

Donders Institute for Brain, Cognition and Behaviour



During 2015, Seet van Hout worked as an artist-in-residence at the Donders Institute. This is one of the pieces of art she made there.

The aim of the Donders Institute is to increase our understanding of the neural basis of human cognition and behaviour, both in health and disease.

Comprehending this complex organ in our heads and how it enables our thoughts, emotions and actions has sparked curiosity for centuries. It's essential to strive for this understanding if we are to be able to answer fundamental questions about human beings. Recent technological and theoretical advancements are delivering unprecedented insights into the way the brain works, making it possible to answer more applied questions as well.

The Donders Institute is home to about 600 researchers from more than 35 countries who share the common goal of contributing to advancing the brain, cognitive and behavioural sciences through investigator and curiosity-driven research, and improving health, education, nutrition, and technology by applying advances in

this field. The Institute's mission includes conducting excellent interdisciplinary research at the unique interface between genetic, molecular and cellular processes at one end of the spectrum and computational, system-level neuroscience with cognitive and behavioural analyses at the other end. Within this wide interdisciplinary range the Institute focuses on four research themes:

- Language and Communication
- Perception, Action and Control
- Plasticity and Memory
- Brain Networks and Neuronal Communication.

Researchers who are renowned worldwide work with young ambitious scientists in small research groups that form a highly interactive, collaborative cross-faculty network that tackles research questions that are too complex to be answered by single groups.

This interdisciplinary, cooperative culture – combined with excellent multidisciplinary research – is also at the core of the Donders Graduate School, which integrates a renowned Research Master's programme with ambitious PhD training. The Master's programme is structured in four tracks that are fully aligned with the four research themes of the Donders Institute, thus integrating young students optimally in the research. The PhD training programme supports young scientists by providing general academic skills while helping them move towards their own independent lines of research.

Research facilities

The Donders Institute has the very best equipment and technical staff, which allows researchers to carry out the most advanced work.

To understand human brain function and dysfunction at the cognitive and behavioural level a large number of laboratories are used, with set-ups for baby and toddler studies, an artificial intelligence laboratory, and numerous sensorimotor facilities, including a fall simulator, a vestibular sled and chair, 'reach-in' 3D visualisation and force-feedback virtual reality equipment.

To measure human brain function with precision while individuals perform specific cognitive tasks, the Institute employs a comprehensive set of neuroimaging tools comprising four research-only MRI scanners, including a joint-venture high-field system that is housed at the Erwin L. Hahn Institute, a whole-head MEG system, several multi-channel EEG and near-infrared spectroscopy systems. These neuroimaging facilities are complemented by equipment enabling modulation of human brain function such as several transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS) laboratories.

To decipher underlying biological mechanisms the Institute also uses a broad range of other laboratories on campus, covering all levels from molecular biology to animal behaviour. State-of-art techniques are available in the forefront of sequencing technology developments, including large data sets of patient cohorts and neural stem-cell cultures. The central animal facility provides animal MRI, PET, CT/SPECT and a great variety of behavioural tasks for rodents. In addition, several other technologies are available, such as 2-photon microscopy, multi-unit *in-vivo* electrophysiology and optogenetics – just to mention a few – and these are being further developed locally within the context of the Radboud Research Facilities and Radboudumc Technology Centres.

These experimental tools are complemented by high-performance computing facilities, which enable advanced data analyses, data modelling and simulations for which the Institute is well known. This computer infrastructure also supports very large-scale studies, creating large databases of several thousands of individuals for brain-imaging genetics and patient cohorts.

Staff

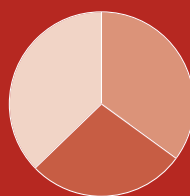
Tenured

Full Professors	25,96 FTE
Associate Professors	12,38 FTE
Assistant Professors	28,52 FTE
Researchers	22,35 FTE

Non-tenured

Researchers	133,05 FTE
Doctoral candidates	225,78 FTE

Research funding



■ Core ■ Grants ■ Contracts

(o), (e) and (p) see Glossary

Prizes and awards (in alphabetical order)

- Bas Bloem received the Holst Memorial Lecture Award 2015 for his research in the field of healthcare innovation.
- Mark Dingemans, Francisco Torreira and Nick Enfield of Nijmegen's Max Planck Institute for Psycholinguistics won the 2015 Ig Nobel Prize.
- Barbara Franke was elected as a member of the Academia Europaea.
- Marloes Henckens was selected for the Lindau Nobel Laureate Meeting.
- The Branco Weiss Fellowship and the 2015 Hermesdorf Prize 'International' were awarded to Marijn Kroes.
- Karin Roelofs was awarded a Radboud Science Award and has been appointed to the Young Academy of Europe.
- Carmen Sandi (Lausanne) was awarded the Radboud University Medical Centre's 2015 Valkhof Chair.
- Mirjam Ernestus, an affiliated PI (CLS) of the Donders Institute, was elected as a member of The Royal Netherlands Academy of Arts and Sciences (KNAW).
- Peter Kok was awarded the Dutch 2015 Neurofederation PhD thesis prize.

Personal grants

- NWO Veni grants were awarded to Piray Atsak, Inti Brazil, Marloes Henckens and Fleur Zeldenrust
- NWO Vidi grants were awarded to Marcel van Gerven, Floris de Lange, Jan-Mathijs Schoffelen, and Roel Willems
- NWO Vici grants were awarded to Asli Özyürek (affiliated PI, CLS), Roshan Cools, and Joris Veltman
- ERC starting grants were awarded to Michael X. Cohen and Floris de Lange
- An ERC consolidator grant was awarded to Erno Hermans.

Collaboration

Research carried out at the Donders Institute is conducted in a collaborative national and international setting. In Nijmegen the Centre for Language Studies at the Radboud University and the Max Planck Institute for Psycholinguistics are affiliated institutes. In Germany the Institute collaborates with the University of Duisburg-Essen – a preferred partner of Radboud University – on the operation of a joint research centre for high-field MR imaging, the Erwin L. Hahn Institute, in Essen.

Furthermore, the Institute actively strives to collaborate in research consortia with leading institutes, industrial partners and other potential users of its research. Joining forces in this way extends research across the borders of the Institute and makes valorisation of research results possible. The Institute participates in a large number of high-quality, innovative consortia, including:

- An NWO Gravitation Grant *Language in Interaction*, which is coordinated in Nijmegen, brings together 50 researchers from eight universities and one research institute in the Netherlands.
- Fourteen large EU consortium grants, including: *Aggressotype*, *Matrics*, and *PERS*. The consortia mentioned each bring together over 15 European academic and industrial partners and all three are coordinated by the Donders Institute.
- Five EU (Marie Curie) training networks, such as *Healthpac* (led by the Donders Institute), *Childbrain* and *BrainTrainMat*.
- Four national and regionally funded projects that bring together Dutch universities and private-sector partners. Examples are *FOCOM* and *NeuroCIMT*.
- Two consortium projects: *BIG and Cognomics*, with the Donders Institute, the Radboudumc, and the Max Planck Institute for Psycholinguistics as initiating partners.
- The Institute is a collaborating partner in the *Human Brain Project*, which was selected by the EU as one of two flagship projects, and contributes to the US Human Connectome Project.

See the Institute's website for more details on all of these collaborations.

Societal impact

Research conducted at the Institute has considerable potential for benefiting society, especially in education, medicine, technology and food. A key aim is to disseminate expertise and knowledge to a variety of stakeholders.

- To inform the general public, Donders researchers regularly appear on national television (in programmes such as *'De Kennis van Nu'*, *'Tijd voor Max'* and *RTL Late Night*), in numerous national and international newspapers (including the New York Times, NRC, de Volkskrant, de Gelderlander), on radio (e.g. Dutch National Radio, BBC, the Voice of America), at large festivals (e.g. *Down the Rabbit Hole*) and on many websites. Esther Aarts investigates how deep down in our brains our reactions to food are triggered. In cooperation with National Geographic and the Axa Research Fund, she made a video on how to reduce irrational eating. This video has a large number of hits on YouTube. In the blog 'DondersWonders' researchers at the Institute write non-specialist articles on neuroscientific topics for the general public. With two blogs per week, over 100,000 views in 2015 and regular radio and TV interviews resulting from it, it can be said to be a big success.
- To inform the scientific community, Donders researchers took the active lead in workshops and in organizing international conferences. One example is the International Conference on Genetic & Epigenetic Pathways of Disease, Greece, co-organized by Hans van Bokhoven. Neuropsychological tests developed by Roy Kessels and colleagues, such as the 'Nijmegen-Venray Confabulation List', have been published or translated into other languages, as is the case with the 'Location Learning Test'.
- Donders scientists disseminate new findings and knowledge to industry, mostly through numerous mutually beneficial collaborations with commercial partners varying from smaller companies that manufacture technical devices (such as Noldus and Otticon) to large multinationals (e.g. Philips, Siemens, Heinz and Danone). In 2015 the Institute joined 'ICT for Brain, Body & Behaviour' (i3B), a European network of ICT companies and knowledge institutes in the field of brain, cognition, physiology and behaviour with the aim of connecting business and innovating through joint R&D projects. The Institute is also involved in 'Radboud Research Facilities', an initiative by the province Gelderland to stimulate the regional economy by contributing to innovation by small and medium-size enterprises that apply scientific knowledge.

Chair of the Board of Directors: Prof. Guillén Fernández

Guillén Fernández trained as a neurologist and cognitive neuroscientist in Bonn, Magdeburg, and Stanford before becoming a founding Principal Investigator at the Donders Center for Cognitive Neuroimaging in 2002. He then became a professor (in 2006), head of the Cognitive Neuroscience department (in 2010) and director of the Donders Center for Neuroscience (also in 2010). In his research on human cognitive neuroscience, he specializes in the cerebral basis of memory, emotion and the way they interact. He has received an Advanced Investigator Grant from the European Research Council and he has been a member of the Academia Europaea since 2014.



Donders Institute for Brain, Cognition and Behaviour

Postal address

P.O. Box 9101, hp204
6500 HB Nijmegen
The Netherlands

Visiting address

Kapittelweg 29
Nijmegen

T: +31 (0)24 365 32 76
E: info@donders.ru.nl
I: www.ru.nl/donders

- Research is well embedded in clinical care within Radboudumc and beyond. Implementing new findings in clinical practice is part of the daily work of the Donders clinicians as is the education of peers, patients and patient organisations through lectures, meetings and forums (*e.g.* depressievereniging.nl and NEKAD). Donders researchers participate actively in e-science developments such as the digital Parkinson policlinic and Parkinson TV or mental e-health applications, partly in collaboration with patient organisations, thus directly promoting the impact of research.
- Donders researchers actively participate in educational development. Jurjen van der Helden and Harold Bekkering published a book in which they describe important insights into the 'learning individual'. They offer suggestions for educational practice in literacy, numeracy and social interaction.
- Through participation in public debate Donders researchers contribute to regional and national policies by discussing the impact of neuroscientific insights on economic and social development. They also play a key role in guiding and organising platforms for the ethical thinking needed to apply new neurotechnologies. At the national level, researchers at the Institute serve on committees of research policy organisations such as the Netherlands Organisation for Scientific Research (NWO), the Royal Netherlands Academy of Arts and Sciences (KNAW), the National Initiative Brain and Cognition, and the Rathenau Institute. Researchers at the Institute collaborate with external partners in areas such as psychiatry (*i.e.* those working in the Pompe Clinic in Nijmegen), with the Netherlands Forensic Institute (NFI) and the Dutch Department of Education.



Vocal communication by bats is studied by Dr Sonja Vernes.

Theme 1: Language and communication

Prof James McQueen (speaker)

The mission of researcher working on the Language and Communication theme (LC) is to understand something that is uniquely human: language. An important feature of this theme is the substantial involvement of researchers from two affiliated institutes: there are Donders Principal Investigators and Research Fellows at the Max Planck Institute for Psycholinguistics and at the Centre for Language Studies.



Sonja Vernes (Group Leader at Max Planck Institute) was awarded an independent MPI research group by the Max Planck Society. Her group studies the genetics of vocal communication using mice and human models as well as novel bat models, as a way to understand the evolution and biological basis of human speech and language.

LC theme researchers have three key objectives: *a)* to understand core language and communication operations, and to determine how these are related to other domains of cognition; *b)* to determine how the human language faculty is rooted in the 'language-ready' human brain; and *c)* to understand the balance between the universality and the variability of language and language processes. LC uses neuroscientific, behavioural, linguistic, genetic and computational techniques and seeks explanations at multiple levels (neurobiological, psychological and linguistic). The ultimate goal is to link these domains and thus move towards a fuller understanding of the human language faculty, from the molecular to the societal level.

Research results

One study examined the genetic mechanisms underlying Specific Language Impairment (SLI). Another study using molecular techniques investigated an isolated population on Robinson Crusoe Island (Chile) where there is a high incidence of SLI. A single rare coding variant of the protein NFXL1 was found to be significantly associated with language impairment. Subsequent analysis of

people from the UK affected by SLI revealed changes which probably affect this protein in more individuals than would be expected by chance. Coding variants within NFXL1 thus appear to confer an increased risk of SLI.

Other research explored relationships between language and memory by measuring oscillatory brain activity. In a word-learning study, patterns of oscillatory activity changed as a result of memory-consolidation processes. Power in the theta band (4-8Hz) has previously been associated with word-recognition processes. In line with this, the theta increase was lower with new words learned on the same day as the test compared to words that were already known. But theta responses to novel words that had been acquired 24 hours earlier were indistinguishable from responses to known words. Overnight consolidation thus enables novel words to acquire lexically-integrated, neural representations. In a speech production study, participants either judged whether pictures were expected after reading sentences or named the pictures. Across the two tasks, beta desynchronization was observed in brain areas associated with memory processes and in areas associated with motor processes. Memory and motor components of word production thus appear to be reflected in overlapping beta-band brain oscillations.

LC researchers also examined when speakers plan their utterances in conversations. The results showed that participants initiated the cognitively demanding aspects of speech planning only shortly before the end of the preceding speaker's turn. Because it is smart to wait with demanding aspects of planning, this may be the default in everyday conversations.

Finally, a functional Magnetic Resonance Imaging study examined the effects of communicative intent. Utterances with gestures (but not those without) produced additional activity in the right middle temporal gyrus when participants were addressed. Marking communicative intent with gaze direction thus appears to modulate the processing of speech-gesture utterances in brain areas associated with the semantic processing of multi-modal communicative acts.

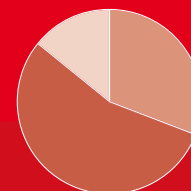
Future research

Researchers working on the LC theme will continue to pursue its key objectives in 2016. An important vehicle for this is the NWO 'Language in Interaction' Gravitation grant, which supports a national consortium of researchers including many LC theme members. PhD and postdoctoral projects already funded by the grant will continue next year, and new projects will start. In particular, the consortium has identified six fundamental questions about language science. In line with the LC theme's goals, these questions are interdisciplinary and multi-level in nature. New projects seeking to answer these questions will begin in 2016.

Staff

Prof. A.F.J. Dijkstra (p)
 Prof. S.E. Fisher (e)
 Prof. P. Hagoort (o)
 Prof. J.M. McQueen (p)
 Prof. A.S. Meyer (e)
 Prof. A.P.A. Roelofs (p)
 Prof. H.J. Schriefers (o)

Research funding



■ Core ■ Grants ■ Contracts

Tenured

	DI	at CLS/MPI
Full Professors	2.49 FTE	9.47 FTE
Associate Professors	0.0 FTE	2.57 FTE
Assistant Professors	1.3 FTE	0.0 FTE
Researchers	0.83 FTE	0.0 FTE

Non-tenured

Researchers	6.94 FTE	69.0 FTE	(o), (e) and (p)
Doctoral candidates	10.5 FTE	35.0 FTE	see Glossary

Key publications

Bakker, I., Takashima, A., van Hell, J.G., Janzen, G., & McQueen, J.M. (2015). Changes in theta and beta oscillations as signatures of novel word consolidation. *Journal of Cognitive Neuroscience*, 27(7), 1286-1297.

Holler, J., Kokal, I., Toni, I., Hagoort, P., Kelly, S.D., & Ozyurek, A. (2015). Eye'm talking to you: Speakers' gaze direction modulates co-speech gesture processing in the right MTG. *Social, Cognitive & Affective Neuroscience*, 10, 255-261.

Piai, V., Roelofs, A., Rommers, J., & Maris, E. (2015). Beta oscillations reflect memory and motor aspects of spoken word production. *Human Brain Mapping*, 36, 2767-2780.

Sjerps, M.J., & Meyer, A.S. (2015). Variation in dual-task performance reveals late initiation of speech planning in turn-taking. *Cognition*, 136, 304-324.

Villanueva, P., Nudel, R., Hoischen, A., Veltman, J.A., Cazier, J.B., De Barbieri, Z., Fisher, S.E., & Newbury, D.F. (2015). Exome sequencing in an admixed isolated population indicates NFXL1 variants confer a risk for specific language impairment. *PLoS Genetics*, 11(3):e1004925.

	DI	CLS/MPI
Dissertations:	11	5
Academic publications:	80	166
Professional publications:	3	23



Measuring brain processes during experimental tasks.

Theme 2: Perception, Action and Control

Prof. Alan Sanfey (speaker)

The mission of researcher working on the Perception, Action and Control (PAC) theme is to understand the relationships between the brain and cognitive mechanisms of perception-action integration in the domains of perceptual inference, sensorimotor functions, cognitive control, decision-making, and social interactions in health and disease. The PAC theme broadly investigates the initial

integration between perception and action (during *sensorimotor integration*), how it is regulated (during *decision-making*) and how it is exploited (during *social interactions*). At the level of *sensorimotor integration*, researchers examine how sensory processing and motor performance interact within the perception-action cycle. At the level of *decision-making*, researchers study how the perception-action cycle is regulated on the basis of cognitive, motivational, and emotional factors. At the level of *social interactions*, researchers study how the perception-action cycle is used when directly interacting with other agents. At each level of investigation, research also focuses on understanding neurological and psychiatric populations, as well as with on the potential social implications of this research. PAC researchers address these issues at the system level; from genes to neuromodulators, from single neurons to brain circuits, from individual organisms to multiple interacting agents. These issues are examined by combining multiple techniques, from electrophysiological and neuroimaging methods to clinical and psychopharmacological studies, from genetic and neurobiological methods to developmental and psychophysical studies, and from computational modelling to



Principal investigator Floris de Lange received an ERC Starting Grant and an NWO Vidi grant. We often say 'Seeing is believing', but the exact opposite is true: to a large extent, our expectations determine what we see. Floris de Lange investigates how expectations change the brain processes that underlie perception, and what the consequences of that are.

theoretical analyses. This multidisciplinary and multi-level approach creates the opportunity for different analytical and theoretical perspectives, providing a fertile ground for effective interactions between fundamental and clinical neuroscientists, and thus, this theme fully integrates the ‘Disorders of movement’ research theme at the Radboudumc.

Research results

A recent study in the perceptual domain, demonstrated that sensory uncertainty could be reliably estimated from the brain, and that this knowledge about the uncertainty of the underlying stimulus is then used in perceptual judgements. Examining sensorimotor integration, researchers revealed the response properties of auditory cortex neurons in awake monkeys, as well as explorations of how different cue representations act within and across effector systems. Another group investigated brain activity that underlies predicting physical movements of objects and a clinical study at Radboudumc has sought to evaluate whether aerobic exercise can lead to significant improvements in motor defects observed in Parkinson’s patients. Investigations of cognitive control have shown that the stimulant methylphenidate amplifies the salience of task-relevant information, leading to enhanced processing of targets, but also increased attention to distractors which are drawn from the same category. Decision-making studies revealed that choices to either exploit or explore resources depend on the social context as well as the expectation model of the environment. Research on social interaction has shown that patients with damage to the ventromedial prefrontal cortex are impaired in terms of non-verbal communicative tasks, indicating that this brain area is necessary for social interactions that require applying knowledge about a social partner. Finally, a pharmacological intervention study demonstrated that the administration of testosterone increases amygdala activation during threat.

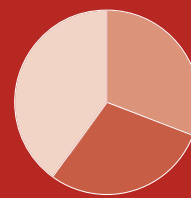
Future research

Researchers will continue to focus their work as described in the mission. There will be an increased focus on efforts to align the work of the basic and applied scientists in order to generate and test models of normal and abnormal function, with the ‘Disorders of movement’ theme at Radboudumc playing a vital role in this regard.

In addition, initial efforts will be undertaken to examine the potential relevance of PAC research in questions of public policy. Other studies will examine how we predict events, and how we then employ these predictions to act in optimal ways, and work on addiction will examine the underlying mechanisms involved in pathological gambling. The theme will continue leading the HealthPac consortium, the innovative doctoral programme that focuses on understanding the neural mechanisms of sensory-motor control and its disorders, and to use this knowledge to enhance the quality of life. PAC researchers also remain involved in the ‘Language in Interaction’ Gravitation grant.

Staff

Prof. H. Bekkering (o)	Tenured	
Prof. B.R. Bloem (o)	Full Professors	8.2 FTE
Prof. J.K. Buitelaar (o)	Associate Professors	8.19 FTE
Prof. R. Cools (p)	Assistant Professors	9.96 FTE
Prof. R. van Ee (e)	Researchers	11.58 FTE
Prof. B.G.M. van Engelen (o)		
Prof. R.J. van der Gaag (o)	Non-tenured	
Prof. A.C.H. Geurts (o)	Researchers	65.88 FTE
Prof. C.J.M. Klijn (o)	Doctoral candidates	108.39 FTE
Prof. W.P. Medendorp (p)		
Prof. R.G.J. Meulenbroek (p)	Research funding	
Prof. A.J. van Opstal (o)		
Prof. K. Roelofs (o)		
Prof. A.G. Sanfey (p)		
Prof. A.F.M. Snik (e)		
Prof. D.F. Stegeman (p)		
Prof. I. Toni (p)		
Prof. M. Ullsperger (p)		
Prof. R.A. Wevers (o)		
Prof. R.J.A. van Wezel (o)		
Prof. M.A.A.P. Willemsen (o)		



Core Grants Contracts

(o), (e) and (p) see Glossary

Key publications

Araujo, R., Ferreira, J.J., Antonini, A. & Bloem, B.R. (2015). “Gunslinger’s gait”: a new cause of unilaterally reduced arm swing. *British Medical Journal*, 351, h6141.

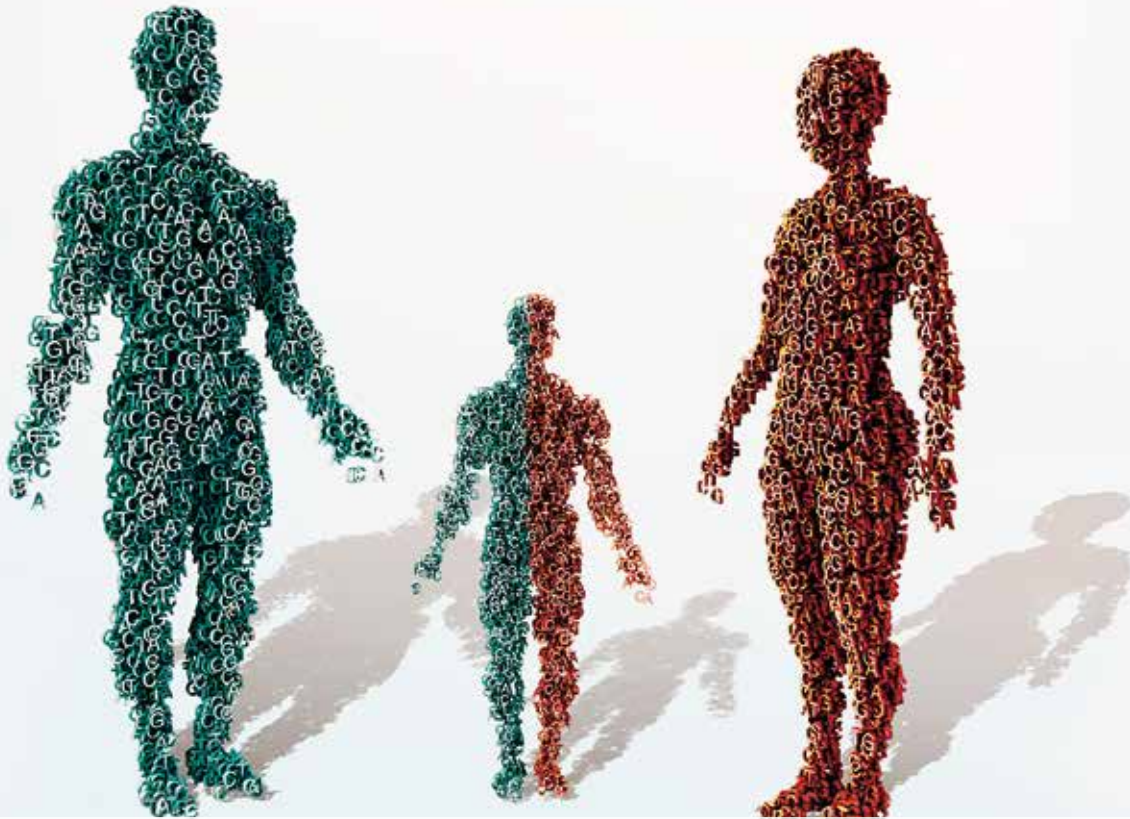
Bergen, R.S. van, Ji Ma, W., Pratte, M.S. & Jehee, J. (2015). Sensory uncertainty decoded from visual cortex predicts behavior. *Nature Neuroscience*, 18 (12), 1728-1730.

Grent-’t Jong, T., Oostenveld, R., Medendorp, W.P. & Praamstra, P. (2015). Separating Visual and Motor Components of Motor Cortex Activation for Multiple Reach Targets: A Visuomotor Adaptation Study. *Journal of Neuroscience*, 35 (45), 15135-15144.

Helmich, R.C.G., Thaler, A., (7 other authors), Bloem, B.R. & Toni, I. (2015). Reorganization of corticostriatal circuits in healthy G2019S LRRK2 carriers. *Neurology*, 84 (4), 399-406.

Schouwenburg, M.R. van, Ouden, H.E.M. den & Cools, R. (2015). Selective attentional enhancement and inhibition of fronto-posterior connectivity by the basal ganglia during attention switching. *Cerebral Cortex*, 25 (6), 1527-1534.

Dissertations: 15
Academic publications: 589
Professional publications: 9



Prof. Joris Veltman studies entire genomes of patients and their parents.

Theme 3: Plasticity and Memory

Prof. Indira Tendolkar (speaker)

Researchers within the Plasticity and Memory (PM) theme tackle the mechanistic underpinnings and behavioural consequences of long-term changes in neural structure and function. More specifically, the mission is to unravel how neuroplasticity supports adaptation to external and internal challenges, as well as learning and memory throughout the life span. The theme combines a focus

on major mental health problems with the ability to have an impact on other areas such as education.

Research is closely integrated with the Radboudumc research themes 'Neurodevelopmental disorders', 'Stress-related disorders', and 'Alzheimer disease' and divided in three subthemes: a) development, studying the mechanisms and consequences of normal and abnormal neurodevelopment, *i.e.* neurodevelopmental disorders and intellectual disability; b) adaptation, focusing on the neurobiological effects of external and internal challenges, such as environmental factors, stress, and brain damage, as well as their behavioural and emotional consequences with a clinical focus on affective disorders; c) learning and memory, investigating the neural and cognitive mechanisms underlying normal and impaired learning and memory and translating these mechanisms into clinically and educationally relevant constructs. The clinical focus of this subtheme is Alzheimer disease.

Researchers working on the theme have created powerful networks making it possible to use state-of-the-art genetic, epigenetic and genomics techniques, translating them to a variety of animal models as well as human functional neuroimaging approaches, experimental



Joris Veltman (Professor of Translational Genomics) was awarded an NWO Vici grant, which will enable him to further explore the role of spontaneous mutations in intellectual disability and expand this to male infertility. He will examine the entire genome of patients and their parents and investigate how paternal age at conception and reproductive technologies impact the number of these mutations in parents' offspring.

psychology and neuropsychological research. Finally, fundamental research at the human system level is combined with clinical applied research both in fine-tuned mechanistic as well as large-scale patient cohort studies.

Research results

Researchers working on development showed that the serotonin transporter 5-HTTLPR genotype moderates the effect of stress on the severity of attention deficit hyperactivity disorder (ADHD) via changes in brain regions involved in social cognitive processing and cognitive control.

Researchers working on adaptation used structural magnetic resonance imaging to show that even in a healthy population different types of childhood adversity are related to specific alterations in brain structure, which are modulated by sex. These findings may help understand neurodevelopmental consequences related to childhood adversity. Other researchers showed that stress can cause a shift away from more controlled processing, depending on the hippocampus towards more reflexive processing supported by the amygdala and striatum, which is mainly mediated by activation of the mineralocorticoid receptor (MR) for cortisol.

Researchers working on learning and memory investigated the relationship between behavioural performance and prefrontal activation by modulating different levels of working-memory load. They examined how healthy elderly subjects performed a spatial working-memory task and how this was related to haemodynamic changes as measured by two functional Near-Infrared Spectroscopy channels. The results showed that bilateral prefrontal activation may not always be successful in compensating brain damage. Individual behavioural performance should be taken into account to be able to distinguish successful and unsuccessful compensation or declined neural efficiency.

Future research

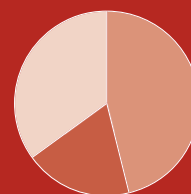
A European Training Network coordinated by Barbara Franke, which involves Jan Buitelaar and Alejandro Arias-Vasquez, Annette Schenck, and Nanda Rommelse, will continue working on the aetiology of ADHD and autism. Aart Schene and collaborators received funding from the 'Fonds psychische gezondheid' to develop e-based cognitive interventions in depression. After an excellent mid-term evaluation from the Helmholtz society, Indira Tendolkar – in collaboration with David Norris – will continue to study the effect of physical activity on neurocognitive changes in type 2 diabetes patients at the Erwin Hahn Institute in Essen, Germany. Supported by the international Alzheimer Organisation Jurgen Claassen and collaborators will study the effect of sleep on Alzheimer. Amanda Kiliaan obtained funding from Danone to study the impact of nutrition on stroke. Erno Hermans was awarded an ERC Consolidator Grant which he will use for his research on stress in daily life and to study how acute stress affects our capacity to switch quickly between large-scale neural systems in the brain.

Staff

Tenured		
Prof. J.H.L.M. van Bokhoven (o)	Full Professors 10.35 FTE	
Prof. H.G. Brunner (o)	Associate Professors 3.88 FTE	
Prof. J.I.M. Egger (e)	Assistant Professors 11.8 FTE	
Prof. L. Fasotti (e)	Researchers 7.74 FTE	
Prof. G.S.E. Fernandez (o)		
Prof. B. Franke (p)		
Prof. R.P.C. Kessels (o)	Non-tenured	
Prof. R.T.C.M. Koopmans (o)	Researchers 36.14 FTE	
Prof. L.T. Kozic (o)	Doctoral candidates 67.27 FTE	

Prof. E.L.J.M. van Lijstelaar (o)
 Prof. G.J.M. Martens (o)
 Prof. M.G.M. Olde Rikkert (o)
 Prof. B. Roozendaal (o)
 Prof. A.H. Schene (o)
 Prof. A.E.M. Speckens (o)
 Prof. J.A. Veltman (o)
 Prof. G.J. van der Wilt (o)

Research funding



(o), (e) and (p) see Glossary

Core Grants Contracts

Key publications

Hibar,* D.P., Stein,* J.L., Renteria,* M.E., Arias-Vasquez,* A., Desrivieres,* S., (*many others*), Martin,* N.G., Wright,* M.J., Schumann,* G., Franke,* B., Thompson,* P.M., Medland,* S.E. (2015). Common genetic variants influence human subcortical brain structures. *Nature* 520: 224-229.

Bus, B.A., Molendijk, M.L., Tendolkar, I., Penninx, B.W., Prickaerts, J., Elzinga, B.M., Voshaar, R.C. (2015). Chronic depression is associated with a pronounced decrease in serum brain-derived neurotrophic factor over time. *Mol Psychiatry* 20(5):602-8.

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Dissertations:	16
Academic publications:	474
Professional publications:	11



Brain activities are measured during the performance of specific tasks.

Theme 4: Brain Networks and Neuronal Communication

Prof. Tansu Celikel (speaker)

The mission of researchers working on the Brain Networks and Neuronal Communication (BNNC) theme is to characterise and understand how groups of neurons interact and which mechanisms are involved in influencing behaviour and cognition. The research focus is on the network perspective, with the aim of understanding neural coding and communication at various levels. Vertical integration is approached experimentally by applying and

developing state-of-the-art methodology, spanning the full range from recording individual neurons in animals to human imaging of brain networks. The experimental methods are complemented by the development of advanced analysis techniques, which also embrace the various levels. Theoretically, computational principles for neuronal coding and communication are developed using computational models ranging from synaptic communication to network dynamics.



Mike Cohen (Assistant Professor at the Science and the Medical Faculty), received an ERC Starting Grant and a Radboudumc Hypatia fellowship. His research focuses on the study of theta oscillations in the mid-frontal cortex. This activity, which is associated with preparing for an action and adapting behaviour, predicts how well people learn from their mistakes.

It is becoming increasingly clear that cognition and behaviour need to be understood at the level of dynamic network interactions involving several brain regions. Likewise, it is now also recognised that pathologies in neural communication may underlie neurological and psychiatric disorders. Researchers working on the BNNC theme are therefore involved in numerous clinically-related projects.

The aim of the theme is to make theories, method developments and state-of-the-art techniques available to the broader community. This is achieved through various proactive efforts to disseminate and educate, including making toolboxes and databases publically available.

Research results

Computational studies found that neural communication across synapses are shaped by independent mechanisms where different modes of neurotransmitter release allow permissive or instructive changes in neuronal communication.

Correlated changes across synaptically coupled networks modify functional connectivity throughout the brain. This coupled activity has been traditionally quantified using covariance. A new probabilistic generative model allows the estimation of functional connectivity in terms of both partial correlations and a graph representing conditional independencies.

It has been proposed that neuronal oscillations could mechanistically mediate consolidation and mnemonic representations in the brain. Experimental observations from the human brain and cross-frequency phase amplitude coupling analyses now suggest that hierarchically nested loops of oscillations, spindles and ripples provide a fine-tuned temporal window for the transfer of hippocampal memory traces.

Systems level understanding of functional networks in the brain requires the study of neural circuits in high-spatial resolution. Most of our current knowledge on the subregions of brain locus of interest originates from animal studies. Application of high-field functional magnetic resonance imaging for mapping the functional organization of the human entorhinal cortex now describes the functional topography along the entorhinal cortex, localizing the human homologue of rodent entorhinal cortex subregions.

System-level studies of neural communication have outstanding promise in providing unique neurofeedback and brain-machine communication applications. In a recent study BNNC researchers identified a 'regulation network' that is activated during real-time fMRI neurofeedback experiments.

Future research

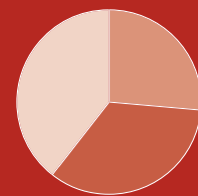
We will continue focus on development of data acquisition techniques while combining methods. MR multiband acquisition will be refined to further reduce the scan times. Imaging with laminar resolution will be improved by developing a statistical model to complement multi-unit recordings in freely behaving animals. Analysis approaches will be scaled to accommodate large and high-dimensional datasets, promoting strategic collaborations to enable vertical data integration.

The findings in humans and animals will be integrated with the aim of providing a system neuroscience perspective on neuronal communication and dynamics. Collaborations on clinical research will be extended to understanding neurological and psychiatric disorders at the network level. Brain-computer interfacing will be further developed, with the aim of improving communication – and device control – by disabled patients.

Staff

Prof. C.F. Beckmann (o)	Tenured	
Prof. T. Celikel (o)	Full Professors	4.92 FTE
Prof. P.W.M. Desain (o)	Associate Professors	0.31 FTE
Prof. P. Fries (e)	Assistant Professors	5.46 FTE
Prof. C.C.A.M. Gielen (o)	Researchers	2.20 FTE
Prof. O. Jensen (o)		
Prof. H.J. Kappen (p)	Non-tenured	
Prof. D.G. Norris (p)	Researchers	24.09 FTE
Prof. B.E.R. de Ruyter (e)	Doctoral candidates	39.62 FTE
Prof. P.H.E. Tiesinga (o)		

Research funding



(o), (e) and (p) see Glossary

Core Grants Contracts

Key publications

Martens, M.B., Celikel, T., Tiesinga, P.H. (2015). A developmental switch for Hebbian plasticity. *PLoS Comput Biol.* 11(7):e1004386.

Hinne, M., Janssen, R.J., Heskes, T., van Gerven, M.A. (2015). Bayesian Estimation of Conditional Independence Graphs Improves Functional Connectivity Estimates. *PLoS Comput Biol.* 11(11):e1004534.

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Dissertations:	6
Academic publications:	165
Professional publications:	7