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The University had an exceptionally good year in 2012. Not only in terms of the number of major grants and prizes awarded to our researchers, but also due to the fact that both the quality and the quantity of our research output have again increased substantially.

We are especially proud of Professors Ieke Moerdijk and Mike Jetten (who each won a prestigious Spinoza Prize), of Professors Bart Jacobs and Nico Verdonschot (who each received an ERC Advanced Investigator grant), and of Professors Peter Hagoort and Jan van Hest (whose proposals for the very large NWO ‘Gravitation’ programme were both successful). In addition to these excellent achievements we would also like to mention the many grants and prizes received by younger generations of researchers across all of the faculties at the University.

Our strategic plans over the last decade have emphasized the importance of focusing on quality. We can now conclude that this strategy has worked very well and that we are harvesting the results of efforts and investments based on these plans. This conclusion is based on the fact that the University performs outstandingly when it comes to acquiring research grants and research contracts – both from national and European funding bodies – as well as on the fact that improvements in our researchers’ citation impact scores have exceeded the national average of all universities in the Netherlands.

By emphasizing our distinctive research profile and strengthening our links with partner institutions, we are also better able to anticipate societal needs. Good academic research is good for society. As you can read in this report, research done at this University is firmly connected to a range of important societal issues. We aim to continue to bridge the gap between academic research and its use in the widest possible sense.

With an eye on the years ahead we intend to become one of the world’s leading academic institutions. Research, education and ensuring that science is of benefit to society are all in good shape at Radboud University Nijmegen, so we feel confident that we will be able to achieve this ambition.

Prof. Gerard Meijer
President

Prof. Sebastian Kortmann
Rector Magnificus
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Introduction

Radboud University Nijmegen is a student-oriented research university. We focus on quality, combining excellent education with leading-edge research. While leaving scope for diversity, we concentrate our efforts on four of the five major academic domains: Arts & Humanities, Social Sciences, Natural Sciences and Life Sciences. For work in the fifth domain (Technical Sciences) – which is not one of our core competences – we cooperate closely with colleagues at the University of Twente, Eindhoven University of Technology and Wageningen University & Research Centre. Furthermore, our academic expertise is closely connected to important societal issues, both in the public and in the private domain.

Our ambition

Research at the University is organized within 17 dedicated institutes. These are responsible for planning research as well as for training and supervising new generations of researchers. We aim to ensure that all research programmes within the institutes are internationally competitive and that they make a significant contribution to each discourse community. Consequently, in independent peer review assessments, all research programmes are expected to receive at least a “very good” score for the criteria quality, productivity, societal relevance and vitality.

Regarding these criteria, all research institutes and their programmes have evolved and improved in recent years. The quality of research has been further enhanced by close cooperation with partners who complement our expertise.

Our ambition is to become one of the leading academic institutions in the world and in 2012 we once again made good progress towards achieving this aim. Radboud University Nijmegen is now one of the top 150 institutions in the Academic Ranking of World Universities (ARWU; Shanghai), reaching the 138th position in 2012. Numbers of academic publications, publications in top-ranking journals, citation impact scores, dissertations and research grants – mostly obtained in strong competition with other universities – have increased substantially (see Figures 1-3).

Aims for the near future are 1) to increase our academic impact, 2) to strengthen our societal impact and 3) to intensify the use of our research results.

Our research profile

It is our intention that all research carried out at Radboud University Nijmegen either already is or will soon be leading nationally and competitive internationally. Among our research topics, nine sub-disciplines

A new President

After twelve years as President of the Executive Board of the Radboud University Nijmegen, Roelof de Wijkerslooth retired in May 2012. He was widely acknowledged for his success, both in strengthening the quality and infrastructure of our University and in building a bridge between Nijmegen and national Dutch politics in The Hague. During his presidency, all academic quality parameters, such as impact factors, also significantly improved.

The new President, Prof. Gerard Meijer, was appointed in September 2012. He is a highly esteemed, internationally recognized researcher and administrator. As the former director of the Fritz Haber Institute of the Max Planck Society in Berlin, he has an excellent international scientific network. He is known for his achievements in Experimental Physics, in particular the manipulation of neutral molecules with electric fields. His publications have been cited over 15,000 times.
have been identified in which the quality exceeds the high level of the rest of the University.

**Organic Chemistry**
The focus areas within Chemistry at our University (Material Science, Life Science, Biomedical Science and Supra-Molecular Chemistry) are all related to Organic Chemistry. We concentrate on Synthesis and on Physical Organic Chemistry and recently the input from the Life Sciences has become more important. This research takes place within the Institute for Molecules and Materials as well as in the Nijmegen Centre for Molecular Life Sciences. The research infrastructure and facilities within these institutes are excellent. Another indication of top-quality research in Organic Chemistry is the numerous prestigious grants awarded in recent years, such as ERC Advanced grants, Spinoza Awards and Netherlands Organisation for Scientific Research (NWO) Vici grants. In 2012, the Organic Chemists at the University received – together with the Eindhoven University of Technology and the University of Groningen – one of the six highly prestigious ‘Gravitation’ programmes from the NWO for work over the next decade. Furthermore, Prof. Wilhelm Huck (Professor of Physical Organic Chemistry) was elected as a member of the Royal Netherlands Academy of Arts and Sciences (KNAW).

**Physics of Condensed Matter**
Research on the Physics of Condensed Matter at the University is strongly interrelated with Chemistry research. It is embedded in the national programmes Nanonex and Nanonext, as well as in international EU programmes. Unique infrastructures such as the High Field Magnet Laboratory (HFML) and three advanced Free-electron Laser Units (FELIX/FELICE/FLARE) create excellent opportunities for further extending international cooperation. Both Experimental Physics of Condensed Matter and Theoretical Physics of Condensed Matter at our University are at the forefront of current science. The cooperation between experimentalists and theoreticians on graphene formed the basis for the 2010 Nobel Prize in Physics, which was awarded to former Associate Professor and current Extraordinary Professor André Geim and Professor Konstantin Novoselov, a PhD graduate from our University. In 2012, some major developments strengthened the position on this field of research in Nijmegen. Contracts for cooperation and joint exploitation were signed by the University and some other key European players (for more details see page 124).

**Astrophysics**
For many decades now Astrophysical research in the Netherlands has been influential and well organized. This research has a more recent history in Nijmegen. Since 2001, when a group of highly talented researchers joined us, Astrophysical research at the University has become truly competitive internationally. It focuses on the evolution of double stars, compact objects and astrophysical particles. The quality of the research is evident from the successful acquisition of prestigious grants such as ERC Advanced grants and the Spinoza Award. In 2012, Prof. Conny Aerts received the most prestigious science prize in Belgium, the Francqui Prize. Another important step in 2012 came when the Astronomy group at Utrecht University joined with colleagues at Radboud University Nijmegen.
Introduction

**Microbiology**
The research on gene-environment interactions at the University concentrates on the composition, functioning and evolution of ecosystems. This includes all major biotic organisms such as micro-organisms, plants and animals, and their interactions. Adaptation – and response to stress – by these organisms are investigated at the level of their molecular and physiological regulation mechanisms. The team of Microbiologists at the University focuses on the reaction of ecosystems to water, both in terms of quantity and quality. In particular, their research on Anammox bacteria, which are able to efficiently degrade ammonium without oxygen, led to revolutionary insights and world-class publications. The excellent quality of research in this field is demonstrated, for instance, by the fact that the team received an ERC Advanced grant. And, in 2012, Prof. Mike Jetten received the NWO Spinoza prize for discovering many new (anammox) bacteria and the elucidation of their unique useful properties.

**Cognitive Neurosciences**
In 2000 the University established the F.C. Donders Centre for Cognitive Neuroimaging. In recent years leading-edge research on brain and cognition has accelerated and several related institutes on the campus have joined forces to form the current Donders Institute for Brain, Cognition and Behaviour. Affiliated institutes (also on the campus) are: the Max Planck Institute for Psycholinguistics, the Centre for Language Studies and the Behavioural Science Institute.

Cognitive Neuroscience research at the University covers all aspects that are important for cognition: from molecules and genes, neurons and networks of brain areas, to behavioural and clinical implications. The multi-disciplinary approach taken by physicists, biologists, chemists, psychologists and informaticists – as well as the excellent advanced infrastructure and facilities – creates the conditions for high-quality research. This is apparent from the many grants won (against strong competition) by this institute: these include an ERC Advanced grant, a Spinoza prize and several NWO Vici grants. Some major successes in 2012 underlined the strength of this research area at the University. First, one of the two KNAW professorships was awarded to Prof. Peter Hagoort, and second, a proposal for the prestigious NWO ‘Gravitation’ programme ‘Language in Interaction’, which is coordinated by Prof. Peter Hagoort, was successful. Third, Prof. Roshan Cools was awarded both the James McDonnell Scholar Award and the Investigator Award of the Cognitive Neuroscience Society. Fourth, one of the five Heineken Young Scientists Awards 2012 went to Dr Floris de Lange, who also won the international Biomag 2012 Young Investigator Award in Paris.

**Infection and Immunology**
Fundamental research and clinical translational research at the University take place at the interface between micro-organisms and hosts.

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_Figure 1: Researchers (in FTEs) per year_

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One of the five Heineken Young Scientists Awards 2012 went to Dr Floris de Lange, who also won the international Biomag 2012 Young Investigator Award in Paris.
and man, defence mechanisms and inflamma-
tion mechanisms following infection, 
inflammatory diseases (such as auto-
immune diseases), as well as cancer and 
transplantation. There is close cooperation 
with researchers at the clinical centres for 
infective diseases, inflammatory diseases 
and immune diseases. The successful 
acquisition of a number of prestigious 
grants, including the ERC Advanced 
grant, the Spinoza prize and the NWO Vici 
grants, confirm the excellent performance 
of the teams involved in Infection and 
Immunology. In 2012, Prof. Wim van den 
Berg received the IAIS Lifetime Achievement 
Award for significant scientific contributions 
in the field of inflammation and Dr Teun 
Bousema won the prestigious EU Merial 
Award for young researchers in parasitology.

**Human Genetics**

The identification of genes involved in 
congenital abnormalities, intellectual 
disability, psychiatric diseases, heritable 
development of tumours, deafness, and 
blindness – as well as the mode of action 
of these genes – are important research 
areas at the University. Human Genetics 
researchers have access to the latest tech-
nologies and modern bio-informatics 
equipment. Alongside fundamental 
research, translational research is also 
highly successful. Some of the newest 
 genetic techniques for diagnosis (such 
as DNA chips and Exome sequencing) 
were applied here for the first time world-
wide. The excellent qualities of the Human 
Genetics team are reflected in the very large 
number of papers published in top journals 
such as *Cell, Nature Genetics, Science* and 
the *New England Journal of Medicine* as well 
as their success in acquiring multi-million 
euro grants from competitive research 
funding bodies in the Netherlands and 
in the EU. Significant achievements in 
2012, such as two NWO Vici grants 
(Prof. Barbara Franke and Prof. Ronald 
Roepman), underscored the academic 
reputation of the researchers working 
in this sub-discipline.

**Linguistics**

Ground-breaking research on Linguistics 
is carried out in language, language 
behaviour, language and speech technology, 
and communication. The research focuses 
on two main themes: Language in the mind 
(including learning a mother tongue, the 
production and processing of language) 
and Language in society (covering the use 
of language in a variety of cultures and 
subcultures). Also, thanks to close multi-
disciplinary cooperation with other 
institutes on the campus (especially the 
Max Planck Institute for Linguistics and 
the Donders Institute for Brain, Cognition 
and Behaviour), the linguistic researchers 
at the University are among the best of the 
world. They have received prestigious grants 
such as ERC Advanced grants and the 
Spinoza prize. In 2012, the Centre for 
Language Studies was assessed as ‘Excellent’ 
and Prof. Antal van den Bosch (Professor 
of Business Communication) was elected 
as a member of the KNAW.

**Business and Law**

Research at the Business & Law Research 
Centre is carried out in close cooperation 
with fourteen highly renowned – mostly 
international – law firms, financial 
institutions and companies. These joint 
efforts relate to academic research in 1) 
company law, 2) financing, security rights 
and insolvency, 3) business and patrimonial 
law, and 4) financial law. The Research 
Centre has excellent facilities and a very 
good library. The quality of its research is 
reflected in the production of numerous 
authoritative text books, monographs and
serial volumes. Moreover, the research groups are very successful in raising funds for their studies. One of the major highlights in 2012 was the launch of a prestigious book series on International and Comparative Insolvency Law, which was published by Oxford University Press. In addition, the 2012 Hudig-Langeveld prize was awarded to Prof. Mop van Tiggele - van der Velde (Professor of Insurance Law).

**Internationalization**

Most of the research at Radboud University Nijmegen is international. Either the research equipment is too large for one university to use alone (this is the case for research in Astronomy, Astrophysics, Particle Physics and High magnetic fields) or the research topic has global dimensions (such as research on human health, education, literature, international law, computer security and nature management). This is why researchers at our institutes actively join forces with colleagues at institutes around the world. The main reasons for our commitment to international cooperation are: complementing and creating synergy of expertise and/or facilities, enhancing critical mass, forming (European) research consortia, recruiting talented students and signalling job opportunities. A substantial number of the doctoral candidates, post-doctoral researchers and other staff working at the University were born outside the Netherlands (22% FTE of all researchers). On the inside front cover of this report you can get an impression of our numerous international partner institutions around the globe.

**Societal impact**

Much of the work done at the University is closely related to important societal issues. As a result, much of the research agenda is inspired by developments in and demands from society. We thus contribute significantly to achieving governmental objectives in relation to innovation. Our societal impact covers seven main themes:

1. Europe’s “worlds”
2. Language and communication
3. The development of society and justice
4. Behaviour and education
5. Molecules and materials
6. Water and wetlands
7. Personalized medicine.

Some highlights in 2012 illustrate the societal relevance of our research in relation to these themes.

**Europe’s “worlds”**

- The modernist literary periodical *Commerce* appeared between 1924 and 1932 in Paris, with contributions by European writers such as Rainer Maria Rilke, T.S. Eliot, Virginia Woolf, Boris Pasternak and André Gide. Among its editors were Paul Valéry and Valery Larbaud. Everyone of any literary importance in Europe in those days published in *Commerce*. Prof. Sophie Levie (Professor of European Literature) edited and annotated the letters between the writers who published in the magazine, the editorial board and the woman who financed the publication: Marguerite

"Figure 3: Dissertations per year"
Caetani. In 2012, the first two volumes of a total of six appeared, containing hundreds of letters that had never been published before, especially those from the Caetani archive.

- Research on the Vatican archives revealed – among other things – new insights into the political motivation for Emperor Constantine’s conversion to Christianity.
- Prof. Marc Slors (Professor of Philosophy of Cognition) published a widely read and very well reviewed book on free will and neuroscience (for a general audience).

**Language and communication**

- Prof. Aslı Özyürek (Professor of Gesture Language and Cognition) found that deaf children who do not have access to sign language (i.e. home signers) lack certain spatial cognitive skills. This finding is in line with the idea that spatial language facilitates spatial thinking.
- Prof. Peter Desain (Professor of Artificial Intelligence) developed a device for sharing the feelings and thoughts of patients who are unable to speak. In 2012, he received the Dutch national prize for innovation in healthcare.
- The proportion of illiterate and low-literate adults in European countries varies between 10 and 15% of the population. Dr Helmer Strik, leader of the project ‘DigLin: Digital Literacy Instructor’, aims to substantially advance literacy training by developing Computer-Assisted Language Learning (CALL) materials that will allow differentiated teacher-independent learning, making it both cheaper and more effective.

**Development of society and justice**

- The Dutch Ministry of Justice awarded Prof. Janneke Gerards (Professor of Fundamental Rights) and Dr Joseph Fleuren a grant for a comparative research project on the effects of the European Convention of Human Rights on national law.

**ERC Advanced Investigator Grant 2012**

Prof. Bart Jacobs (Professor of Digital Security) and Prof. Nico Verdonschot (Professor of Orthopaedics) each received a highly prestigious ERC Advanced Investigator grant. Prof. Bart Jacobs also was the winner of the national Huijbrechts prize for best academic research that is “remarkably innovative, while at the same time containing considerable societal promise.”

**Previous laureates**

1. Prof. Pieter Muysken
   ERC Advanced Grant 2008
2. Prof. Mike Jetten
   ERC Advanced Grant 2008
3. Prof. Henno Falkke
   ERC Advanced Grant 2008
4. Prof. Conny Aerts
   ERC Advanced Grant 2008
5. Prof. Wilhelm Huck
   ERC Advanced Grant 2009
6. Prof. Carl Figdor
   ERC Advanced Grant 2010
7. Prof. Stephen Levinson
   ERC Advanced Grant 2010
8. Prof. Guillén Fernández
   ERC Advanced Grant 2010
9. Prof. Roeland Nolte
   ERC Advanced Grant 2011
• Prof. Weitzel (Professor of Finance) – in collaboration with the London School of Economics and Political Science and Utrecht University School of Economics – obtained a grant from the Ministry of Economic Affairs for a project on Foreign Direct Investment (FDI) and entrepreneurship.
• Prof. Brandsen (Professor of Public Administration) and Dr Helderman contributed to the Dutch Scientific Council for Government Policy (WRR) report on future developments and strategies at the intersection of health care, housing and pensions research.

Behaviour and education
• In recent years studies on language learning have resulted in a large number of academic publications. In order to translate this accumulation of knowledge into daily practice in Dutch primary schools, Prof. Ludo Verhoeven (Professor of Remedial Education) and Dr Eliane Seegers edited a special issue of the Dutch professional journal ‘Didactief’ entitled ‘Language talent’. This issue was disseminated to all primary schools in the Netherlands in 2012.
• Researchers working on the neural underpinnings of memory, emotion and their interactions studied how prior knowledge affects new learning. The results revealed that prior knowledge improved learning of new, related information and that this effect is mediated by encoding and consolidation processes. This research is fundamental in nature, but it is also relevant for education. For example, the data revealed brain processes that predict individual academic success at university.
• Prof. Karin Roelofs (Professor of Experimental Psychopathology) received an NWO Vici grant which will enable her to study freeze-flight-flight behaviour, which is relevant for example for police officers who are exposed to stressful situations.

Molecules and materials
• Prof. Elias Vlieg (Professor of Solid State Chemistry) and Dr John Schermer signed the first innovation contract – within the Dutch Government’s ‘Top sectors’ of major economic importance – for further development and exploitation of high-efficiency solar cells.
• Prof. Alan Rowan (Professor of Molecular Materials) and Dr Paul Kouwer have developed synthetic gels that mimic – in nearly all respects – gels prepared from intermediate filaments which govern the mechanical properties of biological systems. These gels become solid under warm conditions and melt when cold, which makes them useful for numerous practical applications.

Water and wetlands
• Aquatic ecologists at the University were able to unravel a number of exciting new plant-environment interactions, including the extreme oxygenation of peat by vascular plants in pristine Patagonian peatlands, thus neutralizing methane emissions to the atmosphere.
• Animal ecologists established for the first time that aquatic nymphs do heat harden and that such a hardening effect was elicited most strongly by hypoxia, not heat.

Personalized medicine
• Prof. Jelle Barentsz (Professor of Functional Imaging) received a Lifetime Achievement Award from The Society of Uroradiology for his outstanding achievements and innovations in MRI research in bladder, ovarian, cervical and prostate cancer over a period of 20 years. He is the youngest person and only the second non-American to receive this award.

• Prof. Lutgarde Buydens (Professor of Analytical Chemistry) and her group have proposed a new method for identifying complex diseases in individuals. Statistical health control provides a new tool for diagnostic support that is both more objective and flexible (i.e. more useful) in a clinical setting than current practice.
• The causes of intellectual disability remain largely unknown, due to extensive clinical and genetic heterogeneity. In a ground-breaking study in the New England Journal of Medicine, 2012 conducted by Lisenka Vissers and her colleagues, evidence was provided that exome sequencing can be used as a diagnostic procedure for patients with severe intellectual disability of unknown cause. Improvement in methods and the identification of additional genes associated with intellectual disability are likely to further improve the diagnostic yield.

Valorization
Valorization – the conversion of academic knowledge into results with societal value – takes place in various ways within all four major academic domains.

<table>
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<th>Interaction with society</th>
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<td>Public debates, exhibitions, lectures, NGOs</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>Law, mental healthcare institutions, government departments, NGOs</td>
</tr>
<tr>
<td>Natural Sciences</td>
<td>Industries, NGOs</td>
</tr>
<tr>
<td>Life Sciences</td>
<td>Hospitals, companies, NGOs</td>
</tr>
</tbody>
</table>

Research on the Vatican archives revealed – among other things – new insights into the political motivation for Emperor Constantine’s conversion to Christianity.
Knowledge and technology transfer is an integral part of the core tasks and ambitions of Radboud University Nijmegen. By fostering knowledge and technology transfer we aim to stimulate innovation and create conditions for the emergence of entrepreneurship.

In order to encourage the use of academic knowledge in society the University has developed the following activities: post-academic education, joint research with private and public partners, public events, the formulation of guidelines, facilitating the establishment of new companies, encouraging start-up companies and educating students in entrepreneurship.

The University has successfully spun off dozens of innovative companies in the past decade. The idea is to develop innovative high-tech entrepreneurship based on new insights from academic research. As a result, employment in the region has increased substantially.

Researchers at the KNAW-Rathenau Institute compared several quality parameters of Dutch universities and in their recent (2012) report they described Radboud University Nijmegen as a very entrepreneurial university. This conclusion was based on the relationship of contract research to core funding.

Some examples of valorization in 2012:

The Rembrandt Documents Project (see www.ru.nl/remdoc) – a joint initiative of Radboud University Nijmegen, Museum The Rembrandt House in Amsterdam, and the Huygens Institute for the History of the Netherlands – was launched. The aim of RemDoc is to collect and make available all known documents that relate to the renowned Dutch painter Rembrandt van Rijn. All documents will be transcribed and annotated under the supervision of HLCS scholar Prof. Volker Manuth and Jaap van der Veen, research curator at the Rembrandt House Museum, and these will be translated into modern Dutch and English.

Radboud University Nijmegen has the following faculties:
• Faculty of Philosophy, Theology and Religious Studies
• Faculty of Arts
• Faculty of Law
• Faculty of Social Sciences
• Nijmegen School of Management
• Faculty of Science
• Medical Centre (Faculty of Medicine and University Hospital)

Fundamental and applied research is carried out within specialized institutes:
• Research Institute for Philosophy, Theology and Religious Studies
• Institute for Historical, Literary and Cultural Studies
• Research Centres of the Faculty of Law
• Institute for Management Research
• Nijmegen Institute for Social & Cultural Research
• Centre for Language Studies
• Behavioural Science Institute
• Donders Institute for Brain, Cognition and Behaviour
  - Centre for Cognition
  - Centre for Cognitive Neuroimaging
  - Centre for Neuroscience
• Institute for Genetic and Metabolic Diseases
• Research Institute for Oncology
• Nijmegen Institute for Infection, Inflammation and Immunity
• Nijmegen Centre for Evidence-Based Practice
• Nijmegen Centre for Molecular Life Sciences
• Institute for Water and Wetland Research
• Institute for Molecules and Materials
• Institute for Mathematics, Astrophysics and Particle Physics
• Institute for Computing and Information Sciences

Preparing for a career in research with Research Masters studies:
• Behavioural science: the study of behavioural regulation
• Cognitive neuroscience
• Historical sciences
• Art and visual culture
• Language and communication: the empirical study of human communicative capacities
• Literature and literary sciences: new philology
• Molecular mechanisms of disease
• Business and Law
• Philosophy
• Social cultural science: comparative research on societies
Dr Boris Reuderink, a postdoc at the Donders Centre for Cognition and his spin-off company ‘Senzing’, received a STW Valorization grant to continue research on controlling a game using a brain-computer interface.

TropIQ Health Sciences – a spin-off of RUNMC, together with co-founder Prof. Robert Sauerwein – received a grant from the Bill & Melinda Gates Foundation for their groundbreaking innovative research on luminous parasites, which is designed to accelerate the search for a cure for malaria.

Our academic reputation

The NWO Gravitation programme

Through the new NWO ‘Gravitation’ programme the Dutch government encourages excellent research by consortia of the best researchers in the Netherlands. It is dedicated to academic consortia that have the potential to achieve best-in-the-world quality within their field of science. It finances the best research teams for a period of 10 years. Two of the six consortia which received such a programme in 2012 are coordinated by Radboud University Nijmegen.

The overall aim of the programme coordinated by Prof. Peter Hagoort (Language in Interaction) is to understand the universal constraints that biology places on the language system, the interplay between the biology and the environment, population level variation and its relationship with cultural variability.

The NWO Spinoza prize

The NWO awards the annual Spinoza prize to a maximum of four Dutch researchers who are at the very top in their field, both nationally and internationally. These scientists receive this prestigious prize for outstanding, ground-breaking and inspiring research, and their record in inspiring young researchers. In 2012, Prof. Ieke Moerdijk (Professor of Algebra and Topology) and Prof. Mike Jetten (Professor of Environmental Microbiology) were two of the four laureates.

Prof. Ieke Moerdijk won this €2,500,000 prize for his innovative research in algebraic topology and logic. He also received the prestigious Descartes-Huygens prize from the French and Dutch governments.

Prof. Mike Jetten received the Spinoza prize for the discovery of many new (anammox) bacteria and the elucidation of their unique properties.

ERC Advanced Investigator grant

Prof. Bart Jacobs (Professor of Digital security) received the prestigious ERC Advanced Investigator grant to further develop his ideas on quantum computing. He also was the winner of the national Huijghregsen prize for best academic research that is “remarkably innovative, while at the same time containing considerable societal promise.”

Two of the six consortia which received a highly prestigious NWO ‘Gravitation’ programme in 2012 are coordinated by Radboud University Nijmegen.

Newly elected members at international Academic Societies

• Prof. Sible de Blaauw (Professor of Early Christian Art and Architecture) has been appointed as a member of the Academy of Sciences and Literature in Mainz (Germany).

• Prof. Han Brunner (Professor of Human Genetics), Prof. Peter Hagoort (Professor of Cognitive Neuroscience) and Prof. Bart Jacobs (Professor of Digital Security) have been elected as members of the Academia Europaea.

• Emeritus Prof. Jos van der Meer – former director of the N4i – has been elected as President of the European Academies Science Advisory Council (EASAC).

• Prof. Gerard Meijer has been elected as an external scientific member of the Fritz Haber Institute of the Max Planck Society in Berlin.

External evaluations

Research institutes such as those at our University are periodically evaluated by an international committee of peers. Based upon their assessment and recommendations, plans for further improvements are implemented.

The review committees assess the institutes according to the Standard Evaluation Protocol for Academic Research in the Netherlands, including an evaluation of the training and education programme for PhD students. For each research programme, there are four criteria: 1) quality, 2) productivity, 3) relevance and 4) vitality & feasibility. The assessments range from excellent to unsatisfactory, and are defined as follows:
In 2012 the research at two institutes at Radboud University Nijmegen was evaluated.

Centre for Language Studies (CLS)
The Evaluation Committee wrote in its report on the CLS: “The research done in the institute is world leading, and has an important and substantial impact in the international field. The institute has a unique position in language studies, which is made possible by the ‘triangle’ cooperation with the Donders Institute for Brain, Cognition and Behaviour and the Max Planck Institute for psycholinguistics.” In summary, the Committee assessed the research at CLS as “excellent” on each of the four criteria.

Institute for Historical, Literary and Cultural Studies (HLCS)
The research at HLCS was also highly appreciated. The Assessment Committee wrote: “The overall quality of the institute seems very good, although there are differences to be observed between the four programmes. A significant number of the institute’s members are clearly international leaders in their field. The leadership of director Prof. André Lardinois is outstanding; his dedication, creativity, and vigorous actions add dynamism to the institute”. In summary, HLCS was assessed “very good” (overall score: 4.2).

Academic integrity
In 2012 – after the detection of a major case of fraud by a Dutch professor – a national debate on academic integrity has taken place. A nation-wide committee of highly esteemed scientists published

Spinoza prize 2012

Prof. Ieke Moerdijk and Prof. Mike Jetten – two of the four NWO Spinoza Prize laureates in 2012.

Previous laureates

1 Prof. Pieter Muysken Spinoza Award 1998
2 Prof. Anne Cutler Spinoza Award 1999
3 Prof. Bert Meijer Spinoza Award 2001
4 Prof. Henk Barendregt Spinoza Award 2002
5 Prof. Peter Hagoort Spinoza Award 2005
6 Prof. Carl Figueira Spinoza Award 2006
7 Prof. Theo Rasing Spinoza Award 2008
8 Prof. Henk Falcke Spinoza Award 2011
a report on conduct and misconduct of research practice, including recommendations to prevent new violations of academic integrity. Anticipating this report, the University’s Committee on Academic Integrity updated the existing regulations regarding this important issue. The University Board actively promotes the assurance of academic integrity and accountability by stimulating awareness on this topic at every level of research. In this context, all research institutes reported on their current practice, improvements and further implementations of rules and high standards for sound scientific conduct. These practices include dedicated seminars for staff members, doctoral candidates and Research Master’s students, new policies for data storage and management (data acquisition, data analysis and reporting), and securing critical assessment by expert colleagues.

It is our policy to avoid experiments with animals (as far as possible) and to explore alternative methods in which no animals are involved. We also contribute to optimizing the conditions in which animal experiments take place and critically summarizing all available evidence by applying the methodology of systematic reviews. Systematic reviews have been carried out for clinical trials for decades and these are now being applied to animal studies as well (see: www.SYRCLE.nl). Systematic reviews contribute to better quality science, the implementation of the best-practice three Rs (Replacement, Reduction and Refinement) and, last but not least, improved patient safety.

As required by law, experiments that include human or animal subjects are performed only under conditions of positive assessment and justification by an independent ethical committee.

A particular aspect at the Institute for Computing and Information Sciences relates to situations when weaknesses in the security of commercial digital devices have been identified. In such cases results are reported first to the companies or authorities involved, before they are made public.

Grants and awards for excellent young researchers
In 2012 many young researchers and Research Master’s students at the University again received prestigious national or international grants or awards, competing with some of the best in the world.

Twenty researchers received an NWO Veni grant, which will enable them to do research for three years after graduating with a PhD. The winners were Drs Esther Aarts, Heleen Arts, Chantal Bax, Martin Dresler, Margriet Groen, Helle Hvid Hansen, Simon van Heeringen, Wieteke Hoeijmakers, Hans Jacobs, Femke Maij, Theo Plantinga, Hilde van der Schaar, René Scheerenga, Margit Schraders, Nadia Sonneveld, Jeroen Strating, Jochem Tolsma, Maaike Verhagen, Steffen Wiedmann and Erwin van Wijk.

Seven post-doctoral researchers received an NWO Vidi grant, which will enable them to develop their line of research for five years. These grants were awarded to Drs Richard Bartfai, Dan Dediu, Martin Drenthen, Elmar Körding, Frank Erik de Leeuw, Odette Scharenborg and Annemieke van Spriel.

Five more senior researchers received NWO Vici grants, which will enable them to further develop their line of research for five years. These grants were awarded to Profs. Barbara Franke, Bram van Ginneken, Joost Hoenderop and Karin Roelofs, and Dr Ronald Roepman.
Six prestigious Starting Grants from the European Research Council were awarded to Drs Anneke den Hollander, Mihai Netea, Karin Roelofs, Alan Sanfey, Oane Visser and Daniela Wilson. With this grant (which is worth €1,500,000) these budding top researchers can initiate their own line of investigation.

Six young researchers received an NWO Rubicon Scholarship to enable them to go abroad to conduct research immediately after gaining their doctorates. These scholarships were awarded to Drs Pieter Naaijkens, Wouter Verdurmen, Theo Eijsvogels, Johan Mentink, Judith Bergboer and Huanan Wang.

Two Research Master’s students (Paola Carvajal Monroy and Polat Dura) were awarded an NWO Mozaïek Grant for a four-year PhD research programme which they designed themselves. The NWO Mozaïek Grant, which is awarded to talented students from ethnic minorities, is designed to support their academic careers.

In 2005, the Royal Netherlands Academy of Arts and Sciences established ‘The Young Academy’, a platform of excellent young scholars aged 25 to 45. Important criteria for new members are scientific excellence, a broad interest in inter-disciplinary cooperation, and involvement in interaction between academia and society. The large number of members from Nijmegen reflects the quality of the younger researchers at the University (see Table 1). Four of the ten newly elected members of The Young Academy are from Radboud University Nijmegen: Prof. Andrea Evers, and Drs Teun Bousema, Marijke Haverkorn and Lotte Jensen.

<table>
<thead>
<tr>
<th>University</th>
<th>Elected members</th>
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<tr>
<td>Radboud University Nijmegen</td>
<td>21</td>
</tr>
<tr>
<td>VU University Amsterdam</td>
<td>13</td>
</tr>
<tr>
<td>Leiden University</td>
<td>13</td>
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<td>Utrecht University</td>
<td>11</td>
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<td>Erasmus University Rotterdam</td>
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<tr>
<td>University of Amsterdam</td>
<td>8</td>
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<tr>
<td>University of Groningen</td>
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<tr>
<td>Maastricht University</td>
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<tr>
<td>Delft University of Technology</td>
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<tr>
<td>University of Twente</td>
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<tr>
<td>Eindhoven University of Technology</td>
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<td>Wageningen University</td>
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<tr>
<td>Tilburg University</td>
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</tbody>
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*Table 1: Elected members at The Young Academy until 2012*
The Research Institute for Philosophy, Theology and Religious Studies (PTR) provides an inspiring and productive research environment for high-quality research in systematic philosophy, theology and religious studies as well as in their histories. The institute produces critical and prominent contributions to current scholarly and scientific debates. Researchers also contribute to societal debates and offer reflection on scientific developments with high societal impact, both as contributions to society and as feedback to science.

The PTR research institute consists of three thematically organized, multi-disciplinary research programmes:

Programme I: Competing Worldviews
This programme’s subtitle is: Philosophy, Theology, and Science as Competitors and Complements. The programme addresses the – often complicated – relationship between philosophical, scientific and religious views on humankind, society and the natural world. Both the history of these problematic issues and their current status are investigated. The programme encompasses projects that focus on specific concepts (such as e.g. the concept of ‘natural law’), methods (e.g. explanation vs. understanding) and institutions (e.g. the Inquisition or the University). It is carried out by researchers from History of Philosophy (Prof. C. Lüthy), Systematic Religious Studies (Prof. A.J.M. Van den Hoogen), History of Church and Christianity (Prof. D.A.T. Müller) and Fundamental Philosophy (Prof. Van Haute).

Prof. Christoph Lüthy published a book on the prodigy David Gorlaeus (1591-1612), a theology student and the first Dutch atomist.
Programme II: Cognitive Humanities
The point of departure of the Cognitive Humanities programme is the fact that culture, which prominently includes language and religion, and the human cognitive system are inextricably intertwined. On the one hand, language, religion and other cultural artefacts are products of the human mind. On the other hand, they provide a unique cognitive niche within which the human mind can function and flourish. Researchers in the programme investigate language and religion by utilizing existing insights into the functioning of the human cognitive system and, conversely, investigating the human cognitive system through insights into language and religion. The programme involves collaboration between researchers from Comparative Religious Studies (Prof. H.J.M. Venbrux), Empirical and Practical Religious Studies (Prof. C.A.M. Hermans), Textual Sources of Judaism and Christianity (Prof. E.J. Van Wolde) and Philosophy of Mind and Language (Prof. M.V.P. Slors).

Programme III: Modernity Contested
Modernization encompasses the growing impact of science and technology as well as the rationalisation and the individualisation of society. Processes of modernisation are often criticised by communities with strong religious identities. Researchers working in this field investigate the status and legitimacy of various critiques of modernity. They focus both on political and moral forms of critique and on religiously motivated forms such as the rejection of modernity by Muslim or Christian fundamentalists. The programme is a collaboration between researchers in Islamic Studies (Prof. Van Nieuwkerk) and Practical Philosophy (Prof. Wils).

Research facilities
The faculty library, which is integrated in the central humanities library, has excellent collections of books and journals on philosophy, theology and religious studies. It houses one of the world’s largest microfilm collection of medieval and Renaissance manuscripts on logic, semantics, natural philosophy, metaphysics and theology. The library possesses several special collections and includes the Catholic Documentation Centre – a unique source for anthropological and missiological research.

Collaboration
The PTR institute promotes and facilitates national and international collaboration at three levels:
1. It encourages individual researchers to participate in national research schools accredited by the Royal Netherlands Academy for the Arts and Sciences as well as in international groups such as ESF research networks. One aim here is to provide specialised research projects with expertise. Another is to remain in contact with national and international developments in relevant fields and to make Nijmegen’s PTR research visible among peers.
2. International collaboration at the level of chairs allows researchers to acquire international experience, facilitates the co-authoring of papers with colleagues abroad and expands the critical mass of the PTR research groups. For this reason the institute has formal agreements with many universities abroad, including high-ranking institutes such as the universities of Edinburgh, Fribourg and Paris IV (la Sorbonne).
3. The three research programmes allow for programme-based cooperation with existing research groups or institutes with complementary research interests. The aim here is to strive for synergy rather than overlap. Thus the programmes can become recognised internationally without giving up their unique profiles. Currently, partnerships are being established with e.g. the Freiburg Institute for Advanced Studies (programme III) and with the Religion, Cognition and Culture programme at Aarhus University, Denmark (programme II).
Research Institute for Philosophy, Theology and Religious Studies

Research results

Programme I: Competing Worldviews
Marking the completion of three large research projects – 1) ‘From Natural Philosophy to Science’ (ESF), 2) ‘Form of the Body or Ghost in the Machine’ (NWO Vidi), and 3) ‘Visualizing the Invisible’ (NWO programme) – the History of Philosophy chair organised a high-profile international conference on ‘Image, Imagination and Cognition’ at the Netherlands Institute for Advanced Studies. Prof. Lüthy published a book on David Gorlaeus. Dr Palmerino contributed to a polemic on thought experiments in the journal Centaurus. Dr Spruit received a Radboud Science Award for his discovery and publication of the Spinoza Vatican manuscript. Dr Hiro Hirai was awarded the 2013 Japanese Society for the Promotion of Science Prize.

The study on the Cathar heretics by Prof. Müller (History of Church and Christianity) led to the establishment of a new research organization ‘CIRCAED’, in collaboration with the University of Toulouse and the EHSS in Paris. Research on the early Roman Inquisition opened access to Vatican archives, giving insight into i) liturgy and monastic regulation and ii) the differentiation between Protestants and Catholics and iii) the political motivation for Constantine’s conversion to Christianity. Prof. Teule initiated cooperation with Russian theological institutes on human rights and orthodoxy and published reports on present-day Christian minorities in the Middle East.

Research in Systematic Religious Studies focused on the relationship between Christianity and modernity. Dr Van Erp studied new approaches in incarnational and sacramental theology. Dr Hübenthal analysed the relationship between sports and Christianity. Prof. Van den Hoogen published on corporate social responsibility from a theological perspective. Dr De Kesel studied the monotheistic ban on images in the confrontation with the Shoah. Dr Van de Brandt continued his study of the development for Constantine’s conversion to Christianity. Prof. Teule initiated cooperation with Russian theological institutes on human rights and orthodoxy and published reports on present-day Christian minorities in the Middle East.

Within Fundamental Philosophy, Dr Van der Heiden completed his project on hermeneutics as ‘giving a voice to those who have no voice’. He initiated a project on the concept of ‘event’. Prof. Van Haute deepened Freud’s ‘crystal principle’, according to which human beings should be examined from the perspective of psychopathology, using recent developments in philosophy. Dr Vastering completed, together with colleagues, a comprehensive historic overview of female philosophers. E. Delahaye, MA and Dr Cimino started an NWO-funded project, in collaboration with Groningen University, on the philosophical reception of the letters of St. Paul.

Programme II: Cognitive Humanities
Within Textual Sources of Judaism and Christianity, after demonstrating that standard methods of dating Biblical texts based on linguistic data are flawed, Dr Rezetko has developed an alternative, which will be published in a monograph in 2013. Prof. Van Wolde applied her cognitive linguistic method of Bible research to the stories of Sodom and Gomorrah and to the Rainbow story (Genesis 9). She demonstrated that the rainbow does not represent a peaceful covenant, but God’s handing over of his fighting bow as a transfer of power. Prof. Van der Watt conducted a comprehensive study of the research on the Johannine literature in Africa. He also conceptualised, edited and published the interlinear Greek-Africaans New Testament.

Within Philosophy of Mind and Language, Prof. Geurts developed an influential new analysis of ‘framing effects’. Dr De Bruin analysed second-person approaches in cognitive neuroscience and demonstrated the need to take reciprocity into account. Prof. Slors published a widely read and very well reviewed book for a wide audience on free will and neuroscience. Dr Bary won the Women Professors Network Prize in the humanities (intended to honour and encourage young women academics).

Within Empirical and Practical Religious Studies the Cognitive Humanities theme is investigated in real-life cases of contextualised cognition, education and self-understanding. Dr Willems et al. conducted a study on teachers as ‘virtue models’ for pupils in Catholic primary education. In an empirical study among psychiatric patients Dr Scherer-Rath et al. confirmed the congruence between patients’ ultimate life goals and their interpretation of contingent life events.

Research on ‘lived religion’ within Comparative Religious Studies probed the limits of secularization. Prof. Venbrux et al. found that in dealing with death a shift in emphasis has occurred from otherworldliness to maintaining kinship ties. C. Venhorst found that, contrary to widespread assumptions, Muslim migrants do adjust to Dutch norms. Prof. Van der Velde showed how lay Western Buddhism is modelled on monastic Asian Buddhism. Prof. Nissen, et al. discerned a demarginalization of alternative spiritualities. Dr Quartier et al. showed how monastic spirituality and pilgrimage are acquiring new meanings. Prof. Nissen co-edited a book comparing Polish and Dutch religious culture. The Hermesdorf Prize for young talent was awarded to Sophie Bolt of the Refiguring Death Rites research group.

Programme III: Modernity Contested
The relationship between modernity and Islam has been addressed in various ways in research within Islamic Studies. Dr Meijer edited a book on the Muslim Brothers in Europe and organized a conference on that theme. Prof. Van Nieuwkerk organized a double panel at the American Anthropological Association (San Francisco) on the
role of the performing arts during the Arab Uprisings and presented her inaugural lecture entitled *A Passage from darkness to light*. Drs. Noor and drs. Van Geel continued research into the role of women in Muslim communities, Dr De Koning and Dr Wagemakers studied radical and quietist Salafism and Talal MA investigated the Islamic economy. The Ministry of Justice provided a grant to Dr De Koning and Becker MA for a research project on Shariah4Belgium. Noor MA received a Frye stipendium. In February, the book *Analysing Muslim Traditions*, edited by Prof. Motzki et. al., was awarded the ‘World Prize for the Book of the Year of the Islamic Republic of Iran’.

An international conference on *The Sources of Human Rights* was organized by Prof. Wils in November. Research within Practical Philosophy has yielded a number of high-profile results. Dr Terpstra, in collaboration with Dr Ruth Baumann-Hölzle, published a book on the future of health care in which a philosophical diagnosis and sustainable solutions for many of the problems in this area are presented. Dr Becker, Dr Van Stokkom and Dr Eikenaar wrote a book on ‘Citizens as Trustees.’ And Prof. Van Tongeren published a book on moral experience, virtue ethics and ‘life as art’ as well as a book on Nietzsche and European nihilism.

**Societal impact**

Research in philosophy, theology and religious studies allows for three kinds of knowledge-transfer with considerable societal impact: 1) It contributes to cultural memory and sustains our cultural heritage, 2) It offers scholarly and academically informed contributions to societal debates, 3) It produces advice for societal organisations e.g. in the form of commissioned reports. The policy of the PTR research institute is to promote these forms of knowledge-transfer and thereby to highlight the societal relevance of the research. To this effect we have introduced a new way of measuring research output in which knowledge-transfer yields credits along-side scholarly and scientific output. In the coming year we will also organize research meetings with a panel of societal stakeholders to develop new strategies to enhance the institute’s societal impact.

Examples of contributions to cultural memory include projects on the Shoah, on Catharism, on Spinoza and on the until now almost forgotten Dutch academic prodigy David Gorlaeus. Through public lectures, books, newspaper articles and media interviews the institute’s research caters for large audiences as well as for societal organizations dedicated to a variety of aspects of our cultural heritage.

With expertise on topics such as Islam in Europe, the nature and sources of democracy, the role of religion in contemporary society, the impact of neuroscience on our image of man or the impact of Darwinism on our worldview, researchers in the PTR institute contribute to a range of high-profile societal debates in public lectures and fora, newspaper articles, interviews, books, and media performances. The value, significance and impact of contributions of the institute’s researchers to societal debates lies in the fact that they bring the results of sound academic and scholarly research into arenas that are often dominated by opinion.

Advice, often in the form of commissioned reports, is a third kind of society-oriented research output of the institute. Researchers within Empirical and Practical Religious Studies, for instance, have advised Dutch Catholic primary schools and developed a ‘toolkit’ for improving enhancement of civic virtues in classroom situations. The KASKI, a research centre specializing in issues of religion and society, published advisory reports at the request of various societal organizations. And research on contemporary death rites in the Chair of Comparative Religious Studies has yielded advice to funeral organisations, museums, artists, ritual councillors and accompanists, medical nurses and spiritual advisors in hospitals and the Dutch Ministry of Justice.
Key publications


Slors, M.V.P. (2012). Dat had je gedacht! Brein, bewustzijn en vrije wil in filosofisch perspectief. Amsterdam: Boom.


Dissertations: 19
Academic publications: 204
Professional publications: 80
Future research

The three research programmes, described in the first section were only conceived and organized towards the end of last year. Consolidation of these programmes, strengthening their internal coherence, and developing their identities and profiles are the main aims of the PTR research policy for the coming years. An important means of achieving these goals is the development of research projects – and the consequent acquisition of research grants – on topics that straddle the expertise of the various chairs, while contributing to a single programme. Establishing international cooperation with partner research groups is another. Formal assessment of the PTR institute by a committee of international experts in 2013 is expected to yield valuable feedback for the further improvement of the institute.

Director: Prof. Marc Slors

Since November 2005, Marc Slors has been Professor of Philosophy of Mind and Cognition at Radboud University Nijmegen. He got his PhD in philosophy from the University of Utrecht in 1997 (his supervisor was at the University of Illinois in Chicago). He then worked as an NWO postdoc and later as a KNAW research fellow at Radboud University Nijmegen and the Australian National University. He has published widely on problems connected to the mind-brain relationship, mostly in international scholarly journals, but recently also for wider audiences. He is associate editor of Philosophical Explorations.
The Institute for Historical, Literary and Cultural Studies (HLCS) is part of the Faculty of Arts. Its main objective is to create a stimulating research environment for research in the fields of literature and literary theory, cultural studies, history, art history and archaeology.

HLCS research is organized in programmes based on common research themes or a common focus on a specific period. Each programme is designed to maximize integration through joint projects. Research initiatives that combine expertise from different fields and maintain a rigorous standard have ensured that HLCS retains a prominent profile both nationally and internationally.

There are four research programmes:

- **The Ancient World**
  The Ancient World is an interdisciplinary programme in which classicists, ancient historians and archaeologists study ancient Greek and Roman civilization and its reception from the Middle Ages until the present day.

- **Memory: Cultural and Religious Identities**
  Scholars in this interdisciplinary programme explore how people in various historical and cultural settings construct their identity by actively recollecting, shaping, re-shaping and mediating the past.

- **Public and Private Life: the History of Politics and Human Life Courses**
  This programme tackles the long-term developments in politics, economy and culture of Dutch, European and Asian societies.

- **Studying Criticism And Reception Across Borders (SCARAB)**
  SCARAB focuses on the role of literary professionals – book reviewers and critics, and institutions, periodicals and societies, as well as printing and publishing firms – as ‘bearers’ of literary culture and instrumental in the production, dissemination and consumption of literary culture over the centuries.
Each programme contains several smaller sub-programmes, which create platforms for discussing research plans and results, ensuring communication between researchers and supporting scientific integrity.

In October 2012, a committee of peers evaluated the quality of research at the institute during the period from 2006 to 2011. The overall score was 4.2 on a five-point scale (a score of 4 means that research is seen as internationally competitive and leading nationally). Based on the outcome of this evaluation, a shift towards less thematically bound research programmes is being considered.

Awards
Prof. Sible de Blaauw, professor in Early Christian art and architecture, has been appointed as a member of the Academy of Sciences and Literature in Mainz. De Blaauw was elected because of his expertise in Christian archaeology, traditionally a prominent discipline in German academia. De Blaauw will be one of 100 members of the ‘Geistes- und Sozialwissenschaftliche Klasse’.

Dr Lotte Jensen, associate professor in Dutch historical literature, was elected as a Young Academy member of the Royal Netherlands Academy of Arts and Sciences. She is one of ten new members of The Young Academy, a dynamic and innovative group of top young scientists and scholars with outspoken views about science and scholarship and their relationship with society.

Research facilities
• The Humaniora Library (155,000 volumes, 15,500 serial volumes, 750 serial subscriptions and 600 manuscripts)
• Catholic Documentation Centre: archives and publications of Catholic institutions and individuals in the Netherlands, 1800-present (www.ru.nl/kdc)
• Centre for the Documentation of Art History: collections of pictures, photographs, and slides (www.ru.nl/ckd)
• The Auxilia archaeological project bureau (Provincial Roman History; excavations in the former territories of Germania Inferior, especially in Ulpia Noviomagus Batavorum (www.ru.nl/auxilia)
• Kunera: a database of medieval pilgrim badges and other souvenirs (www.let.kun.nl/ckd/kunera/)

Collaboration
HLCS focuses on establishing European research networks with prominent partners in its areas of expertise.

Prof. André Lardinois is one of the founders and chair of a network engaged in the study of archaic Greek lyric, iambic and elegiac poetry and song, with representatives in most European countries as well as at major American universities (Berkeley, Harvard, Stanford and Yale). The aim of this network is to pool the resources of individual scholars, who now often work in isolation, by holding regular meetings, keeping in contact through a network website and a newsletter and defining topics of common interest within archaic Greek poetry that groups of scholars in different countries can work on together.

Prof. Franc Schuerewegen is the founder of Lire en Europe Aujourd’hui (LEA!), a network bringing together French, Spanish, Italian, Belgium, Portuguese, Swiss and Dutch specialists in French and francophone literature, who investigate and discuss the potential consequences of the process of globalization for their approach to texts, the changing role of the francophone literary corpus, and the consequences of these changes for theory and methodology in the field.

In 2012, CPG’s director Prof. Carla van Baalen was awarded an Internationalisation in the Humanities grant by the NWO. The goal of this project, entitled ‘Towards a European History of Parliaments (1789-2009)’, is the firm establishment of a European research net-
work on parliamentary history. Since the founding of the French Assemblée Nationale in 1789, modern parliamentary institutions have been created all across Europe. As the modern parliament has remained for centuries the symbol par excellence of national politics, the historical study of parliaments has tended to stop at the borders of nation states. This project was established to transcend the compartmentalisation in the field. The network includes Europe’s three leading research institutes: History of Parliament Trust, London; Kommission für Geschichte des Parlamentarismus und der politischen Parteien, Berlin; and Centrum voor Parlementaire Geschiedenis, Nijmegen.

Prof. Odin Dekkers and Dr Usha Wilbers are members of the core group of the European Society for Periodical Research (ESPRit), which was founded by periodical researchers from Austria (University of Salzburg), Belgium (University of Ghent), England (University of Salford, Manchester; Manchester Metropolitan University), the Netherlands (Radboud University Nijmegen), Scotland (Edinburgh Napier University) and the United States (New Jersey City University). The aim of the organization is to unite the resources of individual scholars from various disciplines who work with periodicals.

Research results

Art historians at HLCS have previously described 2,200 pilgrim badges – souvenirs of pilgrimages – in parts 1 and 2 of Heilig en profaan (Sacred and profane). In June 2012, 1,300 new findings were presented in part 3. From the twelfth to the mid-sixteenth century, pilgrim badges were produced and sold on a large scale, as the material they were made of was relatively inexpensive. As the common man could afford them, information about these badges – where they were sold and found – provides us with insight into the travel behaviour of ordinary people in medieval times. It turns out that they travelled much more often and further than was previously thought. A walking tour from Groningen to Maastricht – or even to Santiago de Compostela or Canterbury – was no exception.

On 21 September 1787, the Dutch Patriot Revolution – a conflict between the Patriots and the Orangist supporters of the stadtholder – came to a violent climax in the fortified town of Heusden. On the same date in 2012, a study on the events of 1787 was published, written by Dr Joost Rosendaal. He adjusts the perception of the Patriot movement in a number of ways. More than a struggle against Orange, it was a battle for democracy. Tax-paying citizens wanted to elect their own local government and they wanted it to be a reflection of the population. For a long time historians have neglected this Dutch revolution, because they thought of it as a derivative of the American Civil War and the French Revolution. Rosendaal sees it differently: ‘Ordinary citizens fought for democratic principles that we take for granted nowadays: equal rights, equal representation, the separation of church and state. Their ideas were not formulated by great thinkers, but derived from the general public and political practice. That’s what makes this movement so interesting.’

The modernist literary periodical Commerce appeared between 1924 and 1932 in Paris, with contributions by European writers such as Rainer Maria Rilke, T.S. Eliot, Virginia Woolf, Boris Pasternak and André Gide. Among its editors were Paul Valéry and Valery Larbaud. Everyone of any literary importance in Europe in those days published in Commerce. Prof. Sophie Levie, professor of European literature, edited and annotated the letters between writers who published in the magazine, the editorial board and the woman who financed the publication: Marguerite Caetani. In 2012, the first two volumes of a total of six appeared, containing hundreds of letters that were never published before, especially those from the Caetani archive.

For a long time, the man-machine or cyborg was a successor of the creature created by the legendary doctor Frankenstein: a monster. Not anymore, says Prof. Anneke Smelik, professor of visual culture, in her new book Ik, cyborg (1, cyborg). Smelik investigated images and fantasies about technology in popular culture. The cyborg is less frightening, because technology has become more important and commonplace. We have become accustomed to children born after IVF and to artificial devices such as pacemakers helping us to overcome physical problems. We even try to look more like a man-machine than like the ape from which we descend. That is visible in our love for ‘hard bodies’: tight, strong, smooth bodies. Control and perfection – these are the characteristics that make the machine sexy. But the most attractive part of the man-machine or cyborg is the promise of immortality.

Societal impact

HLCS takes the demand of society to make university research more visible and accessible seriously. It encourages its researchers to instigate projects that will interest a wider audience and rewards them for doing so. The research conducted within HLCS, which is particularly well suited for dissemination among a wider audience,
takes several forms, such as the publication of popularizing monographs and articles, translations, public lectures, exhibitions catalogues, appearances in the media and participation in government advisory boards.

In 2012, the Rembrandt Documents Project (see www.ru.nl/remdoc) was launched, a joint initiative of Radboud University Nijmegen, Museum The Rembrandt House in Amsterdam, and the Huygens Institute for the History of the Netherlands. The aim of RemDoc is to collect and make available all known documents that relate to the renowned Dutch painter Rembrandt van Rijn. RemDoc will include extracts from baptism, marriage, and burial records, Rembrandt’s own letters, notarial deeds and inscriptions on drawings and etchings by Rembrandt, his patrons, and collectors. All documents will be transcribed and annotated under the supervision of HLCS’s Rembrandt scholar Prof. Volker Manuth, and Jaap van der Veen, research curator at the Rembrandt House Museum, and they will be translated into modern Dutch and English. The RemDoc infrastructure will provide a gateway to other databases and digital collections that contain images and physical data about Rembrandt’s works of art. RemDoc provides an infrastructure for researchers in academia and in museums, yet the project’s results will also be of interest to the general public.

Never before did the title of the yearbook of the Centre for Parliamentary Studies evoke so many reactions as it did in 2012, even though the title ‘The United States of Europe’ was not intended to be provocative. It is a reference to the history of a controversial topic: European political collaboration. Can we do without it – should we be less involved in Europe – as some political parties in the Netherlands argue? Nobody can deny that changing economic circumstances make European political collaboration more necessary than ever. At the same time, many people dread ‘Brussels rules’, which would be at the expense of Dutch interests and independence. In the 2012 issue of the Yearbook of Parliamentary History, ‘The United States of Europe’ are placed in a broader context.

Future research
Classical archaeologists Prof. Eric Moormann and Dr Stephan Mols obtained an Investment Subsidy from the NWO for their international project ‘Mapping the Via Appia’. The Via Appia is still seen as an iconic monument of ancient Rome. The wealth of archaeological monuments preserved both above and beneath ground level, as well as the opulent documentary evidence in archives and digital resources (mainly photographs), make a very detailed multidisciplinary analysis of the history of the road and its surroundings possible. The project uses an innovative research strategy designed for the efficient recording and study of complex and monumental archaeological landscapes with long occupational histories. For this purpose, professional GPS (DGPS) is used to refine the techniques of archaeological survey and the documentation of visual remains. The project’s main strength lies in the use of new 3D spatial mapping and analysis techniques, combined with geophysical prospection, remote sensing techniques, field survey, excavation and archival studies. The project not only offers invaluable new data on the functioning of this particular and other Roman consular roads, but will also provide a new methodological framework for studying monumental archaeological landscapes that can be used and further developed in other research projects.

The Netherlands Institute for Advanced Study (NIAS) granted a fellowship to Prof. Marit Monteiro to carry out the project ‘Dealing with an Uneasy Legacy: Historical Research on Sexual Abuse of Minors by Core Members of the Roman Catholic Church in the Netherlands (1945-2010)’. In 2011, the Investigative Committee on sexual abuse of minors in the Roman Catholic Church in the Netherlands (1945-2010), led by the former Secretary of Education Wim Deetman, presented its final report. Within this Committee, Prof. Monteiro was responsible for the historical research that was
Key publications


Dissertations: 11
Academic publications: 222
Professional publications: 199
carried out and she had unrestricted access to the major relevant archival collections. The data thus collected made possible fundamental revisions of the paradigms and methods that have dominated international scholarship on clerical sexual abuse in the past.

Researchers at the Meertens Institute – part of the Royal Netherlands Academy of Arts and Sciences – study the diversity in language and culture in the Netherlands. Since 1931, the Institute has collected information on traditional folklore by sending questionnaires to hundreds of informants. Recently, plans have been developed to digitize all 220 questionnaires (to be financed by crowd-sourcing).

Historians at HLCS have started to fill in a database with the answers to a questionnaire from 1971 on engagement customs and patterns. These data on cultural practices are very interesting for historical demography and family history and cannot be obtained systematically in any other way. They will be connected to large databases with individual data on life courses that have recently become available and with socio-economic and demographic data at municipality level.

In NWO’s Free Competition in the Humanities Dr Erica van Boven of the University of Groningen and Dr Mathijs Sanders from Nijmegen received a grant for a research programme called ‘Dutch middelbrow literature 1930-1940: production, distribution, reception’. They will investigate the public-oriented literary culture of the interwar years, which is understood not only as a set of texts, but primarily as a social and cultural practice, specified here as ‘middelbrow’, a concept fruitfully used in international research. The idea of the programme is to apply the concept ‘middelbrow’ to the Dutch interwar years. The central question is: in what ways did ‘middelbrow’ manifest itself, both institutionally and discursively, as a literary field or subfield, with its own institutions and actors, with its own programme, conceptions of literature and qualitative hierarchy?

As a joint project of the Faculty of Arts and the Faculty of Philosophy, Theology and Religious Studies Dr Maarten De Pourcq will be organising a large conference on the theme ‘Europe and its Worlds: Cultural Mobility in, to and from Europe’ in the autumn of 2013. National and international researchers will be debating this topic in twelve panel sessions spread over three days. The proceedings of this conference will be published in a new series of Nijmegen Studies in Humanities (Brill, Leiden).
Research Centres of the Faculty of Law

Internationalisation
The faculty’s policy is to continue exploring options for international cooperation and strengthening existing contacts. Incorporating international and European law in legal research is crucial in a world of interwoven legal systems. The board aims to get involved with European consortia in certain key areas (Insolvency Law, Financial Law, European Private Law, Migration Law, Fundamental Rights and Security issues), in anticipation of the new European Framework programme Horizon 2020.

Societal relevance
Legal research almost always relates to legal practice and is therefore automatically of societal relevance. The Nijmegen faculty cooperates closely with – and advises – external partners such as civil-law notary offices and law firms, financial organisations, international businesses, courts, government bodies, ministries, NGOs and European organisations.

Publications, such as professional journal papers and case notes, are written with the legal practice in mind. The Centre for Post-academic Legal Education (Centrum for Postacademisch Juridisch Onderwijs, CPO) provides postgraduate education for lawyers and judges. Academic publications also provide a solid foundation for the legal practice. One element of the research centres’ mission is to make academic research more practical, for example by preparing best practices, legislative proposals and EU directives.

The Business & Law Research Centre
(Prof. Corjo Jansen)

The Business & Law Research Centre – Onderzoekcentrum Onderneming & Recht (OO&R) – is based on cooperation between the Law Faculty of the Radboud University Nijmegen and fifteen prominent, mostly international, law firms and Dutch multi-
The Centre conducts fundamental research in ‘Business and Law’. It also offers a comprehensive educational programme for gifted young scholars and is actively involved in a wide variety of postgraduate educational and professional training programmes.

The Centre combines academic excellence with the expertise and practical experience of its partners. This unique collaboration has led to cross-fertilization between legal practice and the academic world.

The four key research programmes of the Centre are:
1. Company Law
2. Finance, Security Rights and Insolvency Law
3. Business and Patrimonial Law
4. Business and Financial Law

A major theme of the research conducted by the Centre in all research programmes relates to European private law, comparative law and private international law.

The Centre, which was established in 1991, is recognized as a research school by the KNAW. In 2009, the accreditation was renewed by the KNAW and is now valid until 2015. The Centre’s educational programme for gifted young scholars is certified by the Accreditation Organization NVAO.

The research of the Centre was evaluated in 2012 by a mid-term review committee consisting of Prof. Jan Lokin and Prof. Peter Dortmond. The Centre and its individual research programmes received the highest scores (‘excellent’).

The OO&R has its own set of regulations, which dictate that all parties involved guarantee academic independence.

Research facilities
The Centre houses the Information and Documentation Centre for Business and Law (CIDOR), which has a collection of books, journals and electronic publications on international and domestic Business Law that is unique in the Netherlands.

Collaboration
The Centre has excellent international connections. The OO&R’s board strives for international cooperation in all of its research programmes. There is close collaboration with the Max Planck Institute in Hamburg (Germany). Within the framework of International Working Groups in Company Law, Security Rights,
Insolvency Law and Financial Law, the Centre cooperated in 2012 with leading academics and practitioners from universities and research centres in Europe, the USA, Asia and Australia. Eighty foreign researchers are involved with the OO&R’s research.

The Centre has also collaborated with various international organizations (e.g. INSOL Europe) and participated in existing international networks (e.g. the Ius Commune Casebook Project).

All PhD candidates at the OO&R can carry out part of their research abroad and many make use of this option (for example in Berlin, Montpellier, Poitiers, Oxford and universities in the United States).

Research results

A major project in company law is corporate governance. An International Working Group established by the Centre and the Max Planck Institute in Hamburg extensively analyses one-tier and two-tier board models in a number of European countries. The manuscript of the book ‘Forum Europeum on Corporate Boards in listed companies’ is currently under review by Oxford University Press. A separate volume has been published on the position of shareholders. The ‘Handboek Onderneming en Aandeelhouder’ (Handbook for Companies and Shareholders) discusses the legal position of shareholders, including holders of listed securities, as well as the changes recently implemented as a result of the Flex BV legislation. A new edition of a handbook on various corporate entities was published in the prominent Asser Series.

The Centre published a volume on the Liability of Asset Managers with Oxford University Press. This book contains the only comparative analysis of the law of asset manager liability in the major European jurisdictions, the US and Canada. It was presented during a symposium organized by the Centre and hosted by one of the partners. Another symposium organized by the centre was on the topic ‘Crisis and financial law’. Various aspects of the financial crisis were discussed from a legal and economic perspective. A book written by staff members from a partner of the Centre analyzed the regulation of Over-The-Counter (OTC) derivative markets in the EU and US. The Centre also contributed to the Official Commentary on the UNIDROIT Convention on Substantive Rules for Intermediated Securities.

A major study in patrimonial law focuses on the sale of real estate properties. It addresses issues such as immovable assets, the conclusion of sale contracts, the obligation of the seller and buyer and insurance-related aspects. It also analyses several clauses which are regularly used in real estate sale transactions. Fundamental research is conducted in European Private Law. Important research outcomes include a study of the influence of European law on national private law, in particular the general part of private law. The various sources of law are discussed in sequence: the Treaty on the Functioning of the EU, the general principles of Union Law, a range of directives and regulations, and the European Convention on Human Rights and Fundamental Freedoms. PhD degrees were awarded for theses on Assignment, Possession of Property and Binding Legal Advice.

Societal impact

The Centre has built up knowledge and influenced public debate on a wide variety of topics which are of direct relevance to financial and commercial legal practice. Research topics relating to corporate governance, insolvency fraud, secured transactions, receivables financing, asset management and distressed financial institutions are important examples.

Future research

Future research projects will focus on notarial corporate law, insolvency fraud, termination of limited real rights, liability, insurance & ADR, liability in the financial sector, the administrative enforcement of financial law, and recovery and resolution measures vis-à-vis financial institutions in distress. International Working Groups will work on volumes dealing with the treatment of contracts in insolvency, transnational securities law, the horizontal (private law) effects of EU Law and alternative investment funds in Europe. Permanent research is conducted by the Centre within the framework of several volumes published in the prominent Asser Series.
Awards and acknowledgements

- Dr Bas de Jong was awarded the Harry Honée PhD dissertation prize for his thesis ‘Causation and damages in securities fraud cases’. This prize is awarded every three years to the best PhD dissertation in corporate law. De Jong was also awarded a grant by the Niels Stensen Stichting to conduct research as a visiting scholar at Cambridge University in the UK.
- Prof. Mop van Tiggele-van der Velde received the 2012 Hudig-Langeveldt prize, in recognition of her work on insurance law.

Research Centre for State and Law
(Prof. Raymond Schlössels)

The Centre for State and Law – Onderzoekcentrum voor Staat en Recht (SteR) – focuses on key issues and basic principles in public law. Its researchers critically analyze national, European and international developments in constitutional law, administrative law and criminal law. The Centre provides a stimulating environment in which high-quality, national and international multidisciplinary research can flourish. SteR includes three research programmes:
1. Centre for Migration Law (CMR)
2. Administration of Justice

The CMR brings together researchers from various disciplines. Its purpose is to provide a stimulating context for fundamental and applied research on migration and the protection of minorities. It is unique in Europe due to its interdisciplinary approach and its international staff, who includes lawyer, sociologists, anthropologists and political scientists. It is also known for its comparative international research.

Researchers working on the theme ‘Administration of Justice’ focus on law in action – the working of the courts, public prosecutors and the legal profession. New developments in procedural law are monitored closely against the background of the principles of effective legal protection. In 2012 special attention was paid to the phenomenon of convergence of civil, criminal and administrative procedural law. Methods used to understand the impact of civil, criminal and administrative law (including tax law) at various court levels also represent an important research topic.

Researchers working on the theme ‘Principles of Public Law’ focus on the main principles of public law from a national, European and international perspective. They analyse the relationship between various principles of the democratic constitutional state (i.e. the rule of law, human rights, the democratic order and accountability) as well as national and international social developments. The principles are studied with a keen eye on European and global developments. The programme combines the expertise and know-how of constitutional, criminal, administrative, European and jurisprudential scholars. Research includes exploring the impact of European and International law on fundamental concepts of national law.

The research at the Centre was evaluated in 2012 by a mid-term review committee. The Centre and its individual research programmes received high scores (‘excellent’ and ‘very good’).

Awards and acknowledgements

- The NWO (Netherlands Organization for Scientific Research) awarded a grant for Prof. Janneke Gerards’ PhD project ‘Active protection of fundamental rights in the EU – can a doctrine of positive obligations be incorporated by the EU courts?’
Key publications

**Business and Law Research Centre**


**State and Law**


Centre for Notarial Law


Dissertations: 7
Academic publications: 314
Professional publications: 274
Annotations: 254

• The NWO awarded a grant for Prof. Jan Terpstra’s PhD project ‘Trust in the police in an international comparative and longitudinal perspective’
• The NWO awarded a Veni grant for research by Dr Nadia Sonneveld on women’s rights and Sharia law in post-uprising Egypt
• The Dutch Ministry of Justice awarded Prof. Janneke Gerards and Dr Joseph Fleuren a grant for a comparative research project on the effect of the European Convention of Human Rights on national law
• The Ministry of Infrastructure and the Environment and the Ministry of Home Affairs jointly awarded a grant for Prof. Tonny Nijmeijer’s research project on ‘Renewal of land policy instruments relative to the Infrastructural Code and the Expropriation Code’.

Collaboration

The SteR participates in numerous international projects and networks, including the International Research Universities Network (IRUN) and the Odysseus Network of Experts in European Migration and Asylum Law. The CMR is responsible for coordinating the European Network on Free Movement of Workers within the EU, which is funded by the European Commission.

Research is carried out for international organizations such as the EU, the Council of Europe, the United Nations High Commissioner for Refugees (UNHCR), the International Organization for Migration, the Fundamental Rights Agency (FRA), Amnesty International and the European Council on Refugees and Exiles.

The SteR also has ties with the Max Planck Institute for Foreign and International Criminal Law (Freiburg, Germany), the Max Planck institute for Foreign and International Public Law (Heidelberg, Germany), the University of Bergen, the International Penal and Penitentiary Foundation (IPPF), and the Working Group on the Comparative Study of Legal Profession.

Within the Netherlands, the SteR collaborates with the Council for the Judiciary, the Ministry of Justice, several courts, other universities, municipalities and lawyers.

Research results

CMR researchers are involved in research with the Irish Immigration Council on the implementation of the ‘Family Reunification Directive’ and with the University of Madrid Comillas on ‘Best Practice of Integration measures of the Highly Skilled’. Moreover, the CMR participates in the Network of Socio-economic Experts in the anti-discrimination field (SEN) for which two reports were produced on governance levels and policy on discrimination against the elderly in housing and religious discrimination. In 2012 several workshops and seminars were organized by the CMR. Topics included the implementation of the ‘Blue Card Directive’ and citizenship within the context of a jean Monnet project in which the University of Manchester and the University of Comillas, Madrid, participate.
Within the programme ‘Administration of Justice’ special attention was paid to the methodology of judicial law-making in fourteen selected fields of law. In 2012 two symposia were organized around the theme ‘Administration of Justice’. The first dealt with the convergence and divergence of process law. The second was on methods of interpretation of law in several courts.

Within the programme ‘Principles of Public Law’, PhD titles were awarded in 2012 to Lieske de Jongh and to Néda Armbruster. Several national and international workshops and colloquia were organized. These included the philosophical colloquia ‘Hans Kelsen and International Law’ and ‘Global Justice - Global Democracy’ and the European expert seminar on ‘Shaping Rights: the Role of the European Court of Human Rights in determining the scope of human rights’. National Taiwan University Law School organized a colloquium in cooperation with SteR, which took place in Taipei, Taiwan. Prof. Thomas Mertens published a unique textbook on the topic of people and human rights. Prof. Raymond Schlössels en Dr Lise Kjellevold-Hoegge participated in a large European project on the protection of legitimate expectations under administrative law (‘vertrouwensbeginsel’). Prof. Piet Hein van Kempen gave the keynote speech ‘Pre-trial detention’ at the annual international conference of Europris (Rome). Prof. Johan van de Gronden gave a speech on ‘Services of General Economic Interest in EU competition law’, at the conference ‘Aims and Values in EU Competition Law’ at the University of Copenhagen.

Societal impact

SteR researchers are often asked for advice by national and international public bodies. Research results are made accessible for judges, lawyers, politicians, students and the general public. For example, Rechtspraak Vreemdelingenrecht (Jurisdiction in Refugee Law), which is edited by the CMR, is now also accessible online. Results of the programme ‘Administration of Justice’ published by researchers at SteR were used by the Council for the Judiciary as well as by distinguished courts. Information relating to the Free Movement of Workers Network is of vital importance for the activities to the European Commission (DG Employment). CMR was involved in developing quality terms for a course on Migration in the new education programme of the Dutch Lawyers Association (NOVA). Dispute resolution in education was a topic that was elaborated during a conference attended by both jurists in academic law and politicians in collaboration with the Dutch Association for Education Law (NVOR).

Future research

The CMR will concentrate its research on the Europeanization of migration law. During the next decade European legislation will receive less attention. There will be more emphasis on consolidation, correct implementation and harmonization of legislation through cooperation. The CMR will further extend the project started with the Faculty of Management Sciences of the University on the implementation of EU Directives. Special attention will be paid to the practical consequences of migration law and policies. Several PhD studies will be carried out, including one on the registration of personal data in the public and semi-public sectors, education, health care and policing, and two on legal aid and expert advice in asylum procedures. In 2013 three PhD theses are expected to be defended.

Within the programme ‘Administration of Justice’, research on judicial decision-making and lawyers’ ethics and on the jurisdiction of the European Court of Justice will continue.

The Centre for Notarial Law (Prof. Freek Schols)

The Centre for Notarial Law – Centrum voor Notarieel Recht (CNR) – was established in 2008. Its research focuses on notarial law, in particular family property law (personal and family law and the relationship between property law, inheritance law and estate planning). The strength of the CNR’s research lies in the combination of tax and civil law and cross-fertilization between legal practice and the academic world. Particular attention is paid to the impact of these fields on general property law and to the combination of legal fields, e.g. marital property law, real-estate law and company law. CNR researchers seek to provide a firm foundation for notarial practice.

Collaboration

Nationally, the CNR cooperates with ABN Amro Bank NV on estate planning and monitors the academic level of the consultancy services provided by the bank. The CNR also cooperates with the Dutch Foundation for the Professional Education of Notaries (SBN), the Royal Notarial Association (KNB), the Association of Estate Planners in Notarial Practice (EPN) and the Network Notarial Association.

Research results

The CNR publishes a series called ‘Publicaties vanwege het Centrum voor Notarieel Recht’ (currently 9 volumes). Staff members of the CNR write articles for authoritative national and/or international academic journals and professional journals. Important research is carried out in cooperation with and – in some cases is supervised by – external researchers in order to ensure academic integrity. Ongoing research into marriage contracts and the ‘Erven zonder financiële zorgen?!’ report that was presented to the Dutch House of Representatives is one example. In the current reporting period the focus was on international family property law and this will remain an important area of expertise in future.
Director: Prof. Leonard Verburg

Leonard Verburg is Professor of Employment Law at Radboud University Nijmegen and, since 1 March 2013, he has been Vice Dean for Research at the Faculty of Law. He is a member of the Advisory Board of the Business and Law Research Centre (OO&R). He is also a member of the board of the foundation which supervises the education programmes of the Dutch Bar Association. Prof. Verburg is editor-in-chief of the journal _Arbeidsvereenkomst_, a member of the editorial board of the journal _Arbeidsrechtelijke Annotaties_ and a member of the advisory board of Postacademische Leergang Arbeidsrecht, one of the oldest postgraduate programmes in the field of employment law. He is founder member of the curatorium of the annual Nationaal Arbeidsrecht Congres. In 2010, Prof. Verburg was appointed as a substitute judge in the Court of Appeal in the Hague.

Societal impact

There are strong links between the CNR and legal practice. Researchers advise the Dutch government on several private law issues and lecturers-in-charge work for the SBN, for the KNB, for the estate planners of EPN and for Novex (the Dutch Association for Executors). They also participate in the Commission Succession Law II of the KNB and in the Commission Inheritance Tax Law of the KNB, the Stichting tot Bevordering der Notariële Wetenschap and the Scientific Council and Board of the Thijmgenootschap. The CNR’s research creates an important academic foundation for notarial practice relating to family property law in the Netherlands.

Future research

Continuing projects include the historical development and the current legal position of the surviving spouse in Dutch civil law, the legal exegesis of the provisions of last wills, delegation of last wills to third parties, the new inheritance tax law, international aspects of estate planning and developments in the legislation on marital property. ‘Wills for persons lacking will-making capacity’ is a new project.
The Institute for Management Research (IMR) is the multidisciplinary research institute of the Nijmegen School of Management (NSM). Its mission is to excel in creating knowledge in the service of society. Researchers conduct fundamental and applied research on the design, development and performance of the public and private structures that regulate, govern and manage human interactions.

The IMR’s unique multidisciplinary composition, combining researchers working in business administration, economics, political science, public administration, human geography and environment studies, makes it possible to analyze structures from various theoretical perspectives and at different levels of analysis. The institute aims to provide a richer understanding of international, societal and organizational challenges and to contribute to developing and evaluating intervention strategies.

The IMR aims to further strengthen its international position as a multidisciplinary centre of excellence by expanding collaborations with selected peer institutes of international renown, as well as with commercial and institutional partners.

**Thematic platforms**

IMR platform management – a team of senior researchers – is instrumental in realizing the IMR’s ambitions by creating a fertile and productive research climate. Platform managers bring the multidisciplinary research community together in three thematic platforms, where they debate and exchange ideas and knowledge: DisCon, ResOrg and SCAPES.

DisCon (Distributional Conflicts in a Globalizing World: Consequences for State-Market-Civil Society Arrangements) focuses on the effects of globalization on potential distributional conflicts, regarding material (e.g. natural resources, economic structures) and immaterial (e.g. social-cultural) issues within social systems. Central themes are: the effects of the birth, nature and development of these conflicts on the nature of arrangements between states, markets and civil society; means and strategies designed to prevent or manage (potential) conflicts.
ResOrg (Responsible Organization) focuses on the role of both institutionalized and non-institutionalized organizations and how to engage or manage them responsibly. Central themes are: value creation in multiple dimensions; the dynamics of internal and external stakeholder configurations; (networks of) dominant institutionalized and non-institutionalized arrangements, and accountability and reliability.

SCAPES (The Shaping and Changing of Places and Spaces) focuses on processes of changing the social, economic and environmental meaning of places for individuals, communities and states, and the consequences for territorial governance. Central themes are: transnational territorial identities and cooperation; the geopolitics and geography of territorial borders, migration and development, and regional governance; transport and spatial development; water management, environmental policy and governance, and land policy and location development.

Hotspots of research

The IMR aims to optimize the interaction between multidisciplinary excellence and societal needs. Hotspots of research have been initiated around academic expertise that is most relevant for solving societal problems. In these hotspots, which are developed by a selected team of experts, researchers from different disciplines join forces. The success of this approach is evident from an increasing number of collaborative projects involving such teams and institutional and societal stakeholders. These projects are typically characterized by numerous stakeholders with different goals and ambitions, complex financial arrangements, and high societal relevance.


In this hotspot, researchers investigate and develop interventions related to social innovation in health care. They aim to achieve higher quality and more efficient care by investigating institutional and organizational preconditions for social innovation and initiating change. Institutional collaboration between this group and IQ Healthcare takes the form of a multidisciplinary centre of expertise.

Modelling Urban Decision Making

In this hotspot, researchers analyse negotiation practices, provide life-like simulations of negotiations and support group decision-making through model building. The group focuses on decision-making processes in complex urban settings, including land and property development, urban transformation projects, transit-oriented development, infrastructure and transport services and parking. In these settings, innovative governance and financing solutions are developed and tested in experimental research projects. The aim is to optimize urban and regional decision-making.

EU@RU: Towards Cooperation in the Field of Europeanization Research

In this hotspot researchers analyse the dynamic processes of uploading, downloading and horizontal adaptation of EU politics, policies, and law, with an emphasis on downloading. They integrate expertise from a wide range of theoretical disciplines, notably environment and water, internal market, and migration. Societal stakeholders are political institutions at the local, regional, national and European level.

Gender, Power and Management

In this hotspot, researchers investigate power, diversity, and gender dynamics in national and international politics, business and academia. They aim to use this knowledge to help reduce inequalities in society.
Research facilities
IMR operates the NSM Decision Lab and the Visa Skills Lab. In the Decision Lab, experimental research – based on game and social choice theory – is conducted to study cooperative decision-making. The Visa Skills Lab – an electronic meeting / group decision room set up for studying group processes – allows investigation of policy-making processes. In 2012, the capacity of both Labs was expanded and they were modernized. They are used by various groups of researchers, often in collaboration with other institutes.

The Global Data Lab, developed by Dr Smits, develops innovative instruments for measuring and analysing societal progress, including indicators, specialized databases and web-based tools.

SCAPES developed, together with the Netherlands Environmental Assessment Agency (PBL), a national database with economic, employment and real estate data on industrial estates, which it uses to evaluate industrial policies, processes of deterioration, the effectiveness of regeneration policies and the involvement of the property sector in industrial development.

Collaboration
As part of the institute’s networking ambitions, several partnerships were initiated:
• Dr Helderman, in alliance with IQ Healthcare (Radboud University Nijmegen Medical Centre), obtained a €2.7 million grant from the Dutch Ministry of Healthcare, Welfare and Sports for a 5-year research programme on the long-term financial sustainability of Dutch healthcare. A new interfaculty knowledge and research centre is the result.
• An institutional partnership involving Prof. Benschop, Prof. Van Riel, Prof. Vermeulen, Dr Hillebrand, Dr Helderman and Visser MA with the ParkinsonNet programme at the RijnMC established to increase the quality of care for Parkinson’s patients.
• Dr Martens concluded a collaboration agreement with the Transportation Research Institute (IMOB) of Hasselt University for developing the innovative parking model PARK AGENT. This is the result of an STW Valorisation Grant, which was awarded to develop a business plan.
• On 1 October the kick-off of the ‘Breng Kenniscentrum voor Mobiliteit en Ruimte’ took place, the result of an agreement between IMR, HAN University of Applied Sciences, The Arnhem-Nijmegen City Region, Hermes Public Transportation (Breng) and travel organization ROCOV Gelderland / City Region. This centre of expertise was established to enhance collaboration relating to urban accessibility in the region, particularly from a public transportation perspective.

Research results
After investing in nine full-time PhD positions in 2011, another ten PhD positions were created in 2012 for research on the institute’s key themes. What’s more, part-time PhD programme enrolments doubled in 2012. The restructuring of the doctoral school, initiated in 2012, is already producing results. In 2012, 21 PhD candidates were admitted to defend their dissertation, a record number.

Selected results:
• Dr Voinea investigated how foreign-owned firms adapt their behaviour as a result of the interventions and actions of non-market actors. She showed that, for example, the media can influence these firms, even when governments have little or no control over their behaviour.
• Dr Mergaert linked the failing attempts of the EU to reduce and eliminate gender inequality in research to the specific organizational structure of the EC. In particular, the high mobility of European Civil Servants hinders the development of an institutional knowledge base.
• Dr van der Linden investigated how businesses create value in multiple dimensions. Recently, researchers become aware that traditional ways of thinking about business ignore this ‘multiple value creation’. Based on a contemporary analysis of value, he proposes an alternative conceptualization of the firm that helps businesses to better organize for simultaneous creation of value in multiple domains.
• Dr Spierings mapped the way women in the Muslim world decide to participate in the labour market, demonstrating that there is no single underlying cultural explanation for these decisions, implying that specific approaches are required to enhance the participation of women in the labour market.
• Dr Belei published ‘The Best of Both Worlds? Effects of Attribute-Induced Goal Conflict on Consumption of Healthy Indulgences’. These findings have broad implications for the food industry and society: consumers consume more when food is labelled as healthy, leading to increased consumption of unhealthy ingredients.
• Prof. Helsloot concluded that the Netherlands could save billions of euros each year by scrapping unnecessary and exaggerated safety rules.
• Prof. De Kam investigated the benefits of service areas for the elderly. Vulnerable people remain active longer and are less dependent when living in these areas, improving their quality of life as well as reducing costs to society. 1500 respondents participated in the study, which was conducted by a team from IMR, HAN University of Applied Sciences, University Medical Center Groningen and Stuurgroep Experimenten Volkshuisvesting (SEV).
• Prof. De Kam revealed that public housing associations save local governments €400 million annually by collaborating with local administrations and using good business models. Furthermore, they earn €5,000-15,000 per house, by developing real estate. Without these practices, 30% less social housing could be provided. The results were published in a report entitled ‘Bouwgrond voor de volkshuisvesting’.
• Prof. Brandsen, Dr van Genuiten, Dr Helderman, Dr Honingh and Dr Resodihardjo hosted the 8th Transatlantic Dialogue, a joint international conference of the European Group of Public Administration (EGPA) and the American Society for Public Administration (ASPA).

• Prof. Van der Krabben organized the first Thought Leadership Conference on Service Marketing with over thirty leading researchers and captains of industry from around the globe to develop new insights. Various articles will be published in the Journal of Service Management.

• The Economics Department organized a workshop on ‘Ambiguity in the Economy and in Economics’ on 5 October.

• The Political Science Department organized an international conference on ‘Financialization & the Welfare State’ on 14 December.

• The 2012 Von Humboldt Lecture Series featured the theme ‘Making Cities Work’. Outstanding international scholars were invited for lectures, master classes and seminars.

• SCAPES organized a conference ‘Europe Matters – European spatial planning, environmental policies and regional development’ on 20 September.

• Dr Delsen (NSM) and Prof. Van den Hoogen (Faculty of Philosophy, Theology and Religious Studies) presented their new book during a multidisciplinary conference on ‘Corporate Social Responsibility in the polder’ (13 June).

Selected grants
• Dr Wiering, Prof. Leroy and Dr Liefferink received an EU 7th Framework Programme grant for their Starflood project.

• Prof. Brandsen and Dr Van Genuiten received an EU 7th Framework Programme grant for their three-year research project ‘Learning from Innovation in Public Sector Environments’ (LIPSE), in which ten European universities participate.

• Dr Van Houtum, the local project leader of EUBORDERSCAPES, received an EU 7th Framework Programme grant for a research project on external borderscapes, 2012-2015.

• Prof. Van der Krabben and Dr Martens participate in the international NWO VERDUS-funded GO SPOOR initiative, which brings together researchers in the field of Transit-Oriented Development (TOD). They collaborate with the University of Amsterdam, Delft University of Technology and University of Twente and invited international experts to develop and test innovative TOD concepts.

• Prof. Van der Krabben received a grant from the NWO ‘Sustainable Accessibility of the Randstad’ programme, together with the University of Amsterdam and Delft University of Technology. The research focuses on innovative governance and finance strategies for transit-oriented developments: field developments in relation to existing and new infrastructure.

• Dr Mastenbroek, Prof. Herweijer and Dr Liefferink received a grant from the Dutch Interprovincial Organization for a research project on the position of the Dutch provinces in EU policymaking.

• Prof. Smith, Dr Van der Velde and Prof. Ernste received a grant for two PhD projects within the KNAW-funded SPIN project ‘New Indonesian Frontiers’.

• Dr Swedlund received a Marie Curie Career Integration Grant for the project ‘Donor-Government Relations in Sub-Saharan Africa’.

• Prof. Weitzel, in collaboration with The London School of Economics and Political Science and Utrecht University School of Economics, obtained a grant from the Ministry of Economic Affairs for a project about Foreign Direct Investment (FDI) and entrepreneurship.

The aim of Patrick Vermeulen’s work (Professor of Strategy and International Management) is to improve our understanding of why organizational change and renewal are often problematic. He won the Carolyn Dexter Award for the best international paper at the 2012 annual meeting of the Academy of Management.
Key publications


Dissertations: 14
Academic publications: 275
Professional publications: 169

Awards

- Dr Blazevic won the 2012 Product Development & Management Association (PDMA) Research Competition.
- Prof. Vermeulen received the Carolyn Dexter Award for the Best International Paper from the Academy of Management for ‘A Community Level Theory of Organizational Resistance to Anti-Smoking Regulation’, which was co-authored by Prof. Simons and Dr Knoben.

Societal impact

IMR research often helps valorize findings from other disciplines by investigating their societal consequences, e.g. by explaining the benefits and limitations of using IT to protect society from physical harm (Prof. Helsloot) or the use of advanced social media systems in patient-care provider interactions (L. Visser MA). Relationships between IMR researchers and a range of stakeholders were further intensified and ideas were exchanged with key organizations and individuals.
Director: Prof. Allard van Riel

Since 1 July 2009 Allard van Riel has been Professor of Business Studies at Radboud University Nijmegen, with a special focus on Marketing. Prof. Van Riel studied Philosophy at the University of Amsterdam and received his PhD in Marketing from the University of Maastricht in 2003. Before he moved to Nijmegen he worked at the University of Maastricht and as a professor at the University of Liege. Prof. Van Riel has published articles on marketing strategy and management, innovation in services, innovation management, project management, brand extensions and private labels in the retail sector.

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- Prof. Brandsen and Dr Helderaman contributed to a Dutch Scientific Council for Government Policy (WRR) report on future developments and strategies at the intersection of health care, housing and pensions research.
- Prof. Helsloot contributed his expertise in crisis management to the societal debate about security and safety. He appeared frequently in the national media.
- Prof. Brandsen presented his project ‘Welfare Innovations at the Local Level’ (WILCO, 2010-2013), to officials of the European Commission.
- Dr Groš gave expert interviews on franchising on national German TV.
- Prof. Van Kranenburg presented a keynote speech on Responsible Organization as part of Sustainability Day on 10 October in the province of Gelderland.
- Prof. R. Van der Heijden presented the keynote speech on the logistics strength of the Netherlands in 2040 at the ‘Logistieke Werkdagen’ as a member of the Dutch Council for the Environment and Infrastructure (RLI).
- Prof. Lauche co-chaired a meeting of 70 executives from the oil & gas industry organized by the Society of Petroleum Engineers in Houston, Texas. Issues such as human factors and process safety for responsible risk governance as well as the prevention of accidents in the aftermath of the Gulf of Mexico oil spill in 2010 were addressed.
- Dr Mastenbroek chaired a session on parliamentary control over EU transposition for the Dutch House of Representatives.
- Dr Rouwette and Prof. Franco (Hull University Business School) reviewed and revised the NATO Code of Best Practice for Judge- ment-based Operational Analysis in Defence Decision-Making.
- Dr Smits introduced the International Wealth Index, which was developed by the Global Data Lab, at the OECD World Forum on Statistics, Knowledge and Policy in New Delhi.
- Prof. Van Thiel was research coordinator of the parliamentary inquiry by the Dutch Senate into privatization and ‘agencification’ in the Netherlands.
- The Public Administration Department was appointed as an observer at the United Nations Committee of Experts in Public Administration (UNCEPA), advising the UN on government policy and research.

Future research

The IMR focuses on a) further consolidation of research in hot-spots, b) further improving the quality of research, as measured in the quality of publications and the acquisition of external funding, and c) further investing in the quality of training and supervision offered by the IMR doctoral school, thus increasing the quality and quantity of dissertations.
Researchers at the Nijmegen Institute for Social & Cultural Research (Nijmeegs Instituut voor Sociaal en Cultureel Onderzoek: NISCO) use integrated multidisciplinary and comparative approaches to describe and explain changes in socio-cultural participation and organization in both Western and non-Western societies. Diverse theoretical approaches, research designs, data collections and analyses are all complementary aspects of a single framework, each contributing to this common research goal.

Researchers at NISCO focus on three themes: inequality, cohesion, and modernization. To understand the dynamics of societal phenomena and processes, they examine these aspects both from a historical perspective within a single society; in a comparative perspective across different societies, and from a historical perspective in different societies. The accredited Research Masters programme in Social Cultural Science provides high-level training in theories and methods for conducting comparative research on societies. NISCO – a research institute of the Faculty of Social Sciences – consists of two research groups: 1) Cultural Anthropology and Development Studies and 2) Sociology.

Inequality
This theme centres on differences in access to and control over resources that affect peoples’ opportunities, such as educational level, success in the labour market and health. Research focuses on the effect of resources on socio-economic achievement and on how variation between and within countries is affected by
structural social differences and national policies. Ways in which individual, family and group resources affect outcomes – such as cultural and political participation as well as intragenerational and intergenerational mobility – are also studied.

**Cohesion**

The aim of this research is to describe and explain differences in social participation in formal organizations as well as in informal social networks, including families and other groups. First, developments in the relationships between individual resources and both pro-social attitudes and anti-social behaviour are explored, focusing on variations among societies with different welfare-state regimes. Second, comparative examinations are made of the extent to which social groups display exclusionist attitudes and behaviour towards particular out-groups, considering differences in economic, cultural and demographic contexts.

### Modernization

Researchers at NISCO compare economic and technological developments – and particularly those that accompany secularization – in Dutch and European societies with such processes taking place in other societies. Much attention is paid to belief systems and to meaning derived from religion, to conceptions of justice and altruism, and the implications of these for societal participation. NISCO researchers also focus on modernization processes in developing countries and their effects on inequality and poverty, as well as on social and political cohesion, while also including other aspects such as gender differences and ethnic identities. In this context, the responses of governments to different aspects of modernization processes and their impact at different levels (e.g. that of civil society organisations and individual citizens) are also investigated and assessed.

### Research facilities

Researchers at NISCO specialize in collecting large-scale data for scientific communities. These include both longitudinal collections – on individuals and their life courses and networks within specific social contexts (in the Netherlands and in several other countries) – as well as cross-national collections that contain data from a wide range of countries. These data are valuable for comparative research, providing useful opportunities for multidisciplinary cooperation. A new edition of the survey on Social and Cultural Developments in the Netherlands was completed in 2012, building on data collections from the early 1980s onwards. This data, which was collected with additional funding from the NWO and then transparently documented and deposited at Data Archiving and Networked Services (DANS) to be exploited by the scientific community, is well known as ‘Religion in Dutch Society 2011-2012’ (follow the link: Persistent Identifier: urn:nbn:nl:ui:13-pgxp-kg). The Dutch database on non-governmental development cooperation was also further elaborated (see: www.ngo-database.nl)
Cooperation with counterparts in other Dutch research schools supports international collaboration and provides high-quality education to young PhDs. These include the Netherlands School for Communication Research (NESCOR), the Research School for Resource Studies for Development (CERES) and the Inter-university Centre for Social Science Theory and Methodology (ICS). NISCO staff also participate in networks, such as the European network for research expertise on economic change, quality of life and social cohesion (EQUALSOC); the European Consortium for Sociological Research (ECSR); the European Association of Social Anthropologists (EASA); the European Society for Oceanists (ESfO); the Research Network on European Port Cities; ERANET Learning in Knowledge Society; the Network of Excellence ‘Enhancing Interest in Science in a Developing Europe’ (EISDE); the International Communication Organization (ICA); the International Association of Mass Communication Research (IAMCR); the Development Policy Review Network, and the International Civil Society Forum on Conflicts (INFOCON).

**Awards and acknowledgments**

Dr O. Visser received a prestigious ERC Starting Grant, which he will use to focus on the process of land grabbing in the former Soviet Union. Dr J. Tolsma received a Veni grant to extend his studies on anti-social behaviour among secondary school students in the Netherlands.

**Research results**

In the field of inequality, studies have shown considerable cross-national variation in the health risks that less educated people run. However, there are few explanations for this variation. This lacuna is being filled by investigating to what extent cross-national variations in the health gap between lower and higher educated people in Europe can be explained. Results show that the relative risk of lower educated individuals being in poor health is smaller in countries where the government spends a great deal on healthcare and in those with a highly modernised labour market.

Inequality is also at the heart of research among smallholder farmers who produce for Fair Trade market outlets in order to get better prices and ensure a stable market. The net effects of production, income and expenditure, wealth and investments are compared. After careful matching, only modest effects on direct income and production were found, but there were significant changes in organization, the use of inputs, wealth and assets, and attitudes to risk. Moreover, important differences between farmers with early and more recent Fair Trade affiliations were noted.

Cohesion in societies is studied by examining volunteering for non-profit organizations. The crucial question is: which individual and contextual characteristics can explain differences in volunteering in relation to educational levels? This question was answered by using secondary data collected in 17 countries. Multilevel analyses show that in particular a lower level of cognitive competence as well as the ‘localist’ orientations of those less educated explain the lower likelihood of volunteering.

Cohesion is also at stake in the paradox of the decolonization process in the Pacific. Colonial grievances are expressed in a variety of different ethno-historical circumstances. Indigenous minorities in settler states demand the restoration of sovereignty and the return of properties that were dispossessed in the colonial past. Political discussions generally revolve around the issue of who is responsible for the harm that colonialism inflicted and the related issue of who was harmed. These lead, in turn, to further questions about how the perpetrators of harm can be identified, how deserving cases of justice and reconciliation are constructed, and how the relevant discourses of responsibility respond to historical, political and cultural change.

Modernization processes are examined in relation to the trend towards increasing labour market flexibility among Dutch school-leavers, particularly among those less educated. The results show that there was an increase in the likelihood of flexible employment between 1992 and 2007. The less educated are thus doubly disadvantaged by the process of labour market flexibilization. It appears that economic globalization provides an explanation for these findings, except for the increasing differences in education among those in flexible employment compared to the unemployed.

Despite the forces of modernization and secularization in Europe, old pilgrimage routes are attracting large numbers of people and giving new meanings to this process. In pilgrimage, religious or spiritual meanings are interwoven with social, cultural and politico-strategic concerns: Swedish women in midlife or young English men testing their endurance on the Camino to Santiago de Compostela, Saints’ festivals in Spain and conservative Catholics challenging Europe’s liberal policies on abortion. Traditional Christian saints such as Mary Magdalene are given new meanings as ‘new age’ goddesses and the legends related to shrines are revived by new visionaries.

The Communication Science research group moved to the Behavioural Science Institute (BSI) in 2010, opening up new and fruitful scientific perspectives for cooperation between NISCO and BSI.

**Societal impact**

Members of NISCO believe that their knowledge should be disseminated widely, both among fellow academics and in society. They therefore regularly advise a wide range of public and private institutions and hold advisory positions in a variety of domains. This work includes supporting international data collections (European Social Survey, European Value Survey), national data collections (Centraal Bureau voor de Statistieke, Data Archiving and Networked Services, Algemene Rekenkamer, Wetenschappelijk
Future research

The past year was a fruitful one for NISCO: new assistant professors were appointed (core-funded tenured positions), providing excellent opportunities to expand the scope of research themes, which will also eventually strongly benefit the teaching programmes.

The research programmes of the Cultural Anthropology and Development Studies Research Group will continue to focus on the key themes inequality, cohesion and modernization. More specific topics include:

- the impact of private aid programmes on poverty, inequality and cohesion
- the role of mobility in the construction of social communities, including those in the Netherlands
- the links between productive health and differences in wealth
- the interfaces between cooperatives and value chains
- the New Aid Architecture and its effects on poverty and inequality in countries receiving aid.

These programmes, which are funded by the Dutch Ministry of Foreign Affairs, Cordaid and several other private aid agencies, will lead to a series of PhD theses, which will be defended in the years ahead.

In the Sociology Research Group the focus is on the key themes inequality, cohesion and modernization, with publications containing life-course analyses and multi-level modelling on topics such as:

- social-cultural capital and health
- the composition of neighbourhoods and the effects of this on their inhabitants
- attitudes of parents to children’s socialisation intended to avoid deviancy and delinquency
- the integration of migrants and labour market vulnerabilities
- the careers of criminals
- and inter-ethnic prejudice and contacts in European and Asian contexts.
Key publications


Dissertations: 9
Academic publications: 106
Professional publications: 23
In 2013 Veni laureate Dr Tolsma will start his research on explaining the causal impact of ethnic diversity on social cohesion between and within ethnic groups. In general, cross-national research in the research programmes is being extended. The NWO programme on Conflict and Security has funded studies on the correlates of ethnic diversity in local communities in Europe (to be carried out by one PhD students and two post-docs). This NWO programme has also funded research on ethno-religious conflicts in South-east Asia (Indonesia and the Philippines) which will be carried out by four PhD students plus one post-doc, jointly supervised by researchers from Cultural Anthropology and Sociology. Both research programmes are headed by Principal Investigator Prof. Scheepers.
The Centre for Language Studies (CLS) carries out top-level research in Linguistics, Language and Speech Technology and Communication in a stimulating academic environment. Key aspects are innovation, an interdisciplinary approach and a strong commitment to acquiring research funds, which helps strengthen the profile of research done at the Centre, both in the Netherlands and abroad.

In October 2012, an international committee of peers evaluated the quality and viability of research at the institute for the period 2006-2011. The overall score was 5 (‘Excellent’) on a five-point scale, which means that the research is world-class. CLS researchers work at the forefront of their discipline internationally and their research has a major impact on the field.

The activities at the CLS are organized within two core programmes:

• Researchers working on Language in Mind view language as a window into the cognitive functioning of the brain. They aim to explain how the architecture of the language system interacts with human language processing skills. Using data from native and foreign language acquisition, from language production and comprehension and from spoken and signed languages, they develop and test comprehensive theories about language processing on the one hand and the structure of the language system on the other, using a wide variety of research methods.

• Researchers working on Language in Society consider language to be a social tool that is essential to society and they study language in its historical, cultural and social context. They focus on language contact, sociolinguistic variation and the interactional foundations of language. In addition, they study aspects of functional communication, including language use in the classroom and in a variety of multilingual contexts, speech technology designed to improve communication with the disabled and persuasive communication.
Awards
Prof. Antal van den Bosch, Professor of Example-based language modelling, was elected as a member of the Royal Netherlands Academy of Arts and Sciences (KNAW).

Prof. Pieter Muysken, Professor of Linguistics, holds an endowed professorial chair (the highest recognition that an institution of higher learning can bestow on its faculty) at Stellenbosch University in South Africa since 1 January 2012.

In 2012, Dr Sander Lestrade received the 2011 Anéla/AVT Dissertation Prize for his dissertation The Space of Case (2010).

Research facilities
Research at the CLS is largely empirical, using large databases and experimental techniques. As a result, experimental laboratories with appropriate equipment, powerful computers and sophisticated software – as well as enriched written, spoken, and multimodal language databases (including sign language) – play an increasingly important role. The Executive Board has established Linguistics as a focal area of research for the University and its structural investment in CLS research has been used to create a state-of-the-art psycholinguistic laboratory, including a web experimentation site, facilities for observations with video recordings and a state-of-the-art computer lab.

Collaboration
For CLS researchers much international collaboration is currently informal. The Centre is making an inventory of universities in order to strategically select preferred partners for long-term collaboration on European grant proposals, which require interdisciplinary collaboration and well as an increase of scale. Below is a list of current formal partners:

• Long-standing collaboration with the Max Planck Institute for Psycholinguistics and the Donders Institute for Brain, Cognition and Behaviour. In particular, the latter collaboration is strengthened by the appointment of two researchers to create a CLS-Donders ‘bridge’ which will stimulate linguistic research by incorporating methods from cognitive neuroscience.

• Collaboration with the Universities of Bergamo, York, Osnabrück, Paris VIII and The American University of Paris in the NWO project ‘Varieties of Initial Learners in Language Acquisition’ (VILLA).

• The CLS coordinates the Marie Curie International Training Network ‘Bayesian Biometrics for Forensics’ (BBfor2), together with Universidad Autonoma de Madrid (Spain), Politecnico di Torino (Italy), the University of Twente (NL), Idiap Research Institute (Switzerland), the University of York (UK), KU Leuven (Belgium), Hogskolan i Halmstad (Sweden), the Netherlands Forensic Institute, Agnitio Voice Biometrics (Spain), TNO (NL) and the MARCS Institute (Australia).

• Collaboration with the University of Chicago, Koç University in Istanbul, Colgate University and University College London in the Vidi project ‘Relations between modality and language structure: Insights from comparisons of sign languages and gestures’.

• Collaboration with the University of Heidelberg (Germany) in two international NWO-DFG programmes in Language Acquisition and Multilingualism.

• Participation in the Marie Curie International Training Network ‘Investigating Speech Processing In Realistic Environments’ (INSPIRE) with the Technical University of Denmark, KU Leuven, Philips Research Laboratories Eindhoven (NL), Technical University Eindhoven (NL), Tampere University of Technology (Finland), Universidad del Pais Vasco (Spain), University College London (UK) and the Universities of Edinburgh, York and Sheffield (UK).

• Collaboration with the Sint Maartenskliniek in Nijmegen and the associated Development Centre for Speech and Language Technology in a Communication Assessment project.

• Collaboration with Aarhus University (Denmark), the University of Antwerp (Belgium), Wirtschaftsuniversität Wien (Austria),
Copenhagen Business School (Denmark), Aalto University (Finland) in the project ‘Linguists for Business Research Initiatives’ (LIBRI).

• Collaboration with the University of Arizona in the project ‘Speech reduction across languages and dialects’, which is funded by the National Science Foundation (USA).

• Collaboration with the University of Oregon (USA) and the Museu Goeldi (Brazil) in a ‘Network Reconstructing the South American Linguistic Past’.

• Collaboration with the Universities of Copenhagen (Denmark), Iceland, Bergen and Oslo (Norway), Uppsala (Sweden), Helsinki (Finland), Freiburg (Germany), Picardie (France), Cardiff (UK), Limerick (Ireland), Vienna (Austria) and Oklahoma State University (USA) in creating a European research consortium ‘Standard ideologies in Late Modernity’.

• Collaboration with Pennsylvania State University in a jointly supervised PhD project on ‘The development of phonological representations in bilinguals’ early years: a cross-linguistic examination’.

Research results
Men and women talk differently: women generally have an involved speaking style, with (relatively) more verbs and they use more common words, whereas men speak more informatively, using more nouns and more distinctive words. Karen Keune reached this conclusion in her dissertation, based on the Spoken Dutch Corpus.

Prof. Asli Özyürek in her ERC project ‘Language in our hands: Acquisition of spatial language in deaf and hearing children’ investigates modality effects in the acquisition of spatial language by deaf and hearing children in Turkey. The results show that while some aspects of spatial language in sign languages provide modality advantages for deaf children (i.e., left-right; front-back encoding), in other aspects deaf and hearing children are alike and both groups quickly learn the language-specific structures of their language. Deaf children who do not have access to sign language (i.e., home signers) lack certain spatial cognitive skills – in line with the idea that spatial language facilitates spatial thinking.

During the campaign for the 2012 Dutch parliamentary elections, Mark Rutte received most TV and radio airtime, followed by Emile Roemer and, at some distance, Geert Wilders, Sybrand van Haersma Buma and Diederik Samsom. These are a few facts from the project ‘Political Speaker Tracking’, developed by researchers from the Centre for Language and Speech Technology (CLST), part of the CLS, in cooperation with the Netherlands Institute for Sound and Vision in Hilversum. CLST recently started a project to make the audio-visual archives of the Netherlands Institute for Sound and Vision more accessible, using speech technology.

The number of video-recorded corpora of natural conversations in the home (including family settings around the world) has been extended. First comparative results emerged in a study of ‘repair’ practices; i.e. the set of resources that people use for online management of problems related to speaking, hearing and understanding. Initial findings give broad support to the hypothesis that cross-cultural commonalities in the principles of language use are more frequent than in the semantics and grammatical structures of the languages themselves.

Societal impact
Language and communication are of great importance in multilingual Europe. The recently installed PI groups at CLS have been asked to come up with a plan that will contribute to knowledge dissemination to the general public, raising awareness of the essential role for language and communication in society and developing ‘products’ based on CLS research. Below are some examples of successful applications.

The Dutch government has referred to comprehensible language – or rather the lack of it – as one of the top ten obstacles in the services it provides to citizens. The Netherlands Organisation for Scientific Research (NWO) has therefore launched the programme Comprehensible Language and Effective Communication in order to collect more knowledge about effective communication and to make the academic expertise in this area available to government bodies and civil society organizations. In 2012, CLS researchers were involved in three projects within this programme.

• Dr José Sanders and Prof. Hans Hoeken: ‘Prevention and health regulation behaviour by understandable personal narratives’

Do lorry drivers fail to understand what is healthy or do they run up against barriers when they want to live more healthily? This study will determine whether personal stories from colleagues who have overcome such barriers can help lorry drivers to eat more healthily and exercise more. This project is carried out in partnership with an Occupational Health Service, health insurers and transport insurers.

• Prof. Ted Sanders, Dr Henk Pander Maat (Utrecht University) and Prof. Antal van den Bosch: ‘LIN: A validated reading level tool for Dutch’

For which reader is this text suitable? This project will develop an automatic predictor for the readability of texts. This Readability index for Dutch will be based on reading research involving the use of texts in textbooks and newspapers. During the project linguistics researchers will collaborate with test developers and computational linguists. This project is carried out in partnership with the Dutch Language Union and Citogroep.

• Dr Wyke Stommel: ‘Mutual understanding via chat and telephone’

The researchers will make a detailed comparison of chat and telephone conversations – from an alcohol and drugs helpline – to investigate which communication channel allows participants
Nelleke Oostdijk (Associate professor of Linguistics) works in the fields of computational linguistics and language technology. In her research she focuses on the use of linguistically-motivated approaches to, for example, text classification and text mining. Language use and variation are recurrent themes which also come into play in her work on the automatic detection of threats in tweets.

CLST researchers have developed software for the Korps Landelijke Politiediensten (KLPD; National Police Services Agency) to detect people sending threatening tweets. This ‘threat detector’ filters serious threats out of the millions of innocent tweets that are sent every day. The first test results, which were published on Prinsjesdag (Budget Day), were encouraging, according to the KLPD. This project was commissioned by the Ministry of Security and Justice, as the police aims to increase the attention paid to individual threats on the Internet.

Future research
The NWO’s new Gravitation programme awarded €27.6 million to the project ‘Language in Interaction’, in which a national consortium of excellent researchers is involved, including a large number of scientists at the Donders Institute, the Max Planck Institute and the Centre for Language Studies. This project brings together brain researchers, social scientists and linguists to study the balance and relationship between universal linguistic characteristics and individual variations, and to understand how cognitive systems such as memory, action and control relate to language.

The basic theme of the ‘universal language brain’ is central to this project, which will run from 2013 to 2023.

Dr Odette Scharenborg received an Innovational Research Incentives Scheme Vidi award for her project ‘Ignoring the merry in marry: The effect of individual differences in attention and proficiency in non-native spoken-word recognition in (conditions of) noise’. Ever increasing numbers of people who travel, live, or work in a non-native language environment communicate in a non-native language. Listening in a non-native language is harder than in one’s native language and even harder in the presence of noise, although there are major individual differences. These might be modulated by individual differences in attention as well as proficiency in the non-native language. This project was established in order to understand why individuals differ.
Key publications


Dissertations: 12
Academic publications: 255
Professional publications: 63
Patent: 1
The NWO awarded an Investment Subsidy to Dr Agnes Tellings (Pedagogical Sciences) and Dr Nelleke Oostdijk for ‘BasiScript’: a corpus of written language output produced by elementary school children in the Netherlands, annotated for spelling, word frequencies and word properties, and a 20,000 lexicon that is annotated for word senses. BasiScript will comprise 12 million richly annotated words from written language output, based on three years of data collection in large representative samples of Dutch elementary school children. This data is vital for researchers and authors of school methods, assessment tests, other child-directed texts, and authors of automatic spelling and writing aid programmes.

The project led by Prof. Antal van den Bosch, ‘Integrated Social History Environment for Research: Digging into Social Unrest (ISHER)’, received an award in the Digging into Data Challenge, an international competition established to promote innovative humanities and social science research using large-scale data analysis. Social historians, like other researchers, rely on text data for their research. These data are increasingly available in electronic form, but researchers are hampered in discovering information, as available exploratory tools are inadequate and require too much manual effort. To mitigate this, an integrated environment using sophisticated text mining tools will be developed, cooperating with researchers from the Universities of Illinois and Manchester and the International Institute of Social History, Amsterdam.

Prof. Asifa Majid, who was appointed in 2012, started her research at the CLS with an Innovational Research Incentives Scheme Vici grant for ‘Human olfaction at the intersection of language, culture and biology’. Our current understanding of human olfaction is strongly limited by reliance on a homogenous group of Western people. Language communities in Asia, Africa and South America use many words to talk about abstract smell qualities. These words are said to apply to a broad spectrum of smells and therefore require abstraction. This project will break new ground in the study of olfactory language and cognition by studying people from a variety of communities in different contexts.

Director: Prof. Paula Fikkert

Paula Fikkert has been Professor of First-Language Acquisition and Phonology at Radboud University Nijmegen since 2007. She obtained her doctorate degree cum laude with a thesis entitled On the development of prosodic structure. After her graduation, Fikkert worked for five years at the University of Konstanz. She then moved to Nijmegen as a KNAW researcher, and subsequently received an innovation grant from the NWO. Her current research group – First-Language Acquisition – focuses on the acquisition of phonological representations in the mental lexicon and the role these representations play in early language perception and production. Much of this research is carried out in the Nijmegen Baby Research Centre. Prof. Fikkert is a board member of the Netherlands National Graduate School of Linguistics.
The Behavioural Science Institute (BSI) conducts research on human behaviour. In addition to our fundamental aim (‘to understand behaviour’), we aim to achieve societal relevance (‘to influence behaviour’). A distinctive feature of the BSI is a strong emphasis on an integrative approach to human behaviour that transcends the traditional disciplinary boundaries of psychology and education.

In 2012, the BSI – a research institute of the Faculty of Social Sciences – was re-accredited as a research school by the Royal Netherlands Academy of Arts and Sciences. A two-year Research Master’s programme in Behavioural Science (www.ru.nl/master/behaviouralscience) is taught within the BSI Graduate School, which was officially recognized by the Netherlands Organisation for Scientific Research (NWO) in 2010.

BSI researchers investigate the nature and development of human behaviour. They study the ways in which human behaviour is influenced by i) individual factors (cognitive, affective, motivational and psycho-physiological processes), ii) social-contextual factors (home, school, peer groups and work organisation), and iii) the dynamic interplay between these factors. In addition, they study the reverse associations, i.e. how human behaviour influences individual factors and the social context. Both normative behaviour and psychopathology are the subject of research, involving laboratory experiments and field studies, large-scale longitudinal studies and randomized controlled trials. Studies include behavioural, self-report, psycho-physiological, neuroscience, genetic and virtual reality measurement paradigms.

BSI research is integrated in six closely linked programmes:

Developmental Psychopathology
The central theme here is the interplay between individual characteristics (such as personality, expectancies, implicit associations and genes), as well as environmental cues and social interactions, in relation to the development of psychopathology.
Experimental Psychopathology and Treatment
Research is focused on abnormal psychology through the experimental study of cognitive and neuro-biological processes. Attention, interpretation, approach and avoidance, and memory are studied in relation to different disorders in order to assess their current status, re-train them, predict treatment success and relapse, and help prevent psychological dysfunctions among individuals who are at risk.

Learning and Plasticity
Researchers in this programme explore the micro-analysis of learning and cognitive plasticity. The main focus is on learning and the development of communication and cognition in both ‘normal’ and atypical populations. Special attention is paid to the cognitive constraints related to learning a first and second language – both spoken and written – in terms of representation and control. To gain more insight into the dynamics of learning, the neural principles of brain plasticity are also taken into account.

Social Cognition
The main theme of this programme is the interface between automatic and controlled aspects of behaviour. Several aspects are investigated, including the interactions between implicit and explicit components of attitudes, prejudice and interpersonal relationships and the role of conscious and unconscious processes in decision making and the pursuit of happiness.

Social Development
Fundamental processes of typical and atypical social development and related cognitive processes over the human life span are studied from a behavioural, psychobiological and neuroscientific perspective. Clinical applications are also investigated. Areas of research include early child development and child care, peer relationships, ADHD, cognitive and motor processes in sighted and visually impaired children, as well as successful aging among older adults.

Work, Stress and Health
The main goal here is to advance knowledge of the cognitive, motivational and physiological processes that underlie task behaviour and performance. The applied goal is to provide evidence-based guidelines for designing healthy work, preventing stress, and promoting recovery, motivation, learning and performance in the context of work and sports.

Since 2010 the research group ‘Communication and Influence’, led by Prof. Moniek Buijzen, has been part of the BSI. The main research issues are communication and media, information and influence, and behavioural change, with a focus on informative communication (e.g. the news) and persuasive communication (e.g. marketing). In 2012 the group was extended with additional staff. Its research will be internally evaluated in 2013.

Research facilities
The Behavioural Science Institute has excellent research facilities:
- A Virtual Reality Lab for immersive, three-dimensional computer-generated environments.
- Mobile labs to accommodate various experimental setups outside the university.
- A Physiological Measurements lab, shared with the Donders Centre for Cognition, for measuring neurocognitive and biomechanical data.
- Stationary and mobile eye-trackers for measuring visual attention and eye movements.
- Stabilometric platforms for research on freeze-approach-avoidance behaviour.
- Observational labs with one-way screens and multiple cameras.
- A computer lab with 22 identical cubicles for computerized experiments.
- A Bar Lab for observational studies of social behaviour in a natural setting.
- Through its participation in the Donders Centre for Cognitive Neuroimaging (DCCN), the BSI has full access to neuro-imaging facilities.
Collaboration
The BSI encourages teamwork within and between research programmes (e.g. joint publications, grant proposals, and PhD supervision). In addition, there is collaboration with numerous international and national partners. In order to strengthen collaboration with distinguished scholars and their institutes, the BSI has appointed a number of international fellows, at least one for each research programme. Currently, Prof. Charles Perfetti (Pittsburgh University), Alex Todorov (Princeton University), Janet van Helle (Pennsylvania State University), Mitch Prinstein (University of North Carolina), Marcel Brass (University of Ghent), William Bukowski (Concordia University), Stefan Hofmann (Boston), Jasper Smits (Dallas), Emmanuel Kuntsche (Lausanne) and Goran Kecklund (Stockholm University) are international BSI fellows.

There are formal collaboration arrangements with Haskins Laboratories in New Haven, the Communication Disorders Program of the University of Virginia, the Trimbos Institute, and the Work and Employment division at TNO. Within the University there are formal collaboration arrangements with the RUNMC, the Donders Institute and its Centres for Cognition (DCC) and Cognitive Neuroimaging (DCCN), and continued collaboration with the Max Planck Institute for Psycholinguistics (Nijmegen). In 2012 the BSI renewed its cooperative agreement with DCCN. It also employs a Principal Investigator in DCCN (Dr Alan Sanfey).

Awards and acknowledgements
• Dr Alan Sanfey received an ERC Starting Grant.
• Prof. Karin Roelofs received an ERC Starting Grant.
• PhD student Marcella Woud, MSc, won the 2012 Frye Stipendium award.
• Dr Maaïke Verhagen won an NWO Veni Award.
• Dr Margriet Groen won an NWO Veni Award.
• Prof. Rutger Engels received the Radboud Science Award for best research carried out at the University.
• PhD student Sanne Nauts, MSc won the Geis Memorial Award (division 35, APA).
• Dr Ron Dotsch received the Dissertation Award from the Society for Experimental Social Psychology (SESP).
• Dr Marloes Kleinjan was awarded the ‘Jubileumpris Network Vrouwelijke Hogleraren’.
• Prof. Bert Steenbergen was appointed as a distinguished research fellow at Australian Catholic University in Melbourne, Australia.

Research results
Within the Developmental Psychopathology programme a series of studies showed that self-efficacy deficits are a strong precursor of both smoking onset and cessation in adolescence. This finding can be effectively implemented in prevention and intervention programmes. An alcohol prevention project involving parents has long-term effects on teenagers. This can be explained by consistent parental rule setting in mid and late adolescence. Although a study in six European countries showed that alcohol portrayals in movies predict drinking in adolescence – and that young people imitate drinking by actors on screen – a different pattern was found for smoking, with hardly any impact of actors who smoke on screen on smoking cognitions or attentional processes in children. Following considerable research on adults, new evidence revealed that imitation of palatable food behaviours and preferences by peers starts in early childhood.

A number of studies investigated automatic approach-avoidance tendencies, using a range of tasks (e.g. joysticks and stabilometric platforms) and addressing disorders such as social anxiety, phobias and addictions. It was found that automatic processes, for example pathological skin picking, can predict the severity of symptoms after treatment. Several other studies examined whether cognitive biases in phobias and generalized anxiety are susceptible to treatment and found that they normalize after brief cognitive behaviour therapy. Thus cognitive biases are not enduring vulnerability factors for developing anxiety. Neuroimaging studies showed that social-emotional behaviour can be altered by both direct neural intervention (TMS) and pharmacological interventions (testosterone and oxytocin). Furthermore, it is now possible to measure freeze reactions in a scanner, which opens up new options for investigating the neural mechanisms underlying human freeze (Experimental Psychopathology and Treatment programme).

Cognitive, linguistic and social markers that relate to the processes involved in speech perception, morphology, phonemic awareness, vocabulary development, reading acquisition, arithmetic learning, code-switching, spatial reference and motor planning were highlighted. Furthermore, it was shown how cognitive, linguistic, and social processes vary in deaf children, second language learners and children with an intellectual impairment. Progress was also made on interventions for individuals with mental disabilities, motor impairment, and language impairment. Finally, the process of knowledge construction in educational gaming and the role of teachers’ beliefs and diversity in schools on student learning were studied (Learning and Plasticity programme).

Research on the unconscious processes involved in creativity showed that, although unconscious thought does not always lead to more creativity, it does lead people to improve the selection of creative ideas. In addition, it was shown that diversifying experiences (experiences in which expectancies are not met) increase creativity. Research on imitation showed that mimicry during interaction fosters prosocial behaviour. Research on intimate relationships demonstrated that merely anticipating interacting with a woman reduces executive control in men. Finally, applied research showed that humour in advertisements unconsciously influences product choice (Social Cognition programme).
In baby research it was shown how parental caregiving decisions influence infants’ stress. Infants sleeping alone was a factor in physiological stress due to reduced parental availability. It was also found that emotion regulation through suppression, but not reappraisal, down-regulated stress in ten-year-olds. In another study we found that school-age children’s stress and peer interactions were affected by maternal postpartum depression. We developed a new stress paradigm for five and six-year-olds. It was also demonstrated that adolescents’ explicit perceptions of popular peers were positive, but implicit associations were negative. We found that teachers can influence students’ relationships by changing classroom arrangements. A friendship enrichment programme proved effective in encouraging self-management in older adults (Social Development programme).

A special issue of the Scandinavian Journal of Work, Environment and Health on work-time control was edited by researchers at the BSI. One conclusion was that work-time control is a promising tool for maintaining employees’ work/non-work balance as well as health and well-being. In recovery research, it was found that short vacations represent an effective, though temporary ‘cure’, which improves health and well-being and that working during a vacation had a negative influence on health and well-being after the vacation. In research on work insecurity, it was demonstrated that agency workers have a lower health status and poorer work-related attitudes, and that job redesign measures which affect the quality of their working life and job insecurity are needed (Work, Stress and Health programme).

It was found that age and gender influence people’s preferences for negative and/or sensationalist content in television news and that competitive pressure in newsrooms influences the amount of sensational television news. Other results showed that advertising makes unhappy children more materialistic. However, thinking aloud while watching adverts makes children more resistant to their influence. The group also investigated how media characters can be used to encourage healthy consumption behaviour among pre-school children (Communication and Influence).

**Societal impact**

In addition to its fundamental aim to understand human behaviour, the BSI also aims at societal relevance. On the one hand, fundamental research, for example on addiction, occupational stress, reading acquisition, anxiety and depression, is translated into practical prevention guidelines and into the development of interventions. These interventions, in turn, are subjected to scientific investigation, preferably in randomized controlled trials. On the other hand, societal issues, such as adolescent alcohol consumption and childrens’ reading problems, serve as the starting point for a more fundamental understanding of such topics. This two-way street (the combination of top-down and bottom-up approaches) is typical of BSI’s research orientation. Two examples of societally relevant research are described below.

- In recent years studies on language learning have resulted in a large number of scientific publications. In order to translate this accumulation of knowledge into daily practice in Dutch primary schools, Prof. Ludo Verhoeven and Dr Eliane Seegers edited a special issue of the Dutch professional journal Didactief called ‘Language talent’. This was disseminated to all primary schools in the Netherlands in 2012 in order to provide insight into recent research on language talent so that teachers can optimally develop children’s talent.
- The BSI specializes in understanding the aetiology and development of mental health problems (e.g. depression) and unhealthy behaviours (e.g. alcohol and smoking), on which many doctoral theses, book chapters, and scientific journal articles have been published in recent years. With a ZonMw grant, and in multi-disciplinary collaboration among professional institutions in the Nijmegen region, the Academic Centre Youth Nijmegen was set up, focusing on the prevention and treatment of the mental and behavioural problems of young people and involving their families.
Key publications


Dissertations: 14
Academic publications: 456
Professional publications: 72
The BSI is also very visible outside academia. Staff contribute to debates related to their research and regularly appear in the media (radio, TV, national and international newspapers). Many BSI senior researchers hold important positions in international professional and scientific bodies (e.g. policy advisory boards), and the institute has strong ties with clinical and educational institutions.

Future research
This was a good year for the BSI. As a follow-up to an international research evaluation in 2012 and in order to further strengthen the relationship between research and teaching, nine new assistant professors were appointed (core-funded tenured positions). The number of post-doctoral researchers was also expanded through core funding. This increase in the number of tenured staff will certainly benefit the BSI’s future performance. In 2012, as in previous years, the BSI was successful in obtaining grants for fundamental and applied research from the European Research Council, the NWO, and the Dutch Organisation for Health Research and Innovation (ZonMw). BSI researchers were also successful in acquiring contracts for PhD projects and other research. In particular, the new ERC Starting Grants (Prof. Karin Roelofs and Dr Alan Sanfey) and Veni grants (Dr Margriet Groen and Dr Maaike Verhagen) will greatly strengthen future research.

In the next few years efforts will continue to deliver top-level behavioural research with societal relevance. Linking fundamental research with applications will continue to lead to innovative new projects. Both internal and external cooperation will continue to be strengthened (e.g. on the neurocognitive foundations of behaviour with the Donders Institute) and further top national and international researchers will be recruited.

The BSI invests strongly in international collaboration. In many MSc and PhD projects, researchers and students collaborate with internationally renowned scholars. Often BSI Graduate School students spend time at the institutes of these international collaborators, which is encouraged and supported financially. International PhD students also visit BSI for joint research and approximately 25 international workshops and colloquia are held annually. These workshops lead to intensive collaboration between international renowned scholars and students. In the future the number of international BSI fellows will be increased. The BSI will also prioritize the maintenance of high standards of scholarly conduct and ethical behaviour in professional scientific research.
Cognitive Neuroscience is a key research topic at Radboud University Nijmegen. The research focuses on cognition and behaviour in humans as well as work on the neuronal substrate, including the genetic, molecular and cellular processes that underlie cognitive functions like language, goal-directed action and memory. This scope reflects a broad spectrum of research, extending ‘from Molecule to Man’.

Understanding mind and brain
The Donders Institute (DI) for Brain, Cognition and Behaviour at Radboud University Nijmegen is a leading centre of expertise with a strong international reputation. The institute is relatively young, has an enterprising spirit, and an excellent track record of research on Brain, Cognition and Behaviour. Its prolific scientific output is known for its quality. The institute takes a highly interdisciplinary approach and its breadth, which spans the faculties of Natural Sciences, Social Sciences and the University Medical Centre, is unrivalled worldwide. Collaboration extends beyond the borders of the institute, both nationally and internationally. Chair of the directors, Prof. Harold Bekkering: “The state-of-the-art research equipment as well as the thematic focus that we have achieved over the last few years attract researchers from far and wide. Our strong focus on the system level of human brain and cognition makes us a key player within the huge field of Cognitive Neurosciences worldwide.”

Critical mass and focus
Over 500 researchers work on unravelling the mechanisms of the brain at the DI. Thanks to the integration of sciences within the institute, there is also a strong theoretical approach. The research combines exploring cognition and behaviour in humans and work on the neuronal substrate, including the genetic, molecular and cellular processes that underlie cognition and behaviour. The full spectrum of research ‘from Molecule to Man’ is structured within four main themes:

Language and Communication
Studying Language and Communication involves understanding core language and communication ‘operations’ and working out how these are grounded in (or related to) other domains of cognition, including perception, action, memory, and sociality. An important goal is to determine how the human language faculty is rooted in the ‘language-ready’ human brain.

Perception, Action and Control
Researchers working on Perception Action and Control study sensorimotor mechanisms, their cognitive and social components, their clinical implications, and their relevance for robotics. Research methods include theoretical analysis, psychophysical and behavioural studies, neurophysiological techniques, neuroimaging, clinical and pharmacological interventions, as well as developmental and genetic approaches.

Plasticity and Memory
The development – and decay – of both the healthy and the mal-adaptive brain is the main focus of researchers working on this theme. They study the mechanistic underpinnings and behavioural consequences of long-term changes in neural structure and function. Genetic, molecular and cellular methods, animal models, as well as human neuroimaging and cognitive neuropsychology are applied.

Brain Networks and Neuronal Communication
This theme centres on brain networks, ranging from the very smallest scale – communication between individual neurons – to the largest: communication between areas of the brain and the outside world. Researchers combine developing new techniques for electrophysiological and anatomical measurements of connectivity and activation with data analysis and the experimental application of these techniques in studies of cognition in humans, primates and rodents. Computational modelling is an important component, as it integrates multi-level experimental data in an attempt to arrive at a clearer understanding of cognitive processes.

Benefits for society
The research conducted at the DI has considerable potential for benefiting society, for example in the fields of health, education and safety.

In the field of Health: ParkinsonNet, a national network of caregivers established to provide Parkinson patients with the best possible care. For example, by offering education to (different groups of) caregivers and encouraging collaboration between these groups. And there are new therapies such as using cannabis (Namisol) to treat dementia and applying an ‘errorless’ learning strategy for patients suffering from cognitive decline (MCI/Alzheimer).

In the field of Education, the DI is actively involved in creating learning programmes for primary schools in the Netherlands, based on recent insights into cognitive, social and emotional early human development. These programmes are developed together with major national publishers of school materials.

In the field of Safety, several programmes for the diagnosis and treatment of a range of forensic populations (i.e., those displaying anti-social or extreme violent behaviour) are being developed in close collaboration with major forensic institutes.
Collaboration
The DI actively collaborates with leading national and international research institutes, companies and other potential users of its research results. Joining forces with these organizations makes it possible to extend research beyond the borders of the institute and to valorize research results. The DI participates in a number of high-quality, pioneering national and international consortia, including the following, which were set up in 2012:

- TACTICS, a national consortium of excellent researchers, including a large number of scientists at the DI, the Max Planck Institute and the Nijmegen Centre for Language Studies received a grant worth €27.6 million for the ‘Language in Interaction’ project from the new NWO gravitation programme. This project brings together brain researchers and social scientists to study the balance and relationship between universal linguistic characteristics and individual variations, and to discover how cognitive systems such as memory, action and control relate to language. This project is expected to make a substantial scientific contribution at the highest international level. This project illustrates the ambition of the DI to develop and strengthen collaboration at the local, national and international level in order to continue making progress in advancing understanding of the human brain and its relationship to behaviour.

- Future developments
The research done at the DI will be evaluated in the spring of 2013 by an external committee of renowned neuroscience scientists. The DI is looking forward to their valuable advice and conclusions.

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The TACTICS project was established to identify, over a five-year period, the neural, genetic and molecular factors involved in the pathogenesis of compulsivity. A strong multidisciplinary team of top preclinical and clinical researchers work together to arrive at a better understanding and treatment of this syndrome. TACTICS, which combines 11 partners from seven countries, is coordinated by researchers from the Donders Institute.

The Cognomics initiative bridges current gaps between scientists working on genes, brain structure and function, and human cognition, revealing the influence of genetic variation. The idea is to establish a database involving thousands of participants to trace such connections. The Radboud University Nijmegen Medical Centre, the DI, and the Max Planck Institute for Psycholinguistics have joined forces to focus on key cognitive processes, especially those related to memory, language and psychiatric disorders.

The Food and Cognition Model (FOCOM) will develop test systems, which will be used to predict the relationship between nutrition and the brain. These systems will help explain perception, choice, and eating behaviour. They will also be able to identify early signals suggesting a risk of obesity, eating and aging disorders, and amnesia. Partners include Wageningen University, the University of Twente, H.J. Heinz, NIZO Food Research and Twente Medical Systems International.

The main focus of SpaceCog is to design a human-like spatial cognition system within a neural architecture grounded in brain anatomy and physiology. The model will be demonstrated as ‘neuroware’ for a virtual human being acting in a virtual reality. SpaceCog brings together experts from universities in Germany, France, the UK and the Netherlands (DI).

Donders Graduate School for Cognitive Neuroscience
In order to train talented young people in this broad field, the Institute has established the Donders Graduate School for Cognitive Neuroscience (DGCN), which offers students a high-quality, tailor-made educational programme at both the Master’s and PhD level. The school is intended for top national and international students in biology, physics, psycholinguistics, behavioural studies and medicine who are strongly motivated to do research in cognitive neuroscience. The DGCN attracts ‘triple-A’ students (those who are Active, Ambitious and Autonomous) and, as a result, graduates from the Master’s programme are much in demand around the world. Currently, there are 70 MSc and 200 PhD students enrolled in the DGCN. The DGCN hosts an annual ‘Top talent’ programme, which provides PhD funding for excellent young DGCN Master’s students; two to three positions are available each year.

The DGCN is officially recognized as a national graduate school within the NWO Graduate School Programme that is endorsed by the Dutch Minister of Education. The MSc programme is approved by the Accreditation Organisation of the Netherlands and Flanders (NVAO). Dr C. Döller is ‘Speaker’ of the DGCN and Prof. R. Meulenbroek is the Director of the MSc programme.

DGCN highlights in 2012:
• DGCN PhD students successfully organized – for the fifth time – the ‘Donders Discussions’ during which they organize national and international exchanges
• In 2012, we celebrated the 100th PhD thesis published in the Donders Series.
• PhD students at the institute again published excellent work in prestigious international journals, e.g. Peter Kok’s study on prior expectations (Kok, Jehee, De Lange, Neuron, 2012)
• S. Beul, an MSc student, received the Dutch MSc Thesis Award for Cognitive Neurosciences.

Future developments
The research done at the DI will be evaluated in the spring of 2013 by an external committee of renowned neuroscience scientists. The DI is looking forward to their valuable advice and conclusions.

A national consortium of excellent researchers, including a large number of scientists at the DI, the Max Planck Institute and the Nijmegen Centre for Language Studies received a grant worth €27.6 million for the ‘Language in Interaction’ project from the new NWO gravitation programme. This project brings together brain researchers and social scientists to study the balance and relationship between universal linguistic characteristics and individual variations, and to discover how cognitive systems such as memory, action and control relate to language. This project is expected to make a substantial scientific contribution at the highest international level. This project illustrates the ambition of the DI to develop and strengthen collaboration at the local, national and international level in order to continue making progress in advancing understanding of the human brain and its relationship to behaviour.

www.ru.nl/donders
The Donders Centre for Cognition (DCC) is one of three centres at the Donders Institute for Brain, Cognition and Behaviour. Scientists working in a range of disciplines jointly study the psychological, formal and neurobiological principles of information processing in biological and artificial cognitive systems. Research collaboration with the Donders Centre for Cognitive Neuroimaging (DCCN) and the Donders Centre for Neuroscience (DCN) covers the four Donders research themes: Language and Communication (LC), Perception, Action and Control (PAC), Plasticity and Memory (PM) and Brain Networks and Neuronal Communication (BNNC). The DCC has five research divisions.

**Psycholinguistics (PL)**
Researchers study the cognitive processes and representations underlying the use of language in a variety of contexts, including speaking, reading and listening, at the word, sentence, and discourse level. Various techniques are used, including studies of reaction times, eye-tracking, neuro-imaging and computational modelling, with a special focus on contextual flexibility and multilingualism. All researchers in this division participate in work related to the LC theme.

**Action, Intention and Motor control (AIM)**
The objective here is to advance the study of the basic sensorimotor as well as the cognitive, contextual and social components of perception-action coupling. Research methods include clinical and behavioural studies, neurophysiological and neuroimaging techniques, developmental and genetic approaches, and computational modelling. Key focus areas include Sensorimotor Integration, Intention and Control, and Social Interaction. All members of AIM contribute to the Donders theme PAC.

**Biological Psychology (BP)**
This division focuses on brain-behaviour relationships, bridging the gap between cognitive & systemic and basic & clinical neuro-
sciences. Neuroimaging and behavioural studies are performed in combination with pharmacological and/or genetic manipulations. Rodents, healthy participants and selected neurological patients are studied. Significant contributions are made to the Donders themes PAC, PM and BNNC.

**Neuropsychology and Rehabilitation Psychology (NRP)**
Research in this area focuses on the interplay between executive control, learning and memory using interdisciplinary, patient-centred studies and ageing individuals in combination with structural and functional neuroimaging methods. An important topic is learning, which can be examined from the perspective of rule learning and learned irrelevance (PAC) as well as learning as part of memory acquisition and cognitive rehabilitation (the PM theme).

**Cognitive Artificial Intelligence (CAI)**
The research focus here is on natural and artificial intelligent systems and their interactions. The main research topics are Brain-Computer Interfaces and Brain Decoding (within the BNNC theme), Theoretical Cognitive Science and Ethics of Cognitive Neuroscience (PAC) and Neurofeedback for second language and music learning (LC).

**Awards and acknowledgements**
- 2012-2017, NWO-TOP grant for a project entitled ‘How the integration of sensorimotor simulation and mentalizing allows for human action understanding’. Main applicant: Prof. Bekkering, co-applicants: Dr Toni, Dr Van Rooij and others.
- 2012-2016 An NWO Free Competition grant for ‘How do brain regions work together to produce adaptive behaviour?’ Main applicant: Prof. Ullsperger.
- 2012-2016 An EU Marie Curie Initial Training Network grant for ‘ACT - Early Social Development’. Work-package leader: Prof. Bekkering and Dr Hunnius.
- 2012-2016 DFG-SFB 940 grant for ‘Development of intention memory and volitional control’, Dr Altgassen, with TU Dresden.
- NutsOhra grant for ‘Effectivity of internet-based memory training’, Dr Oosterman.
- Lifelong Learning Programme, Erasmus Intensive Programmes. Law and Neuroscience Winterschool Co-applicant: Dr Haselager.
- Dr Femke Maij received an NWO Veni award.
- An STW valorisation grant for Dr Dimitriadis and Prof. Desain.
- The Radboud Science Award, for best research at the University, to Prof. Medendorp.
- A Frye Stipendium for Vitoria Piai – a University award for promising young female researchers.
- Kwaliteitsprijs 2012 for Prof. Desain from the Hersenstichting for the development of an app for afasia patients.
- Nationale Zorgvernieuws prijs 2012 from ZonMw for Prof. Desain for the development of ‘Klikpraat’, an app to assist ALS patients.

**Research facilities**
- The Baby Research Centre has facilities for behavioural and neuroscientific research on infants and young children, including several Tobii eye-trackers, an fNIRS system with 32 sources and 16 detectors and a 32-channel active EEG setup.
- A vestibular sled with combined EEG apparatus (96 channels), motion-tracking devices, and VR stimulus displays, as well as a ‘Reach-in’ 3D visualization and force-feedback equipment.
- Several EEG/ERP laboratories for measuring brain activity during cognitive tasks and online processing in Brain-Computer Interfacing.
Collaboration

DCC strives for cooperation with excellent national and international partners, seeking to develop and strengthen research within the four Donders themes by sharing equipment, people and ideas. Within the University there is fruitful collaboration with researchers at the BSI. Research groups at the DCC have formed strategic alliances with other international research groups in order to develop a distinct competitive edge, to create synergies, and to combine resources in order to acquire financial support for research and related infrastructure. There is also extensive cooperation with business partners and with non-profit organisations for complementary research, products and services. The DCC collaborates with Jagiellonian University in Kraków, Poland – a partner in the International Research Universities Network (IRUN) – on epilepsy research as well as language studies. The DCC is also engaged in many other structural collaborations with academic institutions, including those with:

- Lancaster University, UK and the University of Uppsala, Sweden within the Marie Curie International Training Network ‘ACT – Early Social Development’.
- The University of Chemnitz, University College London, the University Paul Sabatier, Toulouse and University Paris Descartes in the context of an EU STREP FET consortium grant.
- Birkbeck College, London, UK) University of California, San Diego, USA; Prof. Stuart Anstis on Colour perception.
- The University of Leipzig on syntactic processing and language production.
- Hanyang University, Seoul, South Korea on speech perception.
- King’s College, London, UK: collaboration on amnesia and contextual memory research.
- University College London on computational modelling of amnesia/working-memory capacity/semantics and pain.
- Oxford University, UK on computational modelling of associative learning.
- Duke University, North Carolina, USA on episodic memory and ageing.
- Universität Zürich on the neural correlates of prospective memory across the lifespan.
- Technische Universität Dresden on executive control and intention development through childhood and adolescence.
- Université d’Angers on source memory and executive control.
- University of Oldenburg on memory and executive control in brain-injured patients.
- The Universities of Geneva, Aberdeen and Queensland on future thinking, perspective taking and prospective memory.
- University of Queensland on future thinking, perspective taking and prospective memory.
- Amta Jaya Catholic University, Jakarta on neuropsychological assessment and disorders.
- RIKEN institute, Wako, Japan.

In addition, DCC researchers have access to the brain-imaging facilities of DCN (fMRI, MEG, EEG and TMS).

Research results

Language and communication

With respect to speech perception, a breakthrough was the finding that in Berber, a language in which words can be completely vowelless, otherwise language-universal constraints that minimize competition from words within words do not operate. Other studies showed that in toddlers, even for natural objects (e.g. food or animals with a prototypical color), semantic knowledge is a more salient aspect of a toddler’s word meaning than color knowledge. Studies examining the limited vocabulary of deaf children were conducted with the aim of finding ways to alleviate this problem. Researchers further reported on the lexical distributions of cognates (words that are similar in form and meaning) in various European language combinations. An EEG study on overt naming in picture-word interference showed that Stroop-like effects and semantic interference effects arise in a common time window, suggesting that these effects arise during lexical selection. Finally, there were language production studies on the role of competition and on the selection of freestanding and bound gender-marking morphemes, as well as on bilingual event conceptualization during picture description.

Perception, Action and Control

The neural basis of social learning was examined within the Baby Research Centre, showing that infants as young as eight months old are able to acquire bidirectional action-effect associations through their own actions, but also through observing others’ actions with a novel toy. Researchers from the sensorimotor lab revealed the computational and neural mechanisms underlying dynamic spatial perception in moving subjects. Another major finding was that the anterior intraparietal cortex is necessary at an early stage of preparation of goal-directed actions that rely on perceptual features, suggesting a mechanism through which perception creates a bias with respect to action selection. Other research, using EEG and fMRI, found that errors and valence-free novel action outcomes engage the same brain mechanisms and elicit similar adaptive changes in behaviour. Furthermore, a novel
As a postdoc in Cognitive Psychology, Femke Maij investigates behaviour and brain activities in a dynamic environment. She won an NWO Veni grant to study the perception of time and space by people who are in motion.

approach was developed to graph the theoretical analysis of brain functional connectivity, demonstrating that the topology of brain networks is dynamically adjusted from trial to trial when flexibly preparing for changing task demands. Finally, studies on learning and social decision-making in psychopathy and antisociality have shown that these disorders can be differentiated based on ERP measures for modulation of attention.

Plasticity and memory
The cognitive mechanisms of working memory and episodic memory formation were examined in brain-diseased patients as well as in normal ageing. An important result was that in the posteromedial cortex opposite levels of functional MRI activity are found during encoding (learning) and retrieval (remembering). Another important finding was that MTL activation during working-memory task is a byproduct of long-term encoding rather than reflecting ‘pure’ working-memory processing. Further research focused on investigating the basic properties of idiopathic epilepsies and epileptogenesis. New sources of preictal activity were discovered in children with absence epilepsy, which is consistent with work done in genetic epileptic rats.

Brain Networks and Neuronal Communication
Researchers developed a new recording technique and used various network analysis techniques in order to study cortico-thalamo-cortical functional connectivity. They also designed and implemented two BCI systems in models for epilepsy and evaluated various types of deep brain stimulation. Further work showed that neuronal phase-amplitude coupling is spatially distributed and can therefore serve as a backbone of neuronal communication between distant brain areas.

Societal impact
Researchers contribute to the dissemination of fundamental research and its technological and educational applications via teaching programmes, public conferences and the media. Prof. Bekkering worked on translating insights from Cognitive Neuroscience into Education. Together with a major publisher (Malmberg) he developed animations to improve word learning in primary school. He is also involved in a national project designed to improve number processing in primary school, mainly by integrating the sensorimotor system while learning mathematics. Furthermore, the Radboud Science Award will be used by Prof. Medendorp to translate his research on Perception and Action into activities for primary schools.

Researchers at the Baby Research Centre convey their findings to professionals working with young children. Dr Hunnius co-organized a series of annual symposia for Infant Mental Health professionals and gave lectures to psychotherapists (e.g. SPON; GGNet), health-care professionals (e.g. NIDCAP; Amphia Ziekenhuis), and educational professionals (e.g. Boekstart; NSDSK).

Research in the PL division combines academic rigour with practical applicability. Examples of the latter are investigations into Specific Language Impairment and the STW-EarOpener project on a neurofeedback system for learning auditory categories (non-native speech sounds and musical categories) and the study of mood induction and emotion word processing in healthy and clinical populations (e.g. those suffering from autism).

Members of the NRP division have given lectures to the general public, focusing on neuropsychology and cognitive rehabilitation as well as ageing and dementia (Hersenstichting, Alzheimer Nederland). NRP members also have edited and co-edited Dutch-language handbooks in the field of neuropsychology and rehabilitation psychology, which are widely used in BA/MA courses, as well as in post-Masters training programmes. The NRP division has formalized ties with clinical institutes (Vincent van Gogh Institute in Venray, Groot Klimmendaal in Arnhem, the Pompestichting in Nijmegen, and the Kempenheger epilepsie centre). Members collaborate with companies to valorize research results into clinical applications (Pearson Test Publishers, Hogrefe Test Publishers and Diagnosels)
## Key publications

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CAI researchers apply their expertise to real-world solutions and several patents have been granted. Various apps for assisted communication were developed. Prof. Desain became an advisor to the Dr Leo Kannerhuis Centre for Autism. The spin-off company Mind-Affect will market ALS communication devices. Work on a second spin-off on Brain-Computer Interfaces for computer games has just been started. The BrainGain project is in its final stage, emphasizing valorisation and the application of Brain Computer Interfaces, Neurostimulation and Neurofeedback. Dr Haselager played a central role in guiding and organizing platforms to engage in the ethical thinking needed for these new neuro-technologies.

**Future research**

Adopting a multi-disciplinary approach, DCC will continue to study the relationship between brain and cognition, with a focus on both applied studies and research. The centre will continue to encourage research within the four Donders themes. One objective is to increase the proportion of external funding from the EU’s 7th Framework Programme (FP7) as well as the 8th Framework Programme – Horizon 2020. Researchers participate in many new calls and have taken the initiative to coordinate new research proposal in FP7. New neurocognitive research will be carried out in the framework of the Gravitation Grant ‘Language in Interaction’. Furthermore, Prof. Bekkering coordinates a TOP grant awarded by NWO-MaGW that – together with colleagues in the Donders Institute – enables him to investigate the interactions between intention and action during social interaction. Within the Baby Research Centre, five new PhD students started their research in 2012, financed by an EU Marie Curie ITN grant as well as individual scholarships. They will study how infants learn to understand other people’s actions. Prof. Medendorp started using his ERC Consolidator Grant in 2012 and will use his Vici grant in 2013 to work on sensorimotor integration and decision making in dynamic environments. Prof. Medendorp will further lead a work package in an EU STREP Consortium grant on Spatial Cognition. Dr Maij will start research funded by her Veni award, entitled ‘Space and Time in Motion’. Other ongoing work includes four Brain & Cognition grants (Prof. Bekkering, Profs. Desain and McQueen, Profs. Kessels and Fasotti, and Prof. Toni), an STW EarOpener grant (Prof Desain and Prof. McQueen), two Veni projects (Dr Lemhöfer and Dr Selen), two Vidi projects (Prof. Kessels and Dr Fiebach) and several open competition projects funded by the NWO (Dr van Gerven and Prof. Medendorp). Another major research topic will be Second Language Acquisition as well as the genetics and training of attentional control in typical and developmentally impaired (e.g. SLI) speakers. A new research line focusing on prospective memory will be set up by Dr Altgassen and a line dedicated to intra-operative electrocorticography will be initiated by Dr Daselaar. The CAI division expects to be able to extend its contribution in computational modelling and machine learning to all Donder’s themes. Furthermore, the division will push the applicability of Brain-Computer Interfaces beyond the domain of assistive technology, creating efficient new training methods and a tool for scientific research.

In order to further strengthen the relationship between research and teaching, three new assistant professors have been appointed (core-funded tenured positions).
The Donders Centre for Cognitive Neuroimaging (DCCN) conducts basic and applied research in cognitive neuroscience. Much of the recent rapid progress in this field is driven by the development of complex neuro-imaging techniques for the in-vivo scanning of activity in the human brain, an area in which the DCCN plays a leading role.

Research at the DCCN focuses on central cognitive functions. The aim is to unravel these complex functions and understand how they are represented in the brain. This is done by identifying the networks of brain areas that are vital to each of these functions, and determining the role of – and interactions between – regions. In order to achieve this, it is also necessary to understand how neurons make networks and how networks execute cognitive functions, in other words, how to get from neurons to cognition. Research at the centre also aims to establish how the different brain areas coordinate their activity with very high temporal accuracy in order to enable human cognition.

Another important aspect of the research is improving the imaging methods themselves, by optimally combining imaging techniques with high spatial (fMRI) and high temporal (MEG, TMS and EEG) resolution and by developing advanced data analysis tools to extract the relevant information from the highly complex signals which these systems provide. In recent years, some aspects of both the cognitive and the methodological research have been combined in projects related to the brain-computer interface, work for which both a deep understanding of brain functioning and technical excellence are required.

All research at the DCCN is done within the context of the Donders Institute for Brain, Cognition and Behaviour. Research is organized in Principal Investigator (PI)-led groups, which each work within one of the four major research themes of the Donders Institute.

Language and Communication

Language processing is more than just decoding meaning from spoken or orthographic inputs. One has to infer what the speaker wants to achieve. DCCN researchers have shown that understanding these inferences involves applying the Theory of Mind to areas in
the brain. This work provides evidence that contradicts with strong versions of the Mirror Neuron hypothesis, which claim that motor resonance is sufficient for understanding language. These findings also extend the Memory, Unification, and Control (MUC) model. Furthermore, researchers showed that linguistic marking triggers the attentional networks of the brain, making it possible to process new information more profoundly.

The PI working on this theme is Prof. Hagoort.

**Perception, Action and Control**
Research within this theme explores how perceptual and conceptual information can structure action plans as well as the brain dynamics that makes human action possible. It has been shown that planning actions and perceiving those of others rely on a common predictive mechanism that is focused on the goal state of the action and grounded in the current physical configuration of the body. It has also been determined how patients with Parkinson’s Disease and healthy subjects with a genetic predisposition developed that disorder and compensate for disturbances in this grounding mechanism. This opens up potential routes to understanding how perceptual brain regions can support motor function in Parkinson’s Disease.

Perception and decision-making are not automatic processes, but strongly shaped by internal brain states, which incorporate our goals, attention, expectations, and knowledge about the world. The complex relationship between these various top-down factors is characterized using fMRI and MEG. Researchers in this group have shown that valid expectations about the sensory world lead to reduced, but sharper neural representations.

How is visual information represented in the brain and how are visual representations adjusted to better serve behavioural demands? Research has focused on these and other questions relating to the neural basis of visual perception. Results have shown that extensive training on a visual task can lead to targeted functional reorganization of the visual cortex, which refines the cortical representation of behaviourally relevant information.

The mechanisms of individual and interactive decision-making are investigated. Researchers in one group study how social factors such as trust, fairness and cooperation change choices, in contrast to ‘rational’ models of behaviour. This group also constructs biologically-based models of emotional influences, such as guilt and empathy, on decision-making. Results show that prior knowledge about expectations of social exchange can radically alter our decisions, and that affective factors play an important role in decision-making. The researchers also explore the neural systems underlying interactive choice.

The psychopharmacological mechanisms affecting the motivational and cognitive control of both healthy and disordered decision making are assessed. This work focuses on the role of fronto-striatal circuitry and its neuromodulation by dopamine and serotonin, with the ultimate translational aim of understanding the neurochemical basis of a variety of neuropsychiatric disorders. Two key findings were obtained in 2012. Firstly, researchers established the neurochemical specificity of striatal signalling during reward and punishment learning. Secondly, it was shown, using TMS, that the frontal cortex controls cognitive function that depends on the striatum.

The PIs working on this theme are Prof. Toni, Dr de Lange, Dr Jehee, Dr Sanfey and Prof. Cools.

**Plasticity and Memory**
How does the brain map space and form memories? By combining recent advances in high-field fMRI, proxy measures of cellular activity and multivariate data analysis techniques, it was possible to decode the distribution of cell-type specific representations of virtual space. In addition, the neural mechanisms of encoding, stabilization and readout of associative memories were investigated. The results open up the possibility of a detailed meso-level description of neural representation and demonstrate the potential of
using non-invasive neuroimaging technologies to infer the fine-scale properties of neural systems in humans by building on models from single-cell electrophysiology.

Another research line focuses on the neural underpinnings of memory, emotion and their interactions. A series of fMRI studies were used to explore how prior knowledge affects new learning. The results revealed that prior knowledge improved learning of new, related information and that this effect is mediated by encoding and consolidation processes. This research is fundamental in nature, but it is also relevant for education. Our data revealed brain processes that predict individual academic success at university.

The PIs working on this theme are Prof. Fernández and Dr Döller.

Brain, Networks and Neuronal Communication
Researchers working in the Neuronal Oscillations group investigate how oscillatory brain activity is involved in routing information between brain regions. They have shown that alpha band oscillations (10-12 Hz) are under top-down control and set the state of the brain networks. Button-up processing is reflected in the gamma band activity (30-100 Hz) controlled by alpha oscillations. These principles are investigated using attention and memory paradigms in combination with multi-modal imaging.

The ‘MR techniques in brain function’ group conducts research that is designed to improve the ability to measure brain function and structure using magnetic resonance techniques. These techniques are also used to evaluate the connectivity between brain regions. To achieve these goals the group either develops novel techniques or improves existing methodologies. Areas of interest include the acquisition of fMRI data (in activation studies and in the resting state), diffusion tensor imaging, proton spectroscopy and ways to measure brain connectivity.

The Statistical Imaging Neuroscience group develops unified approaches to analysing neuroimaging data in order to provide imaging neuroscientists with powerful multimodal research tools and clinicians with advanced practical tools. These tools are used to investigate cognition, in clinical settings (dementias, MS, addiction and oncology) and in other challenging imaging scenarios, such as pharmacological studies and studies of early brain development in neonates.

The PIs working on this theme are Dr Jensen, Prof. Norris and Prof. Beckmann.

Awards and acknowledgements
- Dr de Lange received the 2012 Heineken Young Scientist Award for Cognitive Science (KNAW)
- Dr de Lange received the 2012 Biomag Young Investigator Award
- Prof. Hagoort received the Academy Professor Prize from the KNAW
- Prof. Hagoort – and co-applicants – received a grant for the Language in Interaction Project within NWO’s Gravitation Programme
- Prof. Cools received the 2012 Young Investigator Award from the Cognitive Neuroscience Society
- Dr Jensen received the 2012 Biomag Mid-Career Achievement Award
- Dr Döller is one of the founders of the Young Academy of Europe
- Prof. Toni was appointed as editor of The Journal of Neuroscience.

Research facilities
- four MR scanners – dedicated to research at 1.5, 3, and 7 Tesla – for measuring structural anatomy and functional brain activity with high spatial resolution
- a 64-channel EEG system for measuring EEG in the MR scanners
- a whole-head, 275-channel MEG system, for measuring neuronal activity with high temporal and good spatial resolution
- two EEG laboratories and two behavioural laboratories
- integrated stimulus presentation and eye-tracking facilities
- centralized data storage and central computation power

Collaboration
Because the research carried out at the Donders Institute is conducted in an international setting, the DCCN strives to collaborate with research institutes at both the national and international level. The DCCN is a research centre at Radboud University Nijmegen, in which the universities of Maastricht, and Twente as well as the Radboud University Nijmegen Medical Centre and the Max Planck Institute for Psycholinguistics also participate.

The DCCN collaborates with the University of Duisburg-Essen, Germany – a preferred partner of the Radboud University Nijmegen – on the operation of a joint research centre for high-field MR imaging, the Erwin L Hahn Institute, in Essen.

The DCCN is engaged in numerous structural collaborations with academic institutions, including:
- Columbia University, New York, USA (TMS, perceptual awareness)
- University of Arizona, Tucson, USA (decision neuroscience)
- University of Trento, Italy (decision neuroscience)
- University of California, Berkeley, USA (cognitive control)
- University College London, UK (neural representation of space)
- National Institute of Mental Health, Bethesda, US (neuronal oscillations)
- University of Edinburgh, UK (memory consolidation)
- Imperial College London, UK (neonatal imaging)
- University of Oxford (image analysis and imaging genetics)
- Heinrich-Heine Universität, Düsseldorf, Germany (multilingualism)
- Vanderbilt University, Nashville, USA (fMRI, visual processing).
Societal impact

Research conducted at the DI has considerable potential for benefiting society, for example in the fields of health, education and safety. A key aim is to contribute to a better understanding of the nervous system by disseminating expertise and knowledge to both the scientific community and the general public.

An annual series of courses entitled ‘The cognitive neuroscience tool-kit’ attracts students and researchers from all over Europe. An advanced analysis software package which is used to analyze MEG and EEG data has been developed and made available to the neuroscience community.

During the past year researchers at the DCCN appeared in various national TV and radio programmes, including VPRO’s Labyrinth and NTR’s Hoe? Zo! Research at the DCCN also featured in many newspapers and on numerous websites. Staff at the DCCN gave a number of lectures for the general public, including the keynote lecture ‘Hersenen en Economie’ (Brains and the economy) by Dr de Lange at the KNAW event ‘Thinking Ahead’. Dr Sanfey gave a presentation to a group of senior police officials about the potential relevance of neuroscience to policy and Prof. Cools became a member of the board of the Rathenau Institute, which promotes the formation of political and public opinion in relation to science and technology.

The DCCN also has several collaborative projects with companies. The centre participates in the BrainGain, VIP Brain Networks, the FOCOM consortia and it collaborates with several commercial partners including Siemens and Abbott. Its researchers are also involved in setting up new companies. A collaboration with DSM resulted in a joint patent application for functional food.

Future research

Language and Communication

Future work will focus on various aspects of language production as well as related structural and functional changes. The balance and relationship between universal linguistic characteristics and individual variations, and how cognitive systems such as memory, action and control relate to language will be studied in the Language in Interaction Project (NWO Gravitation).

Perception, Action and Control

Work in this area, which involves two main lines of research – targeting instrumental and communicative actions – will continue. Experiments are planned which will study the mechanisms that integrate visuo-spatial and perceptual information into a motor plan as well as the cerebral and computational mechanisms that support the generation of human communicative actions.

Assessments of the efficacy of psychopharmacological treatment in psychiatry (an NWO Vidi project) will be extended to include the effects of motivational manipulations in terms of enhancing cognition (James McDonnell Scholar Award).

Work on predictive processing in the brain will be extended to take into account the influence of sensory awareness. Initial steps have been made towards applying research to clinical disorders such as autism and schizophrenia.

The way in which visual information is represented in the brain will be investigated as well as how visual representations are adjusted to better serve behavioural demands. These and other questions relating to visual processing are addressed using both theoretical modelling and experimental approaches, including functional brain imaging, neural decoding techniques and visual psychophysics.
Key publications


Researchers will continue working on the way trust, fairness and cooperation affect decision-making by constructing biologically-based models of emotional influences, such as guilt and empathy. This research is funded by an ERC Starting Grant.

**Plasticity and Memory**

The role of pre-existing knowledge in new, related learning is investigated further by adopting a translational approach that closely integrates work in rodents and humans. The aim of this research is to dissect the underlying brain processes and neural representations, and explore the contribution of specific neuromodulators. It has also a developmental and applied angle, due to the hypothesis that children and adolescents benefit most from schema-congruent learning during their formal education.

It is planned to investigate the mechanisms of memory organization in the brain and to test the overarching hypothesis that memories are stored in mnemonic networks. Future studies will examine how these networks evolve and how they allow us to dynamically link previously disparate memories and help us to access stored representations. This research is funded by an ERC Starting Grant.

**Brain, Networks and Neuronal Communication**

The role of oscillatory brain activity will be investigated using multimodal approaches that employ combinations of MEG, EEG, TMS and fMRI. In particular, the role phase of the brain oscillations will be investigated using these techniques as well as cross-frequency analysis. Brain-computer interfaces will be used to investigate the role of oscillatory brain states on perception and memory online. This research is funded by Veni, Vici and other NWO grants.

In collaboration with Siemens the application of simultaneous multi-slice imaging will be extended, particularly for distortion-free functional imaging at 7 Tesla. The implementation of quantitative GABA measurement at both 3 and 7 Tesla will be started (as part of a project with the Helmholtz society). Work on high-speed fMRI data acquisition and its combination with EEG measurement will be continued. In the context of a Marie-Curie training network, an investigation of the biophysics underlying layer specific activation in the neocortex will start.

New methodology for characterizing the dynamics of interactions in multi-subject data with respect to functional brain connectivity in health and disease will be developed, as will new techniques for functional fingerprinting with the goal of defining more specific targets for biomarker development. This research is funded via Wellcome Trust, Marie Curie, ERC Synergy and NIH blueprint programmes.
Researchers at the Centre for Neuroscience (DCN) aim to reveal biologically plausible mechanistic accounts for neural processes at the brain system level that underlie ongoing cognitive phenomena such as language, perception and cognitive control as well as long-term changes in neural structure and function such as brain development, adaptation and memory. This research is fundamental in nature, but it is also closely related to clinical and technological applications.

The DCN was founded in 2008 as part of the Donders Institute for Brain, Cognition and Behaviour (DI). It includes all of the neuroscience activities associated with the Natural Sciences, Mathematics and Informatics faculty as well as those related to the Medical Science faculty. To strengthen internal coherence and interaction between researchers across campus, the DCN’s activities are currently being concentrated in three units: the Clinical Neuroscience Unit (CNU), the Translational Neuroscience Unit (TNU) and the Neurophysics Unit (NPU).

In DI Theme 1, DCN researchers study the genetic – and thus the molecular – basis of the neural processes that enable language capabilities.

Research in DI Theme 2 concentrates on the neural processing underlying perception, action and control within three focus areas: (a) Perception – the neural underpinnings of visual and auditory perception. This research is done in a clinical context of developmental and acquired hearing impairments and acquired impairment of vision. (b) Action – the basic and cognitive determinants of motor action as they are impaired in movement and muscle disorders. (c) Control – the mechanisms enabling ongoing control of behaviour and emotion (this has clinical relevance for various disorders such as ADHD, psychopathy and substance abuse).
**DI Theme 2** focuses on the mechanistic underpinnings and behavioural consequences of long-term changes in neural structure and function. Here too there are three focus areas: a) Development – the study of the determinants, mechanisms and consequences of normal and abnormal neurodevelopment, with a strong translational drive focusing on intellectual disability and autism. b) Adaptation – the study of the neurobiological mechanism underlying responses to environmental challenges potentially leading to stress-related mental disorders such as mood and anxiety disorders and to internal challenges due to brain damage. c) Memory – focusing on the neural and psychological mechanisms underlying memory, with a translational angle (disorders with memory impairments such as Alzheimer’s disease).

**DI Theme 4** research focuses on brain networks and neuronal communication in order to uncover the fundamental principles of how local circuits compute in the brain. The role of spike timing is studied as well as the functional role of neural oscillations in selective attention. Innovative experimental techniques such as optogenetics and two-photon microscopy are therefore applied as well as computational models, mathematical analyses and the development of new data analysis methods derived from machine learning. Researchers working in theme 4 also investigate and formulate theoretical principles of reasoning and acting in noisy and uncertain environments, using machine learning and optimal control techniques.

**Research facilities**

*The Clinical Neuroscience Unit (CNU)* provides a more interactive and efficient use of the available expertise and instruments for clinical investigators. It facilitates research that involves the assessment of brain function and structure as well as interventions designed to influence brain function in order to improve the diagnosis and treatment of neurological and neuropsychiatric disorders.

*The Translational Neuroscience Unit (TNU)* is a preclinical technology platform that is devoted to in-vivo and in-vitro neurosciences, focusing on a system-level approach to understand brain-based diseases. TNU offers state-of-the-art equipment to behavioural researchers as well as invasive measurements and manipulations. These include optogenetics, microdialysis, multi-unit-recordings, and highly sensitive biosensors. By acting as the link between molecular research, neuroimaging and clinical research, TNU bridges the empirical gap between fundamental and clinical research.

*The Neurophysics Unit (NPU)* performs model-inspired experimental, neurotechnological and neurocomputational research, comprising Biophysics, Neuroinformatics, Neurophysiology, Machine learning (including spin-off Adaptive Intelligence (SNN)) and the Donders Hearing & Implant Lab of Otolaryngology. The group has technical support staff, modern human psychophysics experimental setups, and a top-end monkey electrophysiological research facility.

**Collaboration**

The DCN collaborates both nationally and internationally with partners who have complementary expertise and with whom there is the potential for synergy. In the years ahead, the DCN will extend some of its European contacts in order to tackle some of the ‘grand challenges’ outlined in the new European research agenda Horizon 2020. Current collaborations involve internationally funded projects.

The EU-AIMS project involves individuals and families affected by autism (including the science and advocacy organization Autism Speaks), academia and industry, who together develop the basis for new treatments for autism.
Moving Beyond focuses on the role of supraspinal motor control mechanisms in ageing and Parkinson’s disease. It spans the entire spectrum from basic understanding of these mechanisms, through diagnostics to therapeutic applications. Partners: the Karolinska Institute, the Universities of Tübingen, Nijmegen, Tel Aviv and London (UCL), and six commercial partners.

NETT is a Marie Curie Initial Training Network that focuses on the design and development of brain-computer interface systems, cognitive computers and neural prosthetics. Partners: the Universities of Nottingham, Minho, Nijmegen, London Imperial College, Politecnica de Catalunya, BitBrain Technologies and the national research council in Italy.

The NEUROSCHEMA project, which is financed by an Advanced Investigator Grant from the European Research Council, makes an interdisciplinary experimental analysis of the neurobiological mechanisms of knowledge acquisition. It integrates animal work (University of Edinburgh) with human work at the DCN.

OPTIMISTIC is a randomized controlled trial that should lead to evidence-based clinical guidelines for exercise and cognitive therapy in myotonic dystrophy and identify biomarkers that reflect the disease state. Partners: the Universities of Nijmegen, Munich, Paris, Newcastle, Dundee, and Glasgow.

The aim of TACTICS is to identify the neural, genetic and molecular factors involved in the pathogenesis of compulsivity. It combines 11 partners from 7 different countries and two industrial partners.

The V-TIME project proposes a rehabilitation-oriented training programme that targets fall risk and teaches patients strategies to prevent falling and maintain a healthy lifestyle. Partners: the Universities of Leuven, Sassari, Tel Aviv, Genoa, Newcastle and Nijmegen and three industrial partners.

Research results

The highlights in 2012 are grouped within the four Donders themes.

Theme 1 – Language and Communication
Prof. Fisher’s results showed that mice carrying mutations of the Foxp2 gene, which is involved in speech articulation in humans, have aberrant striatal activity and altered neural plasticity during the acquisition of motor skills and are impaired when learning auditory-motor associations. associations.

Theme 2 – Perception, Action and Control
Perception: The group led by Prof. Van Opstal constructed a network model of the monkey midbrain that explains how the spatial-temporal activity patterns of neural populations generate saccadic eye movements with optimal kinematics.

Action: The movement disorder research group led by Prof. Bloem had a productive year, with four dissertations and several high-impact papers (Lancet Neurology, Brain).

Control: The group led by Prof. Verkoe found further indications that the risk of developing alcohol dependence is associated with a genetically driven low sensitivity of dopamine receptors in the brain in combination with an interaction between a genetic vulnerability and stressful events early in life.

Theme 3 – Plasticity and Memory
Memory: The Radboud Alzheimer Centre developed new imaging strategies to study mechanistic pathways in Alzheimer’s disease. The Kessels group studied mechanisms of cognitive compensation in the elderly and patients with dementia such as behavioural compensation in dementia (‘errorless learning’).

Development: Profs. Franke, Fisher and others initiated Cognomics, a research programme on the link between genes, brain and cognition/behaviour. Cognomics encompasses the large, DNA-neuroimaging-cognition databases that have been set up. The Kolk group focused on molecular determinants in developing brain areas, specifically the prefrontal cortex, using functional assays (in utero electrophoresis/patch clamp assays).

Adaptation: Dr Homberg and her group found that genetic predisposition to stress sensitivity increases vigilance and thereby the ability to detect stress escape possibilities. This observation has heuristic value for patients suffering from stress-related mental disorders. Results of the Roozendaal group indicate that glucocorticoids rapidly change the release of endocannabinoids, which in turn influences memory formation and retrieval.

Theme 4 - Brain networks and Neuronal Communication
A key research focus is the importance of a single spike or a single neuron in a noisy brain. Dr Tiesinga and his colleagues showed that – because of a mathematical phenomenon called bifurcations – there is an optimal noise level, which allows patterns of precise spike times to have maximum influence. Dr Memmesheimer and Prof. Timme showed that non-additive interactions in a neuron’s dendrite make the neuron especially sensitive to this type of spike pattern. Researchers in the Celikel group develop novel neurotechnologies. Research highlights include structural vasculature mapping using spontaneous oscillations and synaptic mechanisms of experience-dependent expression of behavioural despair. The Kappen group organized an interdisciplinary meeting with scientific leaders in mathematics, physics, control and neuroscience to explore the connections between statistical physics and stochastic optimal control theory.

Societal impact

Brain research is currently generating substantial societal interest, underscoring the importance of neuroscience-related research. Activities that are designed to increase the societal impact of DCN research target a wide variety of stakeholders, such as clinics (new
therapies), patients and patient organizations (newsletters and magazines), high-school students (Master classes), the general public (open days), the media (TV programmes, newspapers and news sites), companies (new technologies), third parties (NFU, high court, GGZ) and peers (invited lecturers).

A number of these activities are listed below:

• Prof. Bloem co-founded ‘Spark Magazine’ for Parkinson patients. Its goal is to change negative perceptions about Parkinson’s disease and provide patients, family members or others with reliable information.

• DCN organized a Master class for 5th grade high school students on the physical and mathematical aspects of neuroscience research.

• DCN research appeared on TV Gelderland Live (topic: the treatment of sexual delinquents, following the conviction of Robert M.), in Pavlov (perception in blind people with Vincent Bijlo and dyslexia with Egbert Jan Weeber); in RTL ‘Slapend slim worden’ (Getting smarter while you sleep); and on BBC 1 about the ‘neural basis of conformity’.

• DCN in the news: “De ziekte van Alzheimer bestaat niet” (Alzheimer’s doesn’t exist), (Prof. Olderikkert, NRC newspaper), “Des te meer hersenen des te slimmer” (The more brains, the smarter).

Other notable developments:

• Prof. Martens founded Drug Target ID BV – a spin-off from the Department of Molecular Animal Physiology. Prof. Scheffer developed a diagnostic exome sequencing technique for e.g. movement disorders and intellectual disability.

• Dr Verkes appeared as an expert witness in Court during cases involving neuropsychopharmacology.

• Bonaparte (a software tool developed by the Kappen group and the Netherlands Forensic Institute) was used successfully in the notorious Vaatstra murder case to quickly and accurately determine DNA matches.

• Prof. Fisher gave a Presidential Special Lecture at the Society for Neuroscience’s annual meeting in New Orleans.

• Prof. Cools became a board member of the Rathenau Institute.

Future research

Fundamental research on the neural mechanisms underlying cognitive processes is progressing rapidly using animal models. The DCN not only aims to further strengthen research in this direction, but also to provide the facilities to bring together researchers in a range of fields, thus making an impact on clinical management in neurology and psychiatry as well as in other clinical fields where there are patients with neurologically based symptoms.

Causal neuroscience

The brain is functionally structured at multiple levels, from local microcircuits of a few hundred neurons to brain networks where the components involve billions of neurons. Causal neuroscience is a method-driven approach that uses recently developed experimental and data analytic tools to establish causal relationships between circuit and micro-circuit changes and behaviour. At the core of this approach is the use of optogenetics to disrupt the action of circuits by activating or inactivating specific cell types. DCN researchers combine this form of circuit interrogation with closed loop stimulation using robotic behavioural experiments. They also incorporate machine learning, databasing and model building approaches in order to draw quantitative conclusions.

Applied neuroscience

With the aim of diagnosing and optimizing hearing devices on an individual basis, novel psychophysical techniques will be combined with NIRS-EEG imaging, advanced data acquisition and analysis algorithms in order to help hearing-impaired patients. Further diversification is envisaged by including animal studies, vestibular impairments and new implant technologies. In addition, novel learning paradigms will be developed as treatment strategies for...
Key publications


Dissertations: 39
Academic publications: 751
Professional publications: 1
sensory impairments with a central-nervous-system origin and behavioural psychophysics (eye-hand and eye-head motor control, vestibular control, complex search paradigms) will be used to discover and characterize urgently needed early markers for neurocognitive and neurodegenerative disorders.

Clinical neuroscience
Our long-term goal is to arrive at a mechanistic understanding of the pathophysiological processes underlying neurological symptoms and mental disorders. At an individual level, this will enable personalized care involving causative treatment and prediction of vulnerability and outcome.

Another goal is to improve the personalized treatment of patients with disorders of emotion and impulse-regulation. Neurocognitive and pharmacological research will enhance our understanding of the effect of psychotropic drugs and brain stimulation on social behaviour and in particular the impact on emotional attribution bias, and involving impulse control in social situations. The research objective is to better understand the involvement of HPA-axis reactivity and the role of various neurotransmitter systems unravelled by the use of neuroimaging techniques (fMRI, PET, SPECT), animal models and genetics.

Translational neuroscience
Due to its complexity, the diseases of the brain can only be unravelled by taking a translational system-level approach. It is therefore a long-term goal to integrate in-vivo behavioural research with invasive electrophysiological, genetic, optogenetic and neurochemical measurements as well as in-vitro cellular and molecular techniques. Ultimately this will make it possible to transfer the results of molecular, electrophysiological, behavioural and imaging work in animals to human behavioural and neuroimaging research. Vice versa, it will enable the targeted use of animal models to help understand the function of genes and the detailed brain mechanisms of processes revealed in human studies.

Awards and prizes (in alphabetical order):
• Drs. Beul received the Dutch MSc Thesis Award for Cognitive Neuroscience
• Prof. Bloem was chosen as Nijmegen Citizen of the Year and ‘Zorgheld 2012’ (Healthcare Hero 2012).
• Prof. Cools received the James McDonnell Scholar Award and the Investigator Award of the Cognitive Neuroscience Society.
• Dr Cook received an Axa postdoctoral fellowship.
• Dr Dresler received an NWO Veni grant.
• Dr Helmich received the Annual prize for the best scientific article by a young researcher from the Prinses Beatrix Fund and a prize for best Dutch thesis (‘Cerebral reorganization in Parkinson’s disease’) from the Dutch Neurofederation.
• Drs. Henckens received a Niels Stensen Fellowship.
• Dr van Holst received a Rubicon Fellowship.
• Dr de Leeuw received an NWO Vidi grant.
• Dr Zhou received a ZonMw ‘Meervoud’ grant.
Institute for Genetic and Metabolic Diseases

At the Institute for Genetic and Metabolic Diseases (IGMD) scientists working in a range of disciplines engage in research on rare genetic and metabolic diseases, using a molecule-to-man-to-population-and-back-to-man approach.

Within the Institute’s nine inter-related research themes, fundamental, applied and clinical researchers work closely together to answer specific, patient-related research questions that are designed to reduce the incidence of mortality, as well as the severity and duration of morbidity resulting from genetic and metabolic diseases. The intention is to elucidate the pathophysiology of specific diseases, develop novel diagnostic methods, develop innovative forms of treatment and enhance personalized medicine.

Research themes

Functional imaging
Functional imaging and monitoring is of vital importance for diagnosis, treatment and follow-up. Researchers working within this theme develop and clinically evaluate innovative, non-invasive functional imaging and monitoring techniques such as 2D and 3D Echography, NMR spectroscopy, Near Infrared Spectroscopy and radioisotope imaging (PET and SPECT). The ultimate goal is timely detection of tissue damage in patients with cardiac, cerebral, liver, vascular and pancreatic disorders.

Molecular gastro-enterology and hepatology
The main focus of this theme is on polycystic liver disease, a rare autosomal dominant disorder, providing a unique opportunity to study human cystogenesis. Researchers in this translational programme investigate key intracellular signalling pathways in PCLD in order to find potential therapeutic targets that can be tested in clinical trials. A second research line is the prevention of complications associated with severe intestinal failure.
Genomic disorders and inherited multi-system disorder
Genetic factors are important in most human diseases and traits. This group focuses on finding such genes in order to provide better patient care. Topics include mental retardation, congenital abnormalities, psychiatric disorders, brain development and individual responses to treatment due to pharmacogenetic factors.

Glycosylation disorders
This research focuses on the complex biosynthetic and catabolic pathways of glycans in health and disease, with the emphasis on Congenital Disorders of Glycosylation (CDG). In parallel with developing novel analytic techniques, the research group applies a broad range of biochemical, genetic and cell biological methods to identify new disease entities, improve current diagnostics and better understand pathophysiological mechanisms, aspects that are all crucial for future therapeutic strategies.

Healthy ageing / healthy living
Understanding the process of healthy ageing as well as the role of exercise and activity in senescence are the main topics of this research programme, which covers human in-vivo approaches all the way down to the genetic level. The metabolic syndrome is one of the major focuses of this research programme. Risk factors that contribute to it such as dyslipidemia, hypertension and insulin sensitivity are studied both separately and combined in patients with multiple risk factors.

Hormonal regulation
Research within this theme focuses on patient care and research on adrenal diseases. This work takes place in the Radboud Adrenal Centre (RAC) – a centre of expertise for the diagnosis and treatment of adults and children with adrenal diseases. The four main areas of interest are hyper/hypocortisolism, congenital adrenal hyperplasia, pheochromocytoma and primary aldosteronism.

Iron metabolism
Research in this theme focuses on identifying and characterizing novel factors that might alleviate the dysregulation of iron homeostasis in some of the world’s most prevalent diseases, including anaemias, rheumatic diseases, haemochromatosis, bacterial and malarial infections, cardiovascular disease and hepatic iron overload, hepatitis C and the metabolic syndrome. The recently discovered iron regulatory hormone peptide hepcidin is currently the subject of several translational studies.

Mitochondrial medicine
The aim of research here is to develop new forms of treatment for diseases and adverse health conditions in which the mitochondrial energy capacity is reduced. Defects of the human oxidative phosphorylation system are among the most frequently encountered inborn errors of metabolism and studying patients with these devastating disorders has revealed important information about the role that mitochondria play in the normal process of ageing as well as in neurodegenerative diseases such as Parkinson’s.

Renal disorders
Within this theme, in which the results of fundamental and clinical research are integrated, the regulation of the physiological development of the kidney is studied in order to better understand the pathogenesis of acquired and inherited kidney disorders. The aim is to be able to diagnose and ultimately cure or prevent these disorders. Research projects are carried out at the genetic (gene defects, polymorphisms), molecular (transport proteins), and cellular (glomerular and epithelial cells) level.

Research facilities
IGMD research and patient care requires an excellent laboratory infrastructure. State-of-the-art technology platforms are at the heart of this infrastructure, offering unique research opportunities. The core components of the Institute are clinical departments (Paediatrics, Nuclear Medicine, Gastroenterology & Hepatology,
Human Genetics, Neurology, Physiology, General Internal Medicine, Endocrinology, Cell biology and Pharmaco-toxicology, which provide access to patients and clinical material and have dedicated research laboratories. In addition, there are the Laboratories of Clinical Pharmacy and of Genetic, Endocrine and Metabolic diseases.

The Radboud University Nijmegen Medical Centre (RUNMC) has several technology platforms which are available for its researchers to use (see: www.ncms.eu/technology-platform/) including the Animal Facility, the Microscopic Imaging Centre, Micro-array Facility Nijmegen, the Nijmegen Proteomics Facility, the Centre for Molecular and Biomolecular Informatics (CMBI), the Clinical Research Centres Nijmegen (children and adults), and the GMP facility. In 2012 the Laboratory for Genetic and Metabolic Disease (mitochondrial diagnostics) and the mitochondrial research group led by Prof. Smeitink moved to a newly equipped location and Prof. A. van Gool was appointed head of the Proteomics Facility. The Radboud Biobank officially started, merging pre-existing small banks and ‘String of Pearls Initiative’ collections. In future it will expand to further develop a unique, high-quality source of materials and clinical data – from both patients and non-patients – for clinical research.

Collaboration

Researchers at IGMD, who are involved in a wide range of regional, national and international networks, collaborate with groups at many universities, research institutes and companies. This collaboration is designed to create synergy, to recruit talent and to enhance the earning capacity of the IGMD through consortium grants from the EU and elsewhere. A few examples:

- Dr M. Doyley, University of Rochester, New York, USA (NWO and NIH grant)
- Prof. P. Nuutila, University of Turku, Finland (EU grant)
- Prof. J. Banales, University of Navarra, Pamplona, Spain (Zambon finance)
- Prof. V. Torres, Mayo Clinic, Rochester, USA (Novartis finance)
- Prof. X. Estivill, Centre for Genomic Regulation, Barcelona, Spain (EU grant)
- Prof. B. Kirchhof, University of Cologne, Germany
- Prof. G. Matthijs, University of Leuven, Belgium
- Prof. R Gerardy-Schahn, Hannover Medical School, Germany
- Prof. B. Levine, IEM’s Environmental Physiology Laboratory, Dallas, USA (NIH grant)
- Prof. T. Cable, John Moores University, Liverpool, UK (EU grant)
- Prof. G. Eisenhofer, University of Dresden, Germany (EU grant)
- Prof. M. Schmitt, Technical University of Munich, Germany (EU grant)
- Prof. G. Weiss, Medical University of Innsbruck, Austria (EU grant)
- Prof. D. Turnbull, University of Newcastle upon Tyne, UK (EU grant)
- Prof. M. Zeviani, MRC Cambridge, UK (EU grant)
- Prof. O. Devuyst, University of Zurich, Switzerland (EU grant)
- Dr D. Miller, National Institute of Environmental Health Sciences, Durham, USA.

Awards

The Royal Academy of Medicine of Belgium granted Prof. J. Drenth the prestigious Dr Karel-Lodewijk Verleysen award and Prof. D. Swinkels received the annual research prize of the Dutch Society of Clinical Chemistry and Laboratory Medicine.

Dr A. den Hollander received the prestigious Carl Camras Translational Research Award from the ARVO Foundation for Eye Research, USA, for the major impact of her work on our knowledge of the genetics of hereditary retinal disorders. In addition, she was awarded the highly prestigious ERC Starting Grant, which is worth €1.5 million, to study the causes of age-related macular degeneration.

Prof. F. Russel was appointed by Royal Decree as a member of the Health Council of the Netherlands and its Standing Committee on Health and the Environment.

Prof. U. Brandt was attracted from Frankfurt and appointed professor of Mitochondrial Molecular Medicine at the Department of Paediatrics. Dr B. Franke was appointed professor of Molecular Psychiatry and Dr M. Willemse professor of Paediatric Neurology.

Several young IGMG researchers received Young Investigator awards and poster prizes from various learned societies, including the Dutch Societies of Ophthalmology and Toxicology, the Dutch Association of Study of the Liver, the Dutch Society for Inborn Errors of Metabolism and the Netherlands Bioinformatics Centre.

Research results

Many new research results were published in high ranking scientific journals. A selection is presented below.

An important finding was the identification of mutations in the phospholipid remodelling gene SERAC1 that impair mitochondrial function and intracellular cholesterol trafficking and thus cause dystonia and deafness. Dr A de Brouwer and S. Wortmann were the main contributors.

Whole exome-sequencing technology, which was successfully applