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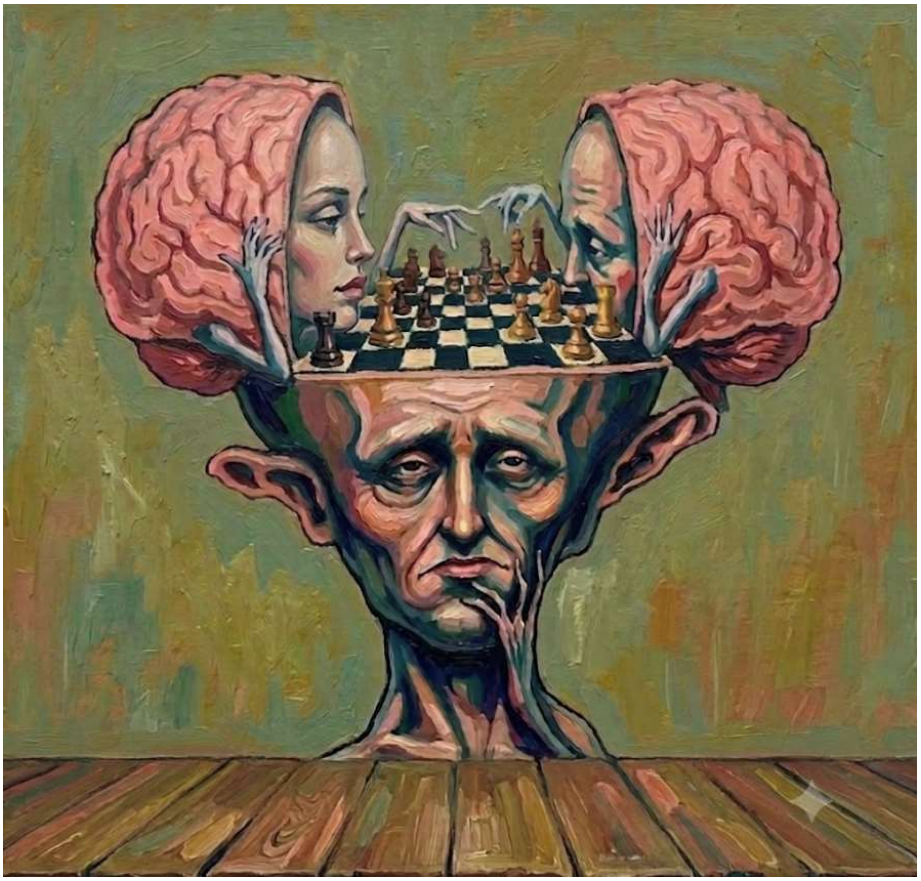
bcn

Research School of Behavioural and Cognitive Neurosciences

BCN & CAD Symposium

Lateralization of brain, cognition and behaviour

From evolution to clinical relevance



October 30, 2026

Groningen

Theme

Welcome to the BCN & CAD* Symposium "Lateralization of brain, cognition and behaviour".

Lateralisation of the brain has intrigued people since its discovery in the 19th century. Being originally the research field of mainly neurology and psychologists, the study of laterality became really interdisciplinary over the last decades, adding disciplines such as molecular genetics and physiology, cognitive neurosciences, and theoretical, behavioural and evolutionary biology. This revealed that lateralization is not a typical human traits, as originally claimed, but a fundamental principle of the organization of the neural system in the entire animal kingdom. It induced not only a search for which hemisphere is doing what, but also for its underlying genetics and ontogenetic development and plasticity, its functional consequences for both perception, cognition and social and non-behaviour, its relationship with pathology, as well as its Darwinian function and evolution, both in humans and non-human animals. In this full day symposium we will provide the current status of this interdisciplinary research field, address all these aspects in presentations by 6 internationally well recognized speakers. The morning session will be devoted to more fundamental principles and the afternoon session focusing on more clinical aspects, followed by a general forum discussion.

On behalf of the BCN Symposium organizing committee,

Ton Groothuis
Joke Spikman
Sanne Brederoo
Anne Buunk
Floor Gelmers
Marie-Christine van de Glind
Femke Siebenga
Diana Koopmans
Evelyn Kuiper

*UMCG research program Cognition Ageing and Disease

BCN

The Research School of Behavioural and Cognitive Neurosciences (BCN) is a research and training center for the study of normal and pathological processes of the nervous system at the University of Groningen, the Netherlands.

Our main objectives are twofold:

- to initiate, stimulate and integrate scientific research on the biological bases of behavioural and cognitive processes
- to provide our Research Master and PhD students with an integrated training program consisting of courses, lectures, master classes, workshops, seminars, symposia and multidisciplinary research

Some 300 senior researchers, 50 postdoctoral researchers and about 220 PhD students from five faculties within the University of Groningen participate in BCN. Research ranges from molecular processes to the whole organism and from yeast to humans.

BCN Cross-Disciplinary Symposia

BCN organizes special symposia which are part of the obligatory education program of our PhD students and appreciated meeting platforms for our senior scientists.
With these symposia we aim to:

- demonstrate the value of interdisciplinary research by approaching a single theme, central to BCN, from different angles
- encourage discussion of members of different research faculties, particularly graduate students
- inform BCN members about the state of their relevant research topics

Organization

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Program

9:00 –9.30	*Registration with coffee/tea*
9:30 – 10:00	**Prof. dr. Ton Groothuis** – University of Groningen (Groningen Institute for Evolutionary Sciences) *Lateralization of brain, cognition and behaviour: an introduction into its four why's*
10:00 – 10:45	**Prof. dr. Chris McManus** – University College London, United Kingdom (Department of Psychology and Medical Education) *Cutting handedness at nature's joints, rather than wielding the butcher's axe*
10:45 – 11:15	*Coffee break*
11:15 – 12:00	**Dr. Elisa Frasnelli** – University of Trento, Italy (Animal Cognition and Neuroscience Lab) *The Asymmetric Advantage: Evolutionary evidence and functional significance of lateralization in non-human animals*
12:00 – 12.30	**Something special**
12:30 – 13:30	*Lunch break*
13:30 – 14.15	**Prof. dr. Guy Vingerhoets** – Ghent University, Belgium (Department of Experimental Clinical and Health Psychology) *Beyond the textbook brain: Individual differences in brain organization and their functional implications*
14:15 – 15:00	**Prof. dr. Sebastian Ocklenburg** – Medical School Hamburg (MSH) Germany (Department of Psychology) *Clinical Relevance of Lateralization*
15:00 – 15:30	*Coffee break*
15:30 – 16:15	**Prof. dr. Linda Douw** – Amsterdam UMC (Multiscale Network Neuroscience (MULTINET) lab) *Clinical network neuroscience: from localization to lateralization to distributed networks*
16:15 – 16:45	**Debate**
16:45 – 17:30	*Drinks*

Location
Registration and breaks: Fonteinpatio, UMCG, Hanzeplein 1
Plenary sessions: Rode Zaal, 2nd floor UMCG, via Winkelstraat



Prof. dr. Ton Groothuis

Groningen Institute for Evolutionary Sciences, University of Groningen

Ton Groothuis is Emeritus Professor of Behavioural Biology and still active in a variety of research projects. He obtained as biologist his PhD degree cum laude on the development of social behaviour in a bird species in Groningen, after which he studies the hormonal control of behavioural development in Canbridge, UK. He subsequently obtained a position at the Groningen university, becoming full professor in 2005. His current main research lines are the influence of maternal and paternal hormones and their Darwinian function on offspring development, and linked to this the development, Darwinian function and evolution of laterality in brain and behaviour. He has worked with a wide variety of animal species, ranging from insects and fish to birds, rodents and humans. He erected and was director of the Groningen Institute for Evolutionary Life Sciences and served on several university, national and international committees. He is currently chair of the research school Behavioural and Cognitive Neurosciences (BCN).

Lateralization of brain, cognition and behaviour: an introduction into its four why's.

Due to the asymmetry of the central nervous system, in vertebrates by the two hemispheres, many behaviours and cognitive processes are to some extent lateralized, due to the asymmetry in neural activation. Originally claimed to be unique to humans, it is now clear that this asymmetry is a fundamental part of the neural organization throughout the animal kingdom. That allows us not only to enrich the human literature on lateralization with animal experiments, but also to ask all four questions that can be asked about every biological phenomenon: the underlying causation, the ontogenetic development, its Darwinian function and its evolution. Although we do know quite a bit about the causation in terms of activity and structural differences between the hemispheres and its implication for health and disease, how the two hemispheres communicate with each other and work together is still unclear. In addition, how the interaction between genetic and environmental information is guiding the development of lateralization is still far from understood. Moreover, although several hypotheses have been postulated for its Darwinian function and evolution, experimental tests are at the moment inconsistent. I will briefly discuss these topics as a prelude to the next speakers and present some results of work in my own group on the ontogeny of lateralization, its potential advantage for cognition, as well as how to explain both the strong bias and the variation in human handedness, For the latter I will discuss our data on reproductive success in relation to handedness in a pre-industrial and modern human society.



