively called hyperalignment, rotate neural representational spaces into a common template space that preserves fine-grained representational content and circumvents the idiosyncratic functional topographies of individual brains. These approaches use either time-locked responses to dynamic, naturalistic stimuli or inter-voxel correlations to register neural representational spaces. Importantly, naturalistic audiovisual paradigms increase ecological validity, more fully sample neural representational spaces, and can reveal neural representations that are obscured by reliance on static, controlled stimuli. A representational atlas must also accommodate how varying behavioral goals alter neural responses. We demonstrate that attentional allocation reshapes distributed response patterns to make task-relevant representations more discriminable. Ultimately, a representational atlas provides a mapping between the representational spaces of individual brains, and can provide a basis for characterizing individual differences and predicting neural responses in novel individuals.

Tuesday, November 29th

9:30-10:30 – Chair: Felipe Pegado

Measuring perceptual experience and its neural signature

Sam Schwarzkopf

UCL Experimental Psychology, UCL Institute of Cognitive Neuroscience, United Kingdom

Perceptual experience is by definition subjective. Studying it experimentally is therefore fraught with challenges. My talk will discuss two streams of research in my lab in which we seek to improve the methods with which we can infer what a person perceives and better understand how subjective experience arises in the human brain. Many traditional methods for estimating perceptual biases or illusions are confounded by cognitive factors influencing the observer's decisions. Moreover, these methods typically require substantial data collection and testing single stimuli at a time. To address these issues, we developed the Multiple Alternatives Perceptual Search (MAPS) procedure that allows us to measure perceptual biases and sensitivities simultaneously at several locations in the visual field. We investigated to what extent selective attention, decision-making biases, and feedback affect these measurements. Further, I will discuss ways in which similar methods could be employed to address questions on more complex perception. In the second half of my talk I will present neuroimaging studies using voxel encoding models that allow us to make inferences about the neural signature of subjective perception. I will demonstrate how we can use these methods to better understand the representation of bistable stimuli in visual cortex. This approach also has the potential to address confounds with behavioral measures of perception.

11:00-12:00 – Chair: Hans Op de Beeck

Gaining a spatio-temporally resolved and algorithmically explicit account of visual cognition through method integration

Radoslaw Cichy

Center of Cognitive Neuroscience, Berlin University, Germany

Understanding visual cognition in the brain requires answering three questions: what is happening where and when in the human brain when we see? In this talk I will present recent work that addresses these questions by integrating magnetoencephalography (MEG), functional magnetic resonance imaging (fMRI) and deep neural networks (DNNs) in a common framework. The talk has three parts. In the first part, I will show how fMRI and MEG can be combined using multivariate analysis techniques (multivariate analysis plus representational similarity analysis) to yield a spatio-temporally integrated view of human brain activity during object vision (Cichy et al., 2014 NatNeuro). In the second part I will show how DNNs can be used to understand the human visual system. In one study, we showed that DNNs predicted the spatial-temporal hierarchy of the human visual system. In another study, we showed that representations of abstract visual properties, such as scene size, find an analogue in DNNs. In the third part I will discuss current and future developments, and discuss potential pitfalls and limitations of the approach.

16:00-17:00 – Chair: Cees van Leeuwen

Brain algorithmics: reverse engineering dynamic information processing in brain networks from EEG/MEG time series

Philippe Schyns

Institute of Neuroscience and Psychology, Glasgow University, United Kingdom

The ultimate goal of cognitive neuroscience is to understand the brain as an organ of information processing. This will remain difficult unless we understand more directly what information the brain processes when it categorizes the external world. For example, our brain can extract from a face-- a powerful social communication tool --information to categorize identity, age, gender, ethnicity, emotion, personality and even health. Though our brain knows what information to use for each task, as information receivers we typically do not have direct access to this knowledge. The current state of cognitive neuroscience is similar – we aim to understand the brain as an information processor, but we do not know what stimulus information it processes. Using face categorisations, I will present a framework and recent examples that started to address this fundamental problem. We start by first isolating what specific information underlies a given face categorization, and then we examine where, when and how the brain networks process this information.

Oral Presentations

Monday, November 28th – Chair: Felipe Pegado

14:45-15:05: Beyond the face network defined in fMRI: intracerebral stimulation of the anterior fusiform gyrus elicits transient inability to recognize faces

Jonas, Jacques[1,2,3], Rossion, Bruno[3], Brissart, Hélène[2], Hossu, Gabriela[4], Colnat-Coulbois, Sophie[5], Maillard, Louis[2,3]

1. Université Catholique de Louvain, Louvain-La-Neuve, Belgique; 2. Service de Neurologie, CHU de Nancy, France; 3. UMR 7039, CNRS, Université de Lorraine, Nancy, France; 4. CIC-IT, CHU de Nancy, France; 5. Service de Neurochirurgie, CHU de Nancy, France.

According to neuropsychological evidence, a distributed network of regions of the ventral visual pathway – from the lateral occipital cortex to the temporal pole – supports face recognition. However, functional magnetic resonance imaging (fMRI) studies have generally confined ventral face-selective areas to the posterior section of the occipito-temporal cortex, i.e. the inferior occipital gyrus ("occipital face area", OFA) and the posterior and middle fusiform gyrus ("fusiform face area", FFA). There is recent evidence that intracranial electrical stimulation of these areas in the right hemisphere elicits face matching and recognition impairments (i.e., prosopagnosia) as well as perceptual face distortions. Here we report a case of transient inability to recognize faces following electrical stimulation of the right anterior fusiform gyrus, in a region located anteriorly to the FFA. There was no perceptual face distortion reported during stimulation. This stimulated region was shown face-selective as revealed by intracerebral face-selective event-related potentials and gamma band activity recorded at these critical electrodes. However, no fMRI face-selective responses were found in this region due to severe BOLD signal drop-out caused by the ear canal artefact (as in previous studies). These results point to a causal role in face recognition of the right anterior fusiform gyrus and more generally of face-selective areas located beyond the "core" face processing network in the right ventral temporal cortex. It also illustrates the diagnostic value of intracerebral electrophysiological recordings and stimulation in understanding the neural basis of face recognition and visual recognition in general.

15:05-15:25: Effects of aging on T_1, T_2*, and QSM values in the subcortex using 7T MRI

Keuken, M.C.[1], Schafer, A.[2], Backhouse, K.[1], Beekhuizen, S.[1], Himmer, L.[1], Kandola, A.[1], Lafeber, J.[1], Prochazkova, L.[1], Trutti, A.[1], Turner, R.[1,2], Forstmann, B.U.[1,2], Bazin, P-L.[2]

1. Amsterdam Brain & Cognition Center, University of Amsterdam, Amsterdam, Netherlands; 2. Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany.

Ultra-high field 7T MRI has made significant contributions over the last years in understanding the relationship between structure and function of the human brain. It allows the visualization of small subcortical structures with different tissue properties with tailored MRI sequences. However, the impact of structural changes associated with healthy aging on the visibility of such small subcortical structures remains largely unknown. In the present study, ultra-high field 7T MRI was used to segment the striatum, globus pallidus internal and external, subthalamic nucleus, substantia nigra, red nucleus, periaqueductal grey, as well as the lateral ventricles, 3 th ventricle, aqueduct, and 4 th ventricle in young (n: 30, mean age: 23.8, SD: 2.3), middle aged (n: 14, mean age: 52.5, SD: 6.6), and elderly healthy participants (n: 10, mean age: 69.6, SD: 4.6). The individual masks were used to extract the volume of the structure and the T_1, T_2*, and quantitative susceptibility map (QSM) values. The volumetric measures generally showed a significant decrease with age in grey matter volume and an increase in ventricle volume. The T1 values generally increased with age, likely reflecting a decrease in myelination, whereas the T2* and QSM values showed a more variable pattern reflecting the effect of increased iron deposition. In sum, the results of the present study indicate that structural changes in the subcortex associated with healthy aging influence the T_1, T_2*, and QSM values differently, which may have an impact on structural delineations and volumetry. To characterise each subcortical structure better, it may be helpful to integrate multiple MR contrasts.

15:25-15:45: The impact of blindness onset on the connectivity profile of the occipital cortex.

Rezk, Mohamed[1], Pelland, Maxime[2], Atilgan, Hicret[3], & Collignon, Olivier[1,3]

1. Institut de recherche en sciences psychologiques (IPSY), Universite catholique de Louvain (UCL), Louvain-la-Neuve, Belgium; 2. Centre de Recherche en Neuropsychologie et Cognition (CERNEC), Université de Montréal, Montréal, Canada; 3. Center for Mind/Brain Sciences (CiMeC), University of Trento, Italy.

Resting state functional connectivity (rs-FC) has been widely used to investigate the functional (re)organization of the "visual" cortex in blind people. However, discrepant results have emerged with some studies pointing to massive changes in the connectivity profile of occipital regions in blind individuals while other studies showing similar pattern of occipital connectivity in the blind and the sighted. Moreover, the impact of the onset of blindness on these measures remains poorly understood. This question is however crucial to understand if there is a sensitive period in development for reorganizing occipital networks. In this study we investigated the functional connectivity changes between occipital regions and the rest of the brain in early blind (EB), late blind (LB), and their matched controls using fMRI data acquired at rest. We relied on a bootstrap Analysis of Stable Clusters (BASC) to subdivide the brain into meaningful functional parcels. We found massive reorganization of the connectivity profile of the occipital cortex in both EB and LB when compared to their sighted controls. These connectivity changes occurred both within the occipital regions and with non-visual cortical areas. We also demonstrate that certain connectivity changes occur regardless of the blindness onset, while others being specific to early or late blindness. These results were further supported by using multivariate pattern classification showing highly significant classification rate of individuals to their respective groups based on the connectivity fingerprint of their occipital regions. However, we observed a gradient in group-classification highlighting that blindness impacts differently on the connectivity

fingerprint of specific occipital regions. All together, our data suggests regions-specific impacts of blindness onset on the connectivity architecture of the occipital cortex.

15:45-16:05: Cross-frequency coupling: implications and applications in cognitive neuroscience

Chie Nakatani

Brain & Cognition Research Unit, KU Leuven, Leuven, Belgium.

Field signals from cortex, namely EEG, MEG, ECoG, and LFP, include multiple oscillatory components. The main generators of the oscillations are populations of pyramidal neurons, slow-, and fast-inhibitory interneurons. The first two generate a wide band of slow oscillations, e.g., delta and alpha, while the last generate fast oscillations, e.g. in the gamma band. The oscillations are often coupled across different frequencies, the slower ones modulating amplitude or frequency of the faster. The modulation is effectuated through the connectivity among the neural populations. Fast inhibitory interneuron population activity modulates pyramidal neuron spike timing: pyramidal spikes synchronize in gamma and beta bands. Via the coupling of fast with slow oscillatory activity, the slow activity also controls spike timing. This implies that large number of widely-spread pyramidal neurons fire synchronously in the rhythm of the slow activity, since slow rhythms, such as delta and alpha, synchronize over large cortical areas. I introduce a computational model of cross-frequency coupling (CFC), empirical support for the model from a TMS-EEG experiment, and discuss further applications of the CFC in cognitive neuroscience research.

16:05-16:25: Using MVPA to identify the functional organization of the cognitive control network

Wisniewski, David[1,2,3], Loose, Lasse[2,3], Rusconi, Macro[2], Goschke, Thomas[3] & Haynes, John-Dylan [2,3]

1. Department of Experimental Psychology, Ghent University, Ghent, Belgium; 2. Bernstein Centre for Computational Neuroscience, Berlin, Germany; 3. Collaborative Research Centre "Volition and Cognitive Control", Dresden

Flexible adaptation to changing environmental demands requires cognitive control. Despite decades of research, the neural basis of cognitive control functions remains elusive. Previously, a fronto-parietal cognitive control network (CCN) has been associated with various control functions. The precise functional architecture of this network remains a debated topic however. Some argue that the CCN, or parts of it, are functionally specialized, e.g. along an anterior-posterior gradient. Others argue that the CCN shows no strong functional specialization. Recently, the application of multivariate pattern analysis (MVPA) methods to fMRI data has led to novel insights in this debate. Specific tasks have been shown to be represented in local spatial activation patterns in the CCN, and these representations flexibly adapt to changing external demands (e.g. higher task difficulty). This has been taken as evidence against strong functional specialization of the CCN. Here, we present results from several fMRI experiments, where we assess the neural representations of tasks under varying environmental conditions. In Experiment 1, subjects either freely choose one of two different tasks, or are externally cued to perform these tasks. In Experiment 2, subjects are instructed to repeatedly perform the same task, or to switch between tasks, which leads to increased control demands. Using MVPA and cross-classification, we assessed which brain regions encode specific tasks. We then analysed whether they flexibly adapt to changing demands, or whether they encode tasks invariantly, i.e. using similar patterns under varying conditions. In contrast to previous findings, our results indicate that task representations in the CCN can be invariant with respect to changing external demands. This raises the question of whether flexible task representations are necessary for flexible adaption of behaviour. Possibly, invariant task coding allows robust access to task information, even in novel environments, thus also supporting adaptation. Yet, invariant task coding remains difficult to reconcile with current theories of CCN organization. We will discuss implications of these results on the ongoing debate about the neural basis of adaptive behaviour. Our findings clearly demonstrate that novel methods have the potential to provide novel insights, but without a strong theoretical basis their benefits will not be reaped.

16:25-16:45: Automatic categorization of brief changes of facial expression with fast periodic visual stimulation in EEG

Dzhelyova, Milena[1] & Rossion, Bruno[1]

University of Louvain, Louvain–la–Neuve, Belgium

Despite decades of intense research on facial expression perception, relatively little is known about automatic detection of brief changes in facial expressions and how long these changes are processed in the human brain. Here we address these outstanding issues with an original fast periodic visual stimulation (FPVS) approach, coupled with electroencephalography (EEG) (e.g., Liu-Shuang et al., 2014; Rossion, 2014). In a rapid stream of neutral faces presented at 5.88 Hz (~ 170 ms, one gaze fixation by face) for about one minute, a face briefly changes expression at a fixed rate (every 5 th face, 5.88Hz/5 = 1.18 Hz) into fear, disgust or happiness (in different stimulation sequences). Following Fourier Transform of the averaged EEG epochs by condition, the oddball EEG response (1.18Hz) and its harmonics (e.g., 2f = 2.36 Hz, etc.) are identified at these predefined frequencies, i.e. objectively, in the EEG frequency spectrum. This automatic detection of changes in emotional expression is significant in every single participant, and quantified within only a few minutes of experimentation. This high signal-to- noise ratio (SNR) response focuses on occipito-temporal sites but different expression changes evoke reliably distinct topographical maps, pointing to partly distinct neural generators. Inverting faces significantly reduced facial expression change detection, suggesting that this response essentially reflects high level processes related to the emotional faces. Time-domain analysis after selective (notch) filtering of the 5.88 Hz base rate oscillation shows that brief changes of expression elicit differential occipito-temporal components between 100 ms and 310 ms, indicating a rapid detection process followed by a long integration period of facial expression processing in the human brain. Overall, this FPVS-EEG approach offers an opportunity to clarify within expressive face discrimination, and generalization (invariance) of this change detection across head orientation or face identity. Given its high sensitivity at an individual level, it can be employed to address impairments in processes underlying social perception in patient populations. Its straightforward implementation and robust results open avenue to address its applicability as a sensitive biomarker for assessing clinical populations, such as individuals with ASD.

16:00-16:20: Meta-learning foundations of cognitive control: A neuro-computational model

Silvetti, Massimo[1,2], Vassena, Eliana[1,2] & Verguts, Tom[1,2]

1. Ghent University, Ghent, Belgium; 2. Ghent Institute for Functional and Metabolic Imaging, Ghent, Belgium.

Adapting behavior to uncertain and changing environments is the foundation of intelligence. This capability has been traditionally referred to as cognitive control. Considerable theoretical progress was made by considering cognitive control as a problem of reinforcement learning (RL): Learn to choose actions such that one maximizes reinforcement. Crucially, what is learned are not only motor actions but also internal ("cognitive") actions aimed at changing the inner state of the organism in order to optimize behaviour. Indeed, both human and nonhuman mammals showed the capability of optimal control over internal parameters that regulate learning itself, demonstrating meta-learning, i.e. the capability of controlling the learning functions that regulate behaviour. Meta-learning must occur autonomously (i.e. without the "homunculus" intervention) and without an immediate outcome from the environment (abstract learning), because very seldom in an ecological setting, an animal gets immediate reward after each decision it makes. Here we present a novel RL computational model, based on neurophysiological data, which autonomously shows the emergence of cognitive control phenomena in many different experimental paradigms (from instrumental conditioning to effort-related tasks and working memory tasks). At computational level, the model implements the concepts of abstract learning and meta-learning above described, while at neurophysiological level, it represents a macro-circuit including the anterior cingulate cortex (ACC) and the midbrain nuclei VTA (ventral tegmental area) and LC (locus coeruleus). In this way, the model proposes a mechanistic explanation on how the dialog between the ACC and the midbrain can generate meta-learning and abstract learning, and how the synergy between these two processes can generate the basis of intelligent behaviour.

16:20-16:40: Widespread functional underconnectivity of the language network in children with developmental dysphasia

Verly, Marjolein[1], Gerrits, Robin[1], Lagae, Lieven[2], Sunaert, Stefan[3], Zink, Inge[1], Rommel, Nathalie[1]

1. Dept. Neurosciences, ExpORL, KU Leuven, Leuven, Belgium; 2. Dept. Pediatrics, UZ Leuven, Leuven, Belgium; 3. Dept. Radiology, Translational MRI, KU Leuven, Leuven, Belgium.

Developmental dysphasia (DD) is characterized by persisting difficulties to develop age-appropriate language skills despite the absence of sensory-motor deficits, mental/emotional disorders or neurological lesions. The neural substrate of DD remains poorly understood and results of structural and functional neuroimaging studies are inconsistent. To our knowledge, the current study is the first to explore the intrinsic functional connectivity (iFC) of the language network in a group of children with DD and typically developing (TD) children. Seventeen right-handed children with DD (mean age = 10;06 ± 2;02 years; 17 males) and 30 right-handed TD children (mean age = 12;00 ± 1;09 years; 13 males) were included for final analyses. First, 250 resting state fMRI volumes were acquired on a 3T scanner using a T2* weighted GE-EPI sequence. Next, a verb-to- noun generation task was used to identify the language network. Sixteen regions of interest (ROI) were selected as seeds for a ROI-to-ROI resting state connectivity analysis. The functional connectivity of the language network was evaluated by correlating the mean BOLD time courses for each ROI pair. A total of 59 significant positive correlations was found in TD children. In contrast, only 35 significant positive correlations were detected in children with DD. Out of these 35 correlations, only one connection was specific to the DD group. To rule out the potential confounding effect of age on the observed group differences in iFC, correlations between age and iFC were calculated. No significant correlations were detected between age and iFC for any of the ROI pairs ($\alpha = 0.05$, FDR-corrected). The current study benefitted from the use of resting state fMRI, of which the results are less likely to be influenced by inter-subject differences in task performance compared to task-based fMRI. The iFC of the language network was compared between children with DD and TD peers. Widespread underconnectivity was detected in children with DD and was particularly prominent for the cortico-cerebellar circuits and the long-range intra-hemispheric connections. These patterns of underconnectivity might underlie the language impairment in children with DD.

16:40-17:00: Coordinates-based meta-analyses of neuroimaging studies: A critical overview

Bukowski, Hernyk

Social, Cognitive and Affective Neuroscience unit, Faculty of Psychology, University of Vienna, Vienna, Austria

Coordinates-based meta-analyses (CBMA) have become an increasingly useful tool to integrate the overwhelming number of neuroimaging studies and their discrepant findings. Systematically combining findings about a topic of interest provides a different picture than one what a single study can reveal. However the reliability of that picture is conditional to a series of assumptions that are often not met. This presentation aims to shortly describe the existing CBMA softwares, to explain what CBMA actually measures, and how the results can be severely biased. Finally, advices to overcome some of the drawbacks are proposed.

Poster Session 1

Monday, November 28th

13:15-14:45

1.1. **Taking motion of brain signals seriously: task-related trajectories in cortical waves**
Alexander, David M.
Brain and Cognition Research Unit, KU Leuven, Leuven, Belgium

Globally coherent patterns of phase can be obscured by analysis techniques that aggregate brain activity measures across-trials, whether prior to source localization or for estimating inter-areal coherence. When analyzed at single-trial level, episodes of globally coherent activity occur in the delta, theta, alpha and beta bands in data from EEG, MEG and ECoG. The relevant signal has the form of large-scale waves, which propagate with a range of velocities. Their mean speed at each frequency band was proportional to temporal frequency, giving a range of speeds in the MEG of 0.06 to 4.0 m/s, over the temporal frequencies of delta to beta. The wave peaks moved over the entire measurement array, during both ongoing activity and task-relevant intervals; direction of motion was more predictable during the latter. We illustrate the task-related nature of the wave trajectories with data from experimental tasks including hand movements, visual perception (dot lattices and Vernier), and auditory and visual oddball. The waves show systematic variation in velocity and direction, locked to the timing of task components. These episodes of wave activity are related, via their latency, temporal frequency and task-dependency, to known ERP events such as the P2 and P3. This is despite often not being visible in the trial-averaged ERPs themselves; due to the trial-averaging itself. Traveling waves may index processes involved in global coordination of cortical activity.

1.2. **Changes in motor function following sustained nociceptive input generating central sensitization**
Maxime, Algoet, Gan, Huang, André, Mouraux
Institute of Neuroscience (IoNS), Université catholique de Louvain, Brussel, Belgium.

Following a lesion, pain-related changes in motor behavior can protect from further injury and promote recovery. Our aim was to characterize changes in motor function induced by a sustained nociceptive stimulus generating a central sensitization. To assess changes in motor system excitability, single pulses of transcranial magnetic stimulation (TMS) were applied at different points to the scalp to generate a map of the left and right primary motor cortex. Motor-evoked potentials (MEPs) were recorded from 3 muscles, namely: first dorsal interosseous (FDI), *flexor carpi radialis* (FCR) and *extensor carpi radialis* (ECR). Next we applied high frequency electrical stimulation (HFS), a validated procedure to induce both central and peripheral sensitization at the area of stimulation, to the forearm, 10 cm distal to the fossa cubita. The left and right TMS-mapped representations of the FDI, FCR and ECR muscles were quantified before HFS (T0), 20 minutes after HFS (T1) and 45 minutes after HFS (T2). The following measures were obtained from each map: the size of the map, the MEP amplitude at the hot-spot and the volume of the map (sum of the MEP amplitude across the map). Finally, to identify possible changes in the cortical distribution, we assessed the center of gravity (CoG) of the maps. All measures were compared using a 2-way ANOVA with the factors side (ipsilateral and contralateral hemisphere) and time (T0, T1 and T2). The results suggest that the intense activation of nociceptors does not only induces central sensitization of the nociceptive system but also induces sustained changes outside the nociceptive system, here the motor system. Indeed, the motor maps measured at the different time points showed significant differences, both at T1 and T2. Moreover, these changes seem to be specific for the sensitized limb.

1.3. **Crossing the Styx: An integrative pipeline translating post mortem findings to MRI space**
Alkemade Anneke (1,2), Keuken Max C (1), De Hollander Gilles (1), Balesar Rawien (1,2), Forstmann Birte U (1,2).
Amsterdam Brain and Cognition Center, University of Amsterdam, Amsterdam, The Netherlands

Magnetic Resonance Imaging (MRI) research represents a major focus of cognitive neuroscience research, and provides and excellent tool for studying how structure underlies function. However, the anatomical and chemical detail provided by MRI techniques is limited, and even today histological observations represent the gold standard in anatomical research. Intuitively, an integrative approach combining MRI techniques with microscopic anatomical detail obtained from post mortem studies has the potential to greatly improve our understanding of structure-function relationships in the human brain. However, postmortem observations validating MRI studies are scarce. For proof of concept we studied the human subthalamic nucleus, a small biconvex nucleus that functionally is part of the basal ganglia, and plays a role in motor, cognitive and limbic functions. Human post mortem brain specimens were collected and formalin fixed, embedded in paraffin and cut in 6 micrometer sections while performing blockface imaging with 300 micrometer intervals. Consecutive sections were sampled with 300 micrometer intervals and subjected to immunohistochemical staining using various markers including GABA-ergic, glutamatergic, dopaminergic, and serotonergic signaling. Sections were digitally imaged using a Roche Ventana Slide Scanner and the resulting images were analyzed using thresholding procedures available in the ImageJ software. 3D staining patterns were remodeled to individual MRI space using linear and non-linear registration. These studies allow us to compare MRI and histological results, thereby providing the tools to build a bridge between histological studies and functional neuroimaging studies.

1.4. **Mapping Functional Organisation of the occipital cortex in blind individuals**
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The study of congenitally blind individuals has emerged as a unique model to explore the role experience plays in shaping the functional organization of the occipital cortex. Previous studies have shown that the motion responsive region hMT+/V5, typically considered as purely visual, selectively respond to auditory motion in the congenitally blind and, to a lesser extend, in the sighted. However, the possibility to decode motion direction information, as it is the case in the sighted in vision, remains elusive. To create a vivid and ecological sensation of sound location/motion in external space, we relied on individual in-ear stereo recordings of horizontal and vertical moving and static sounds that were re-played to the participants when they were inside fMRI. Preliminary multivariate analyses done on 10 early blinds and 10 sighted controls suggest that auditory motion direction can be decoded in the occipital cortex of both groups. The extent to which visual deprivation impacts on the presence of auditory motion information in these "visual" regions is currently assessed by increasing the number of participants in both groups.

1.5. Visual perspective taking as investigated by fast periodic visual stimulation
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Presenting visual stimuli at a fast periodic (i.e. fixed) rate leads to high signal-to-noise ratio (SNR) responses in the electroencephalogram (EEG) known as "steady-state visual evoked potentials" (Regan, 1966). This fast periodic visual stimulation (FPVS) approach has been successfully used to explore low-level vision, spatial and selective attention, and more recently face perception. The purpose of this study was to assess the potential of FPVS to explore the processes underpinning our ability to compute what is seen by someone else (level 1 visual perspective taking). We presented widely variable stimuli at a rapid rate of 2.5 images/second (2.5 Hz). All stimuli represented a human avatar (whose identity varied) in a room with an object on one of the walls. The identity and location of the object changed at each stimulation cycle. We presented 4 consecutive stimuli in which both, the participant and the avatar saw the object on the wall, while every 5th image showed a stimulus for which only the participant could see the object. We identified specific brain responses at exactly 2.5 Hz and, 0.5 Hz (2.5 Hz/5). Contrary to the 2.5 Hz response, which merely reflects the synchronization of the visual system to the visual stimulation, the 0.5 Hz response represents a clear visual perspective discrimination response. Overall, these findings open an avenue for understanding the processes underpinning visual perspective taking by providing a sensitive new measure that does not require an overt perspective taking response, extending the FPVS approach to investigate higher levels of cognitive processing.

1.6. Task context overrules object- and category-related representational content in the human parietal cortex.
Bracci, Stefania, Daniels, Nicky, & Op de Beeck, Hans
Brain and Cognition, KU Leuven, Belgium

The dorsal, parietal visual stream is activated when seeing objects, but the exact nature and function of parietal object representations is still under discussion. Here we differentiate between two specific hypotheses. First, parietal cortex is biased to host some types of representations more than others, with a different bias compared to ventral visual areas. A prime example would be the actions associated with objects. Second, parietal cortex forms a general multiple-demand network with frontal areas, showing similar task effects and representational content compared to frontal areas. To differentiate between these hypotheses, we implemented a human neuroimaging study with a stimulus set that dissociates associated object action from object category while manipulating task context to be either action-related or category-related. Representations in parietal as well as prefrontal areas represented task-relevant object properties only, with no sign of the irrelevant object property. In contrast, irrelevant object properties were represented in ventral areas. Furthermore, the representations of relevant object properties explain most of the signal variance in parietal and frontal areas but not in ventral areas. These findings emphasize that human parietal cortex does not preferentially represent particular object properties irrespective of task, but together with frontal areas is part of a multiple-demand and content-rich cortical network representing task-relevant object properties.

1.7. Combining a reaction-time distribution fitting approach with EEG methods: Challenges and Solutions
Brady, Daniel, Hill, Elisabeth, & Van Velzen, Jose
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Reaction times provide one of the simplest and most versatile methods by which to examine cognition and behaviour. However, due to the shape of the reaction time distribution the use of the standard summary measures (i.e. the mean and standard deviation) in statistical analyses is somewhat problematic and can mask potentially interesting effects. This is particularly true when examining an atypically developing population such as individuals with developmental coordination disorder (DCD). A potential solution that has been attracting growing attention is fitting an Ex-Gaussian distribution to observed data and analysing the summary statistics for that distribution. This distribution accounts for the positive skew of a reaction time distribution by convoluting an exponential distribution with a Gaussian distribution. The resulting distribution can be described with three summary statistics: the mean of the Gaussian distribution, the standard deviation of the Gaussian distribution and the event rate of the exponential distribution. However, this approach is not widely used and has not been incorporated for use with other methods such as electroencephalography (EEG). Here the potential for combining distribution-fitting with standard EEG methods will be discussed, with particular emphasis on the potential challenges that may be encountered when combining these methods and possible solutions to these problems.

1.8. Multi-voxel pattern similarity analyses show a different response to experience-based versus instructed fear in the human right amygdala

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Although it is commonly thought that fear can be learned through different pathways – via experience or via instructions, it remains unclear whether the brain reserves space for experience-based fear conditioning or whether fear instructions can recruit the same neural substrates and "hijack" the neural circuits that support experience-based fear conditioning. To study this, we used multi-voxel pattern similarity analyses to investigate differentially responding neural patterns of brain activity to merely instructed versus instructed-and-experienced fear stimuli. In a first study, we identified the right amygdala as the only fear-associated region that responded differently to instructed-and-experienced versus merely instructed fear. Moreover, multi-voxel pattern informed connectivity analyses further suggested a higher functional coupling between the right amygdala and anterior cingulate cortex when responding to instructed-and-experienced versus merely instructed fear conditioning. In a second study, we investigated whether this neural pattern response to the experienced-based fear generalized across stimulus category (i.e., house versus face stimuli). Again, the right amygdala was the only region who showed an experienced-based fear response that was different from its response to merely instructed fear, and generalized across stimulus categories.

1.9. Unfolding action: A neurocomputational model of initiation times, movement times, and movement trajectories

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1. Vrije Universiteit Brussels, Brussels, Belgium; 2. Université Libre de Bruxelles, Brussels, Belgium; 3. Ghent University, Ghent, Belgium

Highly parallelized cascade forward models are characterized by substantially blurring the boundaries between processing stages, and thereby promoting an interactive view of brain functioning. Within this framework, recent theoretical and neurocomputational models have suggested that action selection is performed when sensory information biases the activity of a potential action plan until it reaches certain threshold. Yet, these models have to resolve two difficulties. First, because the output of these models is considered as a motor response, they have a computational issue in explaining how one can select an action without immediately implementing it. In other words, these models cannot explain how one can dissociate "what" to do from "when" to do it. Second, these models still implement a discrete stage between action selection and action execution, thereby assuming that cognition is confined prior to motor execution. Such a view has been challenged by many reaching tasks showing that cognition influences motor execution well after action selection. Therefore, these models cannot account for the effects of cognition on unfolding actions. To close this theoretical gap, we developed a model of cognition-action interactions. Our model implements a biased competition between action plans through weighted inputs and lateral inhibition between competing premotor and motor nodes. Moreover, our model has the ability to withhold movement execution based on the influence of environmental constraints on the dynamics of motor activity. Furthermore, the model considers movement as a vector implementing a spatial averaging process of motor nodes. We test our model on two previous reaching tasks stemming from disparate domains, namely cognitive control and numerical cognition. Our model not only captured the effects of cognition on initiation times (i.e. correlate of reaction time in button press tasks), but also on movement times (i.e. the time it takes subject to reach a target upon movement onset) and on movement trajectories. We propose that models of cognition should not only focus on explaining discrete button presses, but additionally should account for unfolding actions. This move should close the current gap between abstract decision making models and behavior observed in natural habitats.

1.10. Multi-method brain imaging reveals impaired representations as well as altered connectivity in adults with dyscalculia

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Two hypotheses have been proposed about the etiology of neurodevelopmental disorders: representation impairments versus disrupted access to representations. We implemented a multi-method brain imaging approach to directly compare the representation vs. access hypotheses in dyscalculia, a highly prevalent but understudied neurodevelopmental disorder. We combined several magnetic resonance imaging methods, including multivariate analyses, functional and structural connectivity, and voxel-based morphometry analysis, in a sample of 24 adults with dyscalculia and 24 carefully matched controls. Results showed a clear deficit in the non-symbolic magnitude representations in parietal, temporal, and frontal regions in dyscalculia. We also observed hyper-connectivity in visual brain regions and increased grey matter volume in the default mode network in adults with dyscalculia. Hence, dyscalculia is related to a combination of diverse neural markers which are altogether distributed across a substantial portion of cerebral cortex, supporting a multifactorial model of this neurodevelopmental disorder.

1.11. A Neural Mass Model of Cross Frequency Coupling

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Cross frequency coupling (CFC) is a key phenomenon in neural population electrophysiological signals. We propose a neural mass model which provides five (out of the theoretically possible six) different types of CFCs, depending only on ambient noise level. For low noise values slow,

delta band activity (<4Hz) engages in phase-frequency coupling (PFC) with fast, gamma band oscillation (>30Hz), while for high noise values phase-amplitude coupling (PAC) results within the components of the model. Across different components, PFC and PAC are synchronized via phase-phase coupling (PPC) of slow activity. The same synchrony mechanism enables frequency-frequency coupling (FFC) as an effect of PFC within model components, amplitude-amplitude coupling (AAC) when PAC exists within model components, and amplitude-frequency coupling (AFC) as a result of PFC in one component and PAC in the other. The model, therefore, provides a coherent account of CFCs within and between components, which may serve as a framework for understanding amplitude and frequency modulation in oscillatory brain activity within and between regions.

1.12. Mirroring multiple agents at the same time: An fMRI study

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There is converging neural evidence that humans automatically mirror the actions of others in their motor system. It has been suggested that this mechanism plays an important role in social interaction because it provides an efficient mechanism to understand observed behaviour. However, this research has mainly focused on situations where the observer views a single agent. In daily life, on the other hand, we often see multiple persons acting at the same time. The goal of the present fMRI study was to investigate if the mirror system is able to integrate the actions of multiple agents. To this end, participants observed two right hands performing gestures (A, B, or C) that were either identical (e.g. A/A) or different (e.g. A/B). In addition, a motor execution localizer was used to delimit the mirror neuron system. The results revealed that seeing two simultaneous hand gestures resulted in stronger parietal mirror activation compared with a baseline condition in which a single hand performed a gesture (e.g. A/N). This suggests that the mirror system is sensitive to the number of observed gestures. However, an important question is also whether this system is sensitive to the content of the observed gestures. To explore this question, we first examined whether seeing two different actions resulted in brain activation associated with motor conflict. In line with this idea, increased ACC activation was observed when the two hands performed different gestures compared with identical gestures. We then used representational similarity analysis to investigate whether the pattern of activation in the different gestures condition was similar to the pattern of activation in the single gesture condition when the gestures overlapped. This analysis indicated that parietal mirror activation in the different gestures condition (A/B) was more similar to the single gesture condition when there was overlap in the observed gestures (A/N or B/N) than when there was no overlap (C/N). Together, these findings support the idea that the human mirror system is able to incorporate multiple identical and different observed actions at the same time.

1.13. Steady-state evoked potentials to research multisensory integration

De Keyser, Roxane, Legrain, Valéry
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Every day, we integrate information from different sensory modalities to form a coherent representation of our surroundings. In animals, such multisensory integration is thought to rely on the existence of multimodal neurons able to respond to sensory inputs from different modalities. The presumably same multisensory integration mechanisms occurs in humans. Essentially, when two sensory different stimuli occur close to a body part, the processing appears to be facilitated. This is reflected in behavioural measures, BOLD activity, and event related potentials. However, these effects can also be explained by spatial attention and might not be due to solely multisensory integration. In order to disentangle the effects from spatial attention from the multisensory integration, we apply the steady-state evoked potential (SSEP) methodology. SSEP allows to tag the cortical activity elicited respectively by different stimuli presented simultaneously using different stimulation frequencies, and, thereby, to track and characterize the cortical response to each stimulus independently, as well to use long-lasting stimulations. We show that multisensory integration seems to rely more on short lasting mechanisms, as we did not succeed to replicate the results obtained by different methodologies with the SSEP methodology.

1.14. Absence without leave or leave without absence: Examining the interrelations among mind wandering, metacognition and cognitive control

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Vrije Universiteit Brussel, Brussels, Belgium

Despite the abundance of recent publications about mind wandering (i.e., off-task thought), its interconnection with the constructs of metacognition and cognitive control has not yet been studied. In the current study, we hypothesized that these three constructs would show clear interrelations. Metacognitive capacity was predicted to correlate positively with cognitive control ability, which in turn was predicted to be positively related to resistance to mind wandering during sustained attention. Moreover, it was expected that participants with good metacognitive capacities would be better at the subjective recognition of objectively present mind wandering. Three computer-based tasks were conducted: The Sustained Attention to Response Task (SART) to measure mind wandering, a task measuring metacognitive efficiency, and a conflict task measuring cognitive control. Structural Equation Modelling was used to test the interrelations among the three constructs. As expected, individual differences in metacognitive efficiency were positively related to cognitive control. Surprisingly, they were negatively related to the degree to which subjective mind wandering reports tracked objective mind wandering. These findings are explained by considering differences in profoundness of mind wandering, as well as the occurrence of intentional mind wandering and task related interference. Ultimately, there was no relation between cognitive control and objective mind wandering. Future research needs to clarify whether the absence of this relation is due to the differential properties of proactive and reactive control.

1.15. Criticality analysis of neuroimaging data: lessons from multiple data set analysis

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Critical dynamics is of interest for cortical information processing: networks operating near the critical point exhibit neuronal avalanches, cascades of spatiotemporal activity that are scale free and thus greatly enhance information capacity and transfer. Criticality analyses have successfully been applied both in animals and humans, and have been shown to be sensitive to global states of the brain, such as arousal. However, while the criticality framework can be naturally applied to spiking neurons because of the all-or-none character of their activity, application to meso/macroscopic neural activity is not quite as straightforward: avalanche analysis can only be carried out after transforming imaging data into binary format though thresholding. No general method exists to date for selecting thresholds, leaving the choice to the discretion of the analyst. Any particular choice, no matter how prima facie plausible, carries the risk of misrepresenting the underlying processes. Such pitfalls can be avoided by applying multiscale analysis - that is, repeating the analysis while systematically varying the analysis parameters. We illustrate this point through avalanche analysis of voltage sensitive dye imaging data collected from rat, cat, and monkey. We show that multiscale criticality analysis is sensitive to different anesthetics. The analysis further suggests that conscious states are characterized by slightly subcritical dynamics, which in fact maximize integration of information, and that loss of consciousness can be effectuated by shifts in either direction (to sub or supra critical regimes) from this optimum. A biophysically realistic model of a cortical network supports this outlook. In the model, criticality measures are associated with network properties and the capacity for integration of information. More generally, our analysis implies that parameter dependent analysis (e.g. graph theoretic analysis) can only be properly understood through multiscale approaches (preferably in conjunction with a model linking between network parameters and the measures of interest), and results shown for a single choice of analysis parameters will necessarily be hard to interpret.

1.16. **Global phase reorganization of the cortical activity following eye movements**

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Animal studies showed that eye movements synchronize ongoing brain activity across multiple brain areas, to optimize the processing of incoming visual information. We asked whether this process can be detected in the large-scale cortical dynamics measured with scalp-recorded EEG in humans. Specifically, we looked for changes in the cortical dynamics associated with the lambda activity, which occurs around 100 ms after fixation onset and is most prominent over the occipital regions. To reveal coherent cortical waves associated with the lambda activity, we used simultaneous recordings of EEG and eye movements acquired in free viewing behaviour. EEG phase was extracted with 2-cycle Morlet wavelets for 31 logarithmically spaced frequencies from 0.5 to 32 Hz. We built a wave model for every frequency and every time point in an interval of 350 ms, starting 150 ms before fixation onset. The model represents the smooth phase gradient that best describes the measured phase at a specific time and frequency. The measured phase was correlated with the phase predicted by the model. We found large-scale phase reorganization which was time-locked to the fixation onset. For a short time period, about 25 ms before maximum lambda activity, the phases in the theta frequency range were aligned on an axis which was predominantly oriented from the posterior-inferior to anterior-superior regions. The prominence of the phase reorganization correlated with size and direction of the preceding saccade. Thus, the lambda activity following saccadic eye movements involves a systematic reorganization of the large-scale cortical dynamics, which may play an integrative role in visual processing.

1.17. **The promises and pitfalls of continuous flash suppression. Part 1: the "dorsal bias" hypothesis**

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Continuous flash suppression (CFS) is an interocular suppression technique that uses high-contrast masks flashed to one eye to suppress the conscious perception of images shown to the other eye. It has become widely used due to its strength of suppression, the prolonged suppression duration for up to several seconds, and the nearly deterministic control of suppression onset and offset. It has been proposed that action-relevant visual processing ascribed to the dorsal stream remains functional, while processing in the ventral stream is completely suppressed when stimuli are invisible under CFS. Here, I will present evidence from two fMRI experiments suggesting that both the ventral and the dorsal visual stream are tightly linked to visual awareness, but that neural activity in ventral areas might more closely reflect graded differences in awareness compared to dorsal areas. In a series of four behavioral experiments, we tested the hypothesis that the (potentially dorsal-stream-based) analysis of prime stimulus elongation during CFS affects the categorization of manipulable target objects. If anything, we found weak evidence for priming in a shape task, but no evidence for priming in a category task when prime stimuli were rendered invisible using CFS. Together, the results thus support the notion that the representation of CF-suppressed stimuli is more limited than previously thought and that there is no conclusive evidence for a "dorsal CFS bias".

1.18. **Transcranial focused ultrasonic brain stimulation: a new alternative for neuromodulation studies**
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Non-invasive techniques such as transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (TDCS) are the two most widely-used techniques to non-invasively modulate human brain activity in a focal and transient manner and, thereby, study brain function. Very recently, it was suggested that transcranial focused ultrasounds (TFUS) can also be used as a non-invasive means to modulate cortical activity. Two recent studies have shown that TFUS delivered over the primary somatosensory cortex (S1) can modulate tactile processing and even generate tactile sensations in humans (Legon et al. 2014, Lee et al. 2015). As compared to TMS and TDCS, TFUS has several advantages. First, the effect can be restricted to a more localized area of the cortex. Second, using transducers having a large focal distance, TFUS could be used to selectively modulate deep cortical structures. Third, TFUS does not generate any unwanted auditory or tactile sensations. Finally, TFUS does not generate any electromagnetic artifact and can thus be combined with EEG to study its effects on brain function. The aim of this preliminary work was to determine the parameters, characterize the sonication and optimize an experimental setup for TFUS. Our results show that the focal point of our transducer was not affected by the variation of fundamental frequency between 250-500 kHz. The size of the focal area varied between 4 and 7 mm in diameter and between 40 and 27 mm in length at full width half maximum, depending on the fundamental frequency used. Because of the strong attenuation by the cranial bone, this attenuation must be taken into consideration when estimating the intensity of stimulation at target site. Considering the size of the focus, the spatial extent of the neuromodulatory effect should be more focused than that of TMS and TDCS. Based on this, we propose a simple device that (i) could be used to modulate non-invasively cortical excitability and (ii) would allow to verify the Isppa, Ispta and MI of any given sonication profile according to the safety guidelines of the European Federation Societies for Ultrasound in Medicine and Biology.

1.19. **Neural representations underlying the perception of social-affective touch**
Lee Masson, Haemy & Op de Beeck, Hans
Brain & Cognition, Leuven, Belgium

Humans frequently express emotions and intensions through nonverbal communication. Therefore, being able to accurately decode nonverbal messages is crucial for efficient interaction and social competence. Among these nonverbal communication behaviours, interpersonal touch conveys a vast amount of information such as socio-affective state and physical and psychological closeness between the interacting people. Thus, understanding of vicarious touch experience through observation is crucial in daily life. Here, we aim at a better understanding and characterization of the behavioural and neural processes involved in interpersonal socio-affective touch. First, we created and validated a large amount of video material (N=39) displaying interpersonal touch. Second, participants (N=13) judged affective aspects of the videos, including both valence and arousal. Individual ratings were averaged to yield group affective representational spaces. Third, the same participants performed an fMRI-experiment in which an orthogonal task (colour detection) was used while presenting the same videos successively for 3sec each (with ISI of 3sec including response period). Using correlational multivariate pattern analysis (MVPA) methods, neural spaces of interpersonal touch information were obtained in the various regions of interest (ROI). Individual neural matrices in each ROI were averaged across participants to obtain group neural matrices. Lastly, to understand where and how the brain processes the complex socio-affective touch information, we correlated group behavioural matrices with neural matrices, followed by the Holm–Bonferroni correction for multiple comparisons. The results suggest that the early somatosensory area, BA7, temporoparietal junction, BA39, the insula and BA6 represent valence information regardless of degree of arousal. Moreover, the precuneus represents both valence and arousal of the interpersonal touch events. The results show the involvement of socio-cognitive brain areas as well as early somatosensory cortex, highlighting the role of socio-affective touch imagery during touch observation in the absence of actual touch.

Poster Session 2

Tuesday, November 28th

13:00-14:30

2.1. **High definition transcranial direct current stimulation (HD-tDCS) to probe the involvement of the primary somatosensory cortex in nociception**

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In order to assess the functional role of a given brain region, one commonly-used approach is to modulate its excitability using, for example, transcranial magnetic stimulation (TMS) or transcranial direct current stimulation (TDCS). In pain research, such "lesion-like" studies can be used to study the involvement and connectivity of the different brain areas responding to nociceptive input. Here, we used high-density transcranial direct current stimulation (HD-tDCS) combined with electroencephalography (EEG) to characterize the involvement of the primary somatosensory cortex (S1) in nociception. The role of S1 in vibrotaction is well established. In contrast, its involvement in nociception remains debated. In two separate groups, we compared, within-subjects, the after-effects of HD-tDCS (HD-tDCS experiment) and sham stimulation (sham experiment) of S1 on the perception and event-related potentials (ERPs) elicited by nociceptive and non-nociceptive somatosensory stimuli delivered to the ipsilateral and contralateral hand. HD-tDCS was delivered using a cathode electrode over C3 or C4, surrounded by four anode electrodes (HD-tDCS experiment: 20 min; 1 mA and sham experiment: 30 s; 1 mA). Nociceptive (laser heat pulses) and non-nociceptive (short-lasting mechanical vibration and transcutaneous electrical stimulation of the median nerve) were delivered to the ipsilateral and contralateral hand, immediately before and after HD-tDCS or sham stimulation. Cathodal HD-tDCS clearly decreased the responses to non-nociceptive somatosensory stimuli delivered to the contralateral hand, both early-latency ERPs from within S1 and late ERPs originating from outside S1. This lateralized effect of HD-tDCS on vibrotaction was not observed in the sham group. This supports the notion that S1 constitutes an obligatory relay for the cortical processing of tactile input originating from the contralateral hemibody. In contrast, HD-tDCS over S1 led to a symmetric reduction of the perception and ERPs elicited by nociceptive stimuli delivered to both the contralateral and ipsilateral hand. This symmetric effect of HD-tDCS on nociception was not observed in the sham experiment. Taken together, our results demonstrate a differential involvement of S1 in vibrotaction and nociception.

2.2. **Cross-modal representation of spoken and written word meaning in left pars triangularis**

Liuzzi Antonietta Gabriella[1], Bruffaerts Rose[1,2], Peeters Ronald[3], Adamczuk Katarzyna[1], Keuleers Emmanuel[4], De Deyne Simon[5], Storms Gerrit[5], Dupont Patrick[1], Vandenberghe Rik[1,2]
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INTRODUCTION:Representational Similarity Analysis (RSA) provides an opportunity to better understand the nature of the commonalities underlying the semantic processing of different input-modalities. In two event-related fMRI experiments, the primary aim was to localize regions showing a cross-modal semantic similarity effect, and secondary to localize regions showing a semantic similarity effect within a given input modality.METHODS:18 and 20 healthy subjects participated in the first and second experiment respectively. 24 animate entities were used. Based on a feature generation experiment(De Deyne et al.(2008)), the pairwise semantic cosine similarity was calculated for each pair of items(semantic cossimilarity matrix). During fMRI subjects performed a property verification task in spoken and in written modality. fMRI data of the first experiment were modelled using a General Linear Model(GLM). Clusters based on (1)main effect of task and (2)conjunction analysis in the first experiment(uncorrected p<0.001 combined with a cluster-level corrected p<0.05)were used as VOIs to be analysed with RSA in the second experiment. The cosine similarity matrix based on fMRI data of the second experiment was generated by calculating the pairwise cosine similarity between every pair of trials(fMRI cossimilarity matrix). Four fMRI cossimilarity matrices were calculated based on the input-modality of the trials: written and spoken words pooled, written only, spoken only and cross-modal. We conducted the RSA between the semantic cossimilarity matrix and the crossmodal fMRI matrix(primary analysis) and the written only and spoken only fMRI matrix(secondary analysis). RESULTS:Contrast(1) and contrast(2) yielded 10 clusters: left ventral occipitotemporal transition zone, left ventromedial temporal cortex, retrosplenial cortex, pars orbitalis bilaterally, left anterodorsal pars triangularis, frontal pole, left pars orbitalis, retrosplenial cortex and left ventromedial temporal cortex. Among these regions, only the left anterodorsal pars triangularis(BA45) showed a crossmodal semantic similarity effect: activity patterns were more similar for word pairs that were more semantically similar, even though the words were presented in different input-modalities(Pearson correlation(r)=0.20,P=0.0002). When we searched for semantic similarity effect within modality, left ventromedial temporal cortex(r=0.18,P=0.002) and left superior temporal gyrus(r=0.17,P=0.002) showed a semantic similarity effect for written and spoken words respectively. CONCLUSIONS:The cross-modal effect is in line with a role of anterodorsal pars triangularis as a semantic working memory space.

2.3. **Domain-general and domain-specific neural effects of visual expertise**

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15

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Experience and learning shape human behaviour and influence the functional architecture of the brain. Research has shown that visual expertise induces changes in neural processing for many different domains of expertise. However, it is still unclear how expertise effects for these different domains are related. In the present fMRI study, we combined large-scale univariate and multi-voxel analyses to contrast the expertise-related neural changes associated with two different domains of expertise across large cortical regions. We included 20 ornithologists (bird experts), 17 mineralogists (mineral experts) and 20 control participants to investigate the interaction between the domain of expertise and its underlying neural changes. Multi-voxel analyses revealed distributed expertise-related neural changes, with effects for both domains of expertise in high-level visual cortex and effects for bird expertise even extending to low-level visual cortex and the frontal lobe. Univariate analyses demonstrated significantly heightened activation for birds in bird experts compared to novices in ventral visual regions. By contrast, no significant expertise effects were found for mineral expertise, indicating that in mineralogists the distributed multivariate changes are not associated with strong local effects. Importantly, a multi-voxel generalization analyses indicated that effects in high-level visual cortex were specific to the domain of expertise, while the neural changes in the frontal lobe for both types of expertise showed significant overlap, signalling the presence of domain-independent expertise effects. In conclusion, expertise is related to a combination of domain-specific and domain-general changes in neural processing.

2.4. Features vs Categories: dissociable representation between physical and categorical features of sounds in the occipital cortex of blind people

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There is clear evidence that the occipital cortex changes its sensory tuning and starts to massively respond to non-visual stimuli in early blind people. However, it was suggested that at least some aspects of the functional architecture of the ventral visual cortex are similar in sighted and congenitally blind individuals, suggesting that some abstract representation of object categories may develop in VOTC in the absence of visual experience. One aim of the present study was to investigate if a gradient between low-level and high-level features of sounds could be mapped in the VOTC of blind people, as it is the case with visual stimuli in the sighted. For this purpose, we relied on representational similarity analysis of fMRI data in order to link similarities of brain activity patterns with different features similarities of our sound stimuli space. More particularly, we investigated if the physical (pitch) and categorical (animate-inanimate) features of the auditory stimuli are encoded in VOTC of blind individuals. Futhermore, we characterized the brain activity of a separate group of sighted people looking at images of the same stimuli. This allowed us to compare the pattern of activity in two sensory modalities, acoustical and visual, in people with or without visual experience, providing a comprehensive investigation for the presence of amodal regions in the brain. First, we observed that the posterior Middle Temporal Gyrus (pMTG) represents the animate-inanimate features of sounds in both blind and sighted groups and for the visual stimuli in the sighted, providing strong support that this region is abstracted from sensory experience or input. In blind individuals only, some information about both sound categories and physical properties of the acoustical stimuli are encoded in different parts of the occipital cortex. In sighted participants viewing picture, we find the expected postero-anterior gradient of information content for the physical and categorical features of visual stimuli, respectively. In contrast, the VOTC of sighted participants did not represent low-level acoustic features and had limited involvement for high-level features. These results provide limited support that VOTC engages in the amodal representation of the stimuli independently of their modality input.

2.5. Refixation measures reveal memory processes in free viewing

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Eye movements are easily accessible indicators of information acquisition and processing. In particular, refixations on items are descriptors of a number of cognitive processes, such as rehearsal of items in working memory, inadequate spatial memory, or inefficient processing of stimuli. To understand the processes involved during accumulation of memory load, we considered refixations in unconstrained eye movement behaviour using traditional as well as advanced techniques for their quantification. The latter involved computing measures based on the number and duration of recurrences from recurrence plots, as a way of describing the state space trajectory of dynamical systems by plotting recurring states. We recorded eye movements during a visual search task, wherein, for 10 seconds, 3, 4 or 5 targets were presented among distractors, all in different orientations. Participants were asked to search for targets and remember their orientations for a subsequent change detection task, in which, in 50% of the cases one of the targets had its orientation changed. We analysed refixations separately for targets and distractors during the search interval. We found that the number of refixations increased with memory load for targets while the opposite happened for distractors, indicating sharing of central resources for memory load and spatial locations. In addition, refixations increased during the course of a trial for targets, while they decreased for distractors, suggesting increased rehearsal of targets in working memory toward the end of the trial. There were more refixations on targets and less refixations on distractors in trials with correct than incorrect responses. This indicates that refixations facilitate memorization. The recurrence analysis showed that for all items, the amount of recurrence increased and the recurrent episodes were farther apart in time for correct than incorrect responses. In addition, the amount of recurrence, the number of repeating gaze patterns and repeated fixations on the same regions increased with memory load. Thus, refixations of targets are essential for their encoding and maintenance

in short-term visual memory. Both refixation and recurrence analyses proved to be useful tools in revealing processes involved in memory accumulation in free viewing.

2.6. Exploring the role of the right inferior frontal gyrus in visual perspective taking using transcranial direct current stimulation

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Perspective taking and handling conflicts between our own and someone else's perspective require the contribution of different areas in the brain. Among the regions of interest, we focused in this study on the right inferior frontal gyrus (rIFG), the role of which remains unclear. Sixty participants performed a level-1 and a level-2 visual perspective taking (VPT) tasks. Both tasks required participants to judge either their own (self-perspective condition) or an avatar's perspective (other-perspective condition), these perspectives being either the same (consistent perspective condition) or different (inconsistent perspective condition). Participants performed the tasks under anodal, cathodal or sham transcranial direct current stimulation (tDCS). Stimulation led to different effects according to the task level. In the level-1 task, stimulation affected performance in the inconsistent perspective condition, irrespective as to whether the irrelevant perspective was the participant's own perspective or that of the avatar, suggesting a role of rIFG in the ability to inhibit both self- and other- perspectives in case of conflict. In the level-2 task, which unlike the level-1 task involves mental body rotation, stimulation had an effect on self-salience, improving the ability to process self-perspective trials as compared to other-perspective trials in the anodal condition, while impairing it in the cathodal condition. This latter result suggests a role of rIFG in mental body rotation inhibition, which in turn might have led to a change in conflict resolution demands between self- and other's perspective.

2.7. Left middle intraparietal sulcus response patterns reflect relatedness for meaningful and meaningless stimuli

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According to the classic two-stream model, cortical visual processing diverges in a ventral pathway, serving object recognition, and a dorsal pathway, engaged in spatial vision and visuomotor control. Here we examined whether the intraparietal sulcus (IPS) also codes for information that is more typically associated with ventral occipitotemporal regions, such as object identity and relatedness between objects. We performed multi-voxel pattern analysis and representational similarity analysis in 65 healthy controls. In two experiments, we displayed either pictures of real-life objects or abstract shapes (geons). The subjects performed a passive viewing task in which the location, orientation and size of the stimuli were manipulated. We used semantic similarity to measure the relatedness between real-life objects. The set of geons consisted of 8 families of 3 related stimuli that differed in metric and non-accidental properties. The middle IPS volume of interest was based on the Jülich cytoarchitectonic atlas (hIPS1-3), for posterior IPS we used coordinates from previous fMRI paradigms of spatially directed attention. For concrete entities, we found an effect of object identity that was invariant for location in both middle (left: Pearson correlation (r) = 0.006, P<0.001; right: r = 0.004, P = 0.001) and posterior IPS (left: r = 0.003, P = 0.003; right: r = 0.001, P = 0.016). We obtained analogous results for geons. Besides location-invariant object identity, activation patterns in the posterior IPS regions also reflected object location as such. An effect of relatedness for both real-life stimuli and geons was found only in the left middle IPS (real-life stimuli: r = 0.147, P = 0.013, geons: r = 0.124, P = 0.020). These correlations were significantly different from the corresponding values in left posterior IPS (signed rank test, resp. P = 0.040 en P = 0.048). These results point to an active contribution of IPS in object processing. Both middle and posterior IPS contain location-invariant object information. Left middle IPS emerges as a region reflecting relatedness between stimuli, regardless whether they are concrete or abstract. Posterior, but not middle, IPS also exhibited a pronounced effect of object location as such.

2.8. EEG-eye movement co-registration – a valuable tool for studying natural vision

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To investigate how observers visually explore their environment, we have to abandon the traditional stimulus-response paradigm and consider more ecologically valid alternatives. A promising strategy involves co-registration of EEG and eye movements. Eye movements can be used as markers for segmentation of ongoing EEG activity. Free viewing behavior can then be studied within as well as between fixations with the highest temporal resolution available. We describe a range of research questions that can be addressed by co-registration, the experimental protocol, the pitfalls and the solutions for simultaneous processing of EEG and eye movements. In particular, we illustrate the main properties of EEG activity around a saccade, consider the difference between the EEG activity time-locked to saccade and fixation onsets, and discuss possible confoundings between cognitive eye movement factors during co-registration. We focus on the main technical problem of co-registration, which is overlapping effects of sequential eye movements on EEG, and will propose possible solutions. Finally, we give an overview of several co-registration studies from our laboratory, which consider visual memory encoding, visual search, and saccade guidance.

2.9. Arithmetic in dyscalculia and dyslexia: Different behavioural, yet similar brain activity profiles

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17

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Children with specific learning disorders, such as dyslexia or dyscalculia, have difficulties in acquiring basic academic skills despite otherwise normal intelligence. These difficulties are assumed to originate from brain abnormalities that to date remain unclear. Dyscalculia and dyslexia also often co-occur, but this comorbidity has not been studied at the level of the brain. We therefore used fMRI to investigate brain activity in children with dyslexia, children with dyscalculia, and children with comorbid dyslexia/dyscalculia. Participants were 62 children aged 9 to 12 and comprised 19 children with dyslexia, 11 children with dyscalculia, 9 children with comorbid dyslexia/dyscalculia, and 23 typically developing children. All completed two fMRI experiments during which they performed an arithmetic task in different formats and a reading task. At the behavioral level, children performed as expected: children with dyscalculia performed more poorly compared to typically developing children on all formats of the arithmetic task. Children with dyslexia scored lower than typically developing children on the symbolic formats (Arabic digits and number words) but not on the non-symbolic format (dots). Children with dyslexia performed more poorly on the reading task. At the neural level, typically developing children showed higher levels of brain activity in the arithmetic and reading tasks compared to the three groups of children with specific learning disorders. Contrary to our expectations, there were very few differences between the three learning disorders under study. Subject generalization analyses further confirmed that the neural activation patterns of children with dyslexia, dyscalculia and dyslexia/dyscalculia were not distinguishable by a trained classifier, neither in arithmetic (Experiment 1) nor in reading (Experiment 2). These data suggest that, despite obvious differences at the behavioral level, the neural profiles of children with different learning disorders may be more similar than initially thought.

2.10. Source-space EEG classification to investigate the respective roles of high and low spatial frequencies in full-spectrum image processing
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We employed a combination of EEG and MRI to elucidate the integration of low spatial frequency (LSF) and high spatial frequency (HSF) components on the processing of full spectrum images at primary and high-level stages of visual processing. So far, most studies addressing SF contribution to high level vision have done so by presenting subjects with one SF range at a time and comparing responses to those isolated components although these are generally combined in natural viewing conditions. In order to catch potential interactions between LSF and HSF processing, we used multivariate pattern analysis on MRI informed dense array (256 channels) EEG data. Participants were presented with images of human faces, monkey faces and their scrambled versions. Images were filtered to contain either LSF only, HSF only or a combination of both. Importantly, our filter cutoffs were chosen to preserve equal contrast across conditions. We localized the early visual cortex and the face-preferring high-level regions via independent fMRI localizers and used the anatomical images to inform EEG source reconstruction. We then trained support vector machine classifiers on source-space EEG data in response to images within one range of spatial frequencies and tested their ability to generalize across time, space and spatial frequency conditions. This approach allows us to track signatures of LSF and HSF responses during the processing of full spectrum images. Preliminary results indicate, that the temporal advantage of FS processing is due to an interaction between the processing of LSF and HSF within the first 180ms of visual processing.

2.11. White Matter Tracts in Children's Arithmetic: A Comparison of DTI and Spherical Deconvolution
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Understanding the role of structural pathways in arithmetic may further clarify the neural mechanisms of individual differences in arithmetic ability. Previously, these white matter (WM) pathways have been examined with Diffusion Tensor Imaging (DTI) and the associated fractional anisotropy (FA) index (Matejko & Ansari, 2015). Despite the availability of the technique, (developmental) DTI research in arithmetic is scarce. Furthermore, the available DTI studies in children have major shortcomings, such as the inclusion of children with wide age ranges, and the fact that classical DTI is subject to various methodological limitations. These limitations include, firstly, that DTI only estimates the direction of one fiber per voxel, which leads to an oversimplification of the underlying anatomy (i.e., DTI will make it seem as if only one fiber runs through voxels with fiber crossings). This is problematic, as many crossing fibers are situated around the inferior parietal lobe, an area associated with individual differences in arithmetic. Secondly, the interpretation of the FA index is not clear-cut, as it provides a quantitative measure per voxel, determined by micro- and macrostructural properties. These two limitations can be resolved by more complex non-tensor models, such as Spherical Deconvolution (SD), which have the asset of characterizing the orientation of more than one fiber per voxel. To overcome FA-issues, the hindrance modulated orientational anisotropy (HMOA) index can be derived from SD, which provides information about the diffusion properties along each fiber orientation, even in regions with fiber crossings. In our own data, a comparison between DTI and SD of WM in the inferior parietal lobe revealed visual differences (e.g., fibers reached further into the cerebral cortex) and showed an increased number of fibers and volume for SD. The current study illustrates the SD-approach to investigate WM tracts and their association with arithmetic abilities in 9- to 10-year-old children.

2.12. Avoiding Illusory Effects in Representational Similarity Analysis: What (Not) To Do with the Diagonal
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Representational similarity analysis (RSA) is an important part of the methodological toolkit in neuroimaging research. The focus of the approach is the construction of representational dissimilarity matrices (RDMs), which provide a single format for making comparisons between different

neural data types, computational models, and behavior. We review the geometric basis and background for RDMs before highlighting two issues with their construction and comparison. First, the diagonal values of RDMs, which should reflect within condition reliability of neural patterns, are typically not estimated in RSA. However, without such an estimate, one lacks a measure of the reliability of an RDM as a whole. Thus, when carrying out RSA, one should calculate the diagonal values of RDMs and not take them for granted. Second, if diagonal values reflect reliable neural patterns, they must nonetheless be excluded when comparing RDMs. Via a simple simulation we show that inclusion of these values can generate convincing looking, but entirely illusory, correlations between independent and entirely unrelated data sets. Both of these points are further illustrated by a critical discussion of Coggan et al. (2016), who investigated the extent to which category-selectivity in the ventral temporal cortex can be accounted for by low-level image properties of visual object stimuli. We observe that their results may depend on the improper inclusion of diagonal values in their analysis. We also emphasize ways to avoid these potential issues when carrying out RSA.

2.13. Functional connectivity changes in attention-related networks of childhood leukemia survivors

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PURPOSE: High dose methotrexate (MTX) is associated with neurocognitive sequelae in childhood leukemia survivors. Still, the underlying mechanisms remain enigmatic. Altered functional brain connectivity might offer an explanation. Previous research indicated that the default mode network (DMN) and fronto-parietal network (FPN) are involved in cognitive flexibility. The goal of this study was to compare resting state functional connectivity (RSFC) between childhood leukemia survivors and control participants, within and between these networks. **METHODS:** We acquired Rs-fMRI in survivors (n=35) ($\underline{x} = 12 years$ [1.5:16yrs] since treatment, no cranial irradiation), and healthy age-matched controls (n=35). RSFC was examined using two analyses. (1) For each network, connectivity (i.e. temporal correlation) matrices were constructed between spherical regions of interest (ROIs), based on earlier MNI coordinates. Unpaired T-tests were used to compare RSFC between patients and controls. (2) Secondly, independent component analysis (ICA) yielded sample-specific DMN and FPN masks. Through dual regression analysis, we assessed RSFC between each network and the rest of the brain. Both analyses were Bonferroni-corrected.Finally, with a regression analysis we linked survivor's RSFC to subjective cognitive complaints (Cognitive Failure Questionnaire), and objectively measured cognitive flexibility (subtask of the Amsterdam Neuropsychological Tasks) in. Socio-economic status (SES), age and relative MTX-dose were included as covariates. **RESULTS:** ROI-based analyses showed differences within the FPN, at uncorrected level. However, these effects disappeared after Bonferroni-correction ($p<.05$). By contrast, dual regression analysis resulted in a significant lower connectivity in survivors between DMN and the inferior temporal gyrus (ITG), located in the FPN ($p<.05$). This connectivity correlated significantly with impaired cognitive flexibility ($p=.019$), but not with subjective complaints ($p=.253$). **CONCLUSION**: The DMN and ITG, was less functionally connected in childhood leukemia survivors compared to controls, suggesting a modified coherence between the DMN and FPN. Furthermore, this connectivity was related to reduced patient's cognitive flexibility.

2.14. Fractality account for extended agency: The case study of Spizzo's effect

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Agency is defined as the twofold feeling of being engaged in actions and of controlling the sensory events concomitant with those engaged actions. To test the relationship between engaged actions and concomitant events in agency, we focused on Spizzo's effect. Spizzo's effect consists in a phenomenon of extended agency arising in sensorimotor coordination tasks, such as coordinating finger tapping with the visual pulses of a metronome. As tapping is being coordinated with the metronome, participants experience the agency on their tapping extended to control over the metronome pulses. The sense of control arises even though participants know that the metronome operates independently of their action. Since participants knew the metronome operates independently, we propose that coordination of tapping with pulses is crucial for the effect to arise. Coordination was evaluated by analyzing the correlation structure in the tapping series, i.e. asynchronies or reaction times between taps and pulses. We analyzed the correlation structure of the series by classifying the signal expressed by the series. The classification was performed following a novel algorithm that combines frequency- with time-domain analyses. Results confirmed the hypothesis: Spizzo's effect arose only if the series exhibited a correlation structure. This correlation structure spanned from short-range ARMA models to long-range ARFIMA models in the time domain. Consistently, in the frequency domain ARFIMA models corresponded to fractal signals, which drifted from fractional Gaussian noise (fGn) to fractional Brownian motion (fBm) as the metronome frequency increased. The fGn-to-fBm drift in the signals induces a transition from proactive to reactive tapping that occurs at the highest metronome frequencies. The transitions in tapping were modeled as rapid change points. Rapid change points coincided with a shift in agency: From controlling the onset to the offset of metronome pulses. The correlation structure constitutes a collective variable describing the global coordination involved in Spizzo's effect. This global coordination, besides the kinematics of tapping, may also encompass attentional and oculomotor events.

2.15. Neuronal populations in occipital cortex of the blind align to the temporal dynamics of speech

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The occipital cortex of early blind individuals shows massive reorganization of its sensory and functional tuning by responding to language. But at what stage of language comprehension do these neuronal populations become important? Here we use magnetoencephalography (MEG) in a group of early blind, and sighted individuals who listened to naturalistic speech. Using speech envelope tracking, we demonstrate that a widespread neuronal network in occipital cortex of the blind synchronizes to the temporal dynamics of human speech. Crucially, increased synchronization to intelligible speech was observed only at the lowest level of the occipital hierarchy (V1/V2). Using directional connectivity analysis we further show that speech-related information within blind occipital cortex flows against the classical visual hierarchy, converging around V1. These results demonstrate the presence of a reverse hierarchy for speech processing in the occipital cortex of blind individuals.

2.16. Investigating the Sensitivity for Socio-communicative Features in ASD using Fast Periodic Visual Stimulation EEG

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Social behaviour is largely determined by efficient face processing. Individuals with autism spectrum disorder (ASD) are characterized by deficits in social communication and interaction, including difficulties processing faces. An extensive research tradition suggests that individuals with ASD are less sensitive for socio-communicative facial information, and pay less attention to the eyes and more to the mouth. Facial emotional processing in ASD has been widely studied using both explicit and implicit test paradigms. However, performance on explicit behavioural tasks can be influenced by several confounding factors (like motivation and decision making), yielding inconsistent findings. More consistent findings are provided by implicit measures, yet these techniques usually are very complex, time-consuming and inconclusive, yielding weak effects and low signal-to-noise ratio. To investigate the nature of face processing impairment in ASD and to delineate biomarkers sensitive at the individual subject level, we are using a new innovative approach where we combine scalp electroencephalography (EEG) with fast periodic visual stimulation (FPVS). The general principle of FPVS EEG is that it elicits a steady-state visual evoked potential at exactly the same frequency of visual stimulation. We present images of faces periodically at a 6 Hz base rate and we assess the sensitivity for certain socio-communicative features by periodically entering oddball images displaying changes in expression and/or identity (*i.e.* every 5th image; 6 Hz/5 = 1.2 Hz oddball rate). Sensitivity for these features can be assessed by quantifying the neural response at the oddball frequency. We will present data on identity and emotion discrimination in 9-to-12 year old children with ASD vs matched typically developing (TD) control children. Subsequently, we will extend our study to children with low functioning ASD (i.e. IQ < 70), compared to mentally disabled children without ASD, and to younger mental age-matched TDs. This highly versatile and robust approach has the advantage of offering an objective and quantifiable index of implicit face processing abilities at an individual level that can be obtained in a few minutes and without complex data analyses. This allows assessing infants and clinical populations, such as ASD. Moreover, this technique can provide a clinically useful biomarker for ASD.

2.17. Space-time measures of the SSVEP response: analysis of large-scale cortical traveling waves

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An assumption in nearly all cognitive neuroscience research is that of space-time separability. It assumes that the mechanisms constituting the cortical signal are functions of space and time, and that these dimensions of signal can be treated separately. This implies that part of the signal - that which is space-time inseparable- is noise. A growing literature focuses on the spatiotemporal dynamics of cortical activity in the form of traveling waves. Traveling waves have been shown to be functionally significant at the single-trial level (Alexander et al., 2006; Alexander et al., 2009) and at multiple spatial scales of cortex (Klimesch et al., 2007; Nauhaus et al., 2009; Takahashi et al., 2011). The steady-state visual evoked potential (SSVEP) data presented in this paper come from an experimental setup in which subjects were shown three aligned LED stimuli flickering at different frequencies and with different phase shifts proportional to the central LED. When flickering in the alpha band, the stimulus induces an EEG response that possesses a spectral component narrowly centered around the frequency of presentation. We assume that this increase in spectral component is, in fact, the result of cortical traveling waves with temporal frequencies similar to the stimulus frequency. In order to verify this, we fitted a smooth phase gradient in the form of a traveling wave per trial onto the original EEG signal and assessed measures for wave fit and velocity of the wave.

2.18. Multistable Speech Perception: An ERPs Study on the Verbal Transformation Effect

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The multistable speech perception occurs when a word is rapidly repeated. Listeners typically hear the word transform to one or more forms constantly although the physical stimulus is not changed. This phenomenon is also called the verbal transformation effect (VTE). It provides a unique window to study the mechanism of speech perception, as it elicits dissociation between objective continuous speech and subjective perception, which may be related to the accuracy of speech perception in the noisy everyday life environment. We measured the event-related brain potentials (ERPs) while the participants were engaged in a behavioural task. This method was chosen because the EEG is a low-cost technique (compared to the MEG) that provides information at millisecond level about the time course of the VTE, which very little previous literature has examined. Additionally, it gives an opportunity to relate the brain correlates to the behavioural results. In the current study, 15 participants were asked to listen to the word [ace] rapidly repeating without pauses and respond whenever they perceived the VTE to [say]. In order to compare the endogenous VTE with the exogenous stimulus-driven perceptual switch, another task (where 2.1, 2.4 or 3.2 second

sequences of [ace] or [say] were presented in alternating trials) was carried out, and the participants were asked to respond only when they heard a real change in the stimuli. Due to the continuous stimuli needed to generate the VTE, the study used the response-locked lateralized readiness potential (LRP) to measure the brain activity when the transformation occurred. The results showed that the VTE between the two words occurred spontaneously approximately every 4 seconds, and that the LRP generated by the VTE had significantly smaller amplitude and later onset latency than that generated by the stimulus-driven perceptual transformation. Previous literature suggested that the LRP represents the preparation of the motor (e.g. hand) response, and the hand motor selection triggered by the stimuli can be affected by the expectation towards the stimuli. Therefore, the current results indicate that both the bottom-up satiation and the top-down processes, such as expectations, were involved in the multistable speech perception process.