Prof. dr. Chris McManus

Department of Psychology and Medical Education, University College London, United Kingdom

Chris McManus is Emeritus Professor of Psychology at University College London, and a previous editor of the journal *Laterality*. He qualified originally as a doctor, followed by a PhD in neuropsychology studying the inheritance of handedness and language dominance. In 2002 he published *Right hand, left hand: The origins of asymmetry in brains, bodies, atoms and cultures*, a popular science book which won the Royal Society Book Prize, and which overviewed a range of issues about asymmetry and lateralization.

Cutting handedness at nature's joints, rather than wielding the butcher's axe

Humans show handedness (lateralisation, asymmetry) in many ways, both behavioural and anatomical, 90% preferring to write with their right hand, and 99.99% having their heart on the left side. Multiple and varied asymmetries are also present throughout other animals. In exploring a range of biological handednesses, my title will follow Plato who talked of being,

> "able to cut up each kind according to its species along its natural joints, … [trying] not to splinter any part, as a bad butcher might do" (*Phaedrus*, 265.e, Nehemas and Woodruff, 1995).

A butcher can use the power and directed force of an axe or a saw to cut anywhere through a carcass, whereas a surgeon's disarticulation through a joint requires minimal force, sharp scalpels, and a deep knowledge of anatomy. When disarticulation occurs easily that informs about the different materials of which flesh is comprised – bone, tendon, ligament, muscle – and indicates 'natural kinds'. Materials that fall apart easily are indicating their underlying deep structures, reflecting the structure and the fault lines of the natural world, rather than something merely specific to human perceptions and needs.

After looking briefly at the behavioural and statistical 'joints' in right and left hand performance, where bimodality and clustering of performance indicators indicate separate, distinguishable processes, I will step back and consider the 'biological joints' in the wider evolutionary phylogenetic pictures of differences in asymmetries.
Species, as well as genera, families, orders, classes and phyla, indicate statistical clusterings of organisms, and phylogenetic trees indicate the 'joints' (nodes) where nature can be cut for understanding the evolution of handednesses and asymmetries. Examples will include: anthropoids, Cetacea, flatfish, Foraminifera, marsupials, and teleosts. A key question will be whether asymmetries arise deep in the root of a phylogenetic tree or at the ends of the terminal branches.



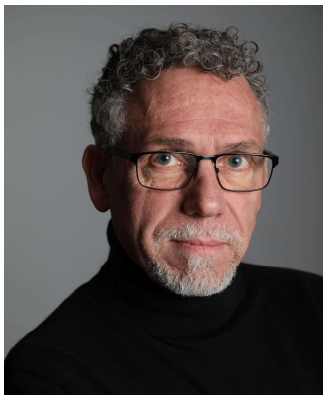
Dr. Elisa Frasnelli

Associate Professor at the Animal Cognition and Neuroscience Lab, University of Trento, Italy

Physicist by training, Elisa Frasnelli got her PhD in Cognitive and Brain Sciences at the Centre for Mind and Brain Sciences of the University of Trento, where she is currently associate professor after 10 years of research abroad, in Australia, Japan, Austria, and the UK.
She studies behaviour and cognition in different animal species – including our own – to understand the evolution of the brain and cognitive abilities, with a specific focus on behavioural and brain asymmetries.

The Asymmetric Advantage: Evolutionary evidence and functional significance of lateralization in non-human animals

Evidence of lateralization across the animal kingdom is widespread, suggesting that it is an important feature not only of complex nervous systems such as the human one as initially believed but also of the simplest ones: even the nematode *C elegans* with only 302 neurons shows an asymmetrical distribution of some neurons. As lateralization expresses itself in a variety of behaviours such as the asymmetrical use of limbs and paired organs (e.g. eyes), investigating behavioural asymmetries in a comparative approach among different taxa has shown that behavioural asymmetries share a similar pattern in different species. Indeed, the left hemisphere is specialised in routine behaviours such as feeding, whereas the right hemisphere responds to unexpected stimuli like, for example, a potential predator.
The comparative research of this fascinating phenomenon has allowed a better understanding of the evolution and function of lateralized brains. In terms of fitness advantage, in fact, lateralized animals have been shown to outperform non-lateralized ones. However, for humans as well as for other species, there seems to be an optimal degree of lateralization that maximise the advantages connected with it in term of cognitive performance or fitness.
Another intriguing feature of lateralization is that it often manifests itself as a population-level bias, with most individuals aligned in the same direction.
If an asymmetrical brain confers advantages to a single individual because, for example, it is possible to process stimuli in parallel and to avoid competition between the right and the left sides of the brain in the control of response, it is harder to explain the function of the directional bias. Comparative research suggests that the alignment arises evolutionarily, when the need to coordinate an individual's behaviour with other individuals within the population became more and more important.



Prof. dr. Guy Vingerhoets

Department of Experimental Clinical and Health Psychology, Ghent University, Belgium

Guy Vingerhoets is Full Professor of Clinical Neuropsychology at Ghent University, Belgium. He began his academic career at the Faculty of Medicine in 2001, where he conducted neuropsychological research on neurological disorders including epilepsy, dementia, Parkinson's disease, and stroke, while also investigating the cognitive effects of cardiac and vascular interventions.
His early adoption of functional neuroimaging techniques, particularly functional MRI and transcranial Doppler ultrasonography, led to a growing interest in the functional neuroanatomy of language and praxis. Since his appointment as Full Professor at the Faculty of Psychology and Educational Sciences in 2011, his research has focused on brain asymmetry and its behavioral consequences in both typical and atypical populations.
Guy has served on the boards of the International Neuropsychological Society and the Federation of European Societies of Neuropsychology. His research examines structural and functional brain asymmetries, with a particular interest in atypical patterns of laterality and their implications for brain-behavior relationships.

Beyond the textbook brain: Individual differences in brain organization and their functional implications

Most people's brain show a characteristic pattern of hemispheric functional segregation, with language and praxis lateralised to the left hemisphere, and spatial attention and face recognition favouring the right hemisphere. This prototypical pattern is believed to result from selective evolutionary adaptation and reflect an optimal division of labour, implicitly assuming that atypical segregation might come at a biological cost. We aimed to investigate individual differences of this population bias and used functional MRI to investigate hemispheric dominance of four cognitive localizers (representing language, praxis, spatial attention, and face perception) in a healthy and representative sample of one hundred right handers and one hundred left handers from the Flemish population. In addition to the MRI-session all participants completed a neuropsychological assessment investigating cognitive performance and IQ-estimation.

In right-handers 71% showed the prototypical hemispheric segregation and 29% showed an atypical pattern (i.e. at least one function lateralized to an atypical hemisphere). In left-handers 42% showed the typical pattern, 8% showed a complete reversal of the typical pattern, and half of the left-handers showed atypical functional segregation. We will compare these results against current putative mechanisms of hemispheric specialization and discuss the implications for these models. Contrary to expectations, no significant group differences were found for cognitive or IQ performance between participants with typical, atypical, or reversed typical functional segregation. Alternative accounts to explain the relation between brain organization and cognition include the (in)consistency of the lateralized network as observed in some neurodevelopmental disorders. Empirical findings in participants with dyslexia will be used as an example. We suggest that decomposing the population bias into at least three different sub-biases and explore the effects of each component on behaviour might help structure research on the complex interaction between individual differences in brain organisation and its functional repercussions. We will also underline the implications of the high prevalence in atypical brain organization for research and clinical protocols.



Prof. dr. Sebastian Ocklenburg

Department of Psychology, Medical School Hamburg (MSH), Germany

Sebastian Ocklenburg is a professor of research methods in psychology at the Medical School Hamburg, Germany. Sebastian conducted his PhD thesis on the genetics and neurophysiology of hemispheric asymmetries. For this work, he was awarded the prestigious Heinz Heckhausen award by the German Society for Psychology. Subsequently, he worked as a postdoc in the Bergen fMRI group in Norway, before returning to Germany. For understanding how hemispheric asymmetries develop, he uses an integrative multimethod approach, including neuroimaging, electrophysiology, and molecular genetic techniques. Apart from many papers and still actively involved in laterality research. Sebastian has written books on left-handedness, brain asymmetries, research methods, hugging and the climate crisis.

Clinical Relevance of Lateralization

Functional and structural brain asymmetries are fundamental principles of brain organization, and a large body of research suggests a higher prevalence of atypical hemispheric asymmetries in various groups of patients with mental and developmental disorders. In this talk, I will give an overview about several recent theoretical developments, empirical studies and meta-analyses that focused on hemispheric asymmetries in clinical groups. In general, atypical asymmetries are more prevalent in patients with mental and developmental disorders compared to healthy controls. However, case-control differences vary substantially with diagnosis. Some diagnoses, like schizophrenia, autism spectrum disorders and dyslexia are associated with a higher prevalence of atypical asymmetries than other diagnoses. Specifically, the data suggest that neurodevelopmental conditions, nonneurodevelopmental conditions with an early age of onset, and conditions that include symptoms related to language were all associated with higher rates of atypical functional asymmetries. These finding suggests that the association between atypical asymmetries and clinical conditions is best understood from a transdiagnostic, developmental, and symptom-focused perspective. Moreover, I will also highlight the relevance of lateralization for disease symptom onset in neurodegenerative diseases and their implications for lateralized treatments, including brain stimulation.



Prof. dr. Linda Douw

Multiscale Network Neuroscience (MULTINET) lab, Amsterdam UMC

Linda Douw obtained a Master's degree in Clinical Neuropsychology in Amsterdam and completed her PhD on neural networks, brain tumors, cognition, and epilepsy at VU University Medical Center in 2010. After postdoctoral research at MGH/MIT/Harvard, she returned to Amsterdam in 2014 to establish her own lab.
Today, she is Full Professor of Network Neuroscience, with a focus on oncology, at Amsterdam UMC and leads the Multiscale Network Neuroscience (MULTINET) lab. Her research integrates cellular, network, and clinical perspectives to understand patient variability and improve outcomes. She also promotes interdisciplinary collaboration and translational research through the Translational Neuroscience Network.
More information: www.multinetlab.com

Clinical network neuroscience: from localization to lateralization to distributed networks

Where does cognition live in the brain? Clinical neuroscience has long answered this through localization: map a function to a region, and protect it. Lateralization refined this view, yet surgical experience increasingly tells a different story. In epilepsy and glioma surgery, direct electrical stimulation, intracranial recordings and pre- and postoperative imaging reveal that function depends on distributed networks rather than isolated regions or hemispheres. Seizures spread along network pathways, resecting hub regions has consequences far beyond the removed tissue, and patients with comparable lesions show strikingly different cognitive outcomes depending on how their tumor or epileptogenic zone is embedded in the wider connectome. In this talk, Linda Douw brings together MEG, fMRI and diffusion MRI evidence from these surgical populations to show how large-scale network topology shapes cognitive functioning and predicts postoperative outcome. Crucially, surgery also offers a rare window across scales: resected human tissue allows us to link cellular and microcircuit properties, such as neuronal excitability, to the macroscale networks measured in the same patients. This multiscale perspective moves clinical network neuroscience beyond maps of where functions reside, toward mechanistic understanding of how brain networks are built, how they fail, and how we can predict and preserve cognition for individual patients.

Debate

Guy Vingerhoets

Statement: Do we really believe that functions lateralize completely independently from one another?

Elisa Frasnelli

Statement: For many years among the scientific community it was common to state that lateralized individuals outperform non-lateralized ones (especially in non-human animals), but there are also disadvantages associated with strong lateralization. I then wonder whether there is an optimal degree of lateralization, if it is "measurable" and if it is a continuum with not clear trade-off thresholds.

Ton Groothuis

Statement: Left handedness or a deviating lateralization pattern might be an adaptation rather than a potential health risk only and this can ultimately only be determined by Darwinian fitness measures.

Linda Douw

Statement: Hemispheric specialization is written in the bridge, not in the banks.

Sebastian Ocklenburg

Statement: Handedness may have less direct evolutionary advantages than often proposed, but its distribution could be driven by an piggyback effect caused by other, more directly fitness-relevant functions of the genes relevant to handedness.

Chris McManus

Statement: Is any but a tiny fraction of handedness variance likely to be due to the external environment?

Speakers

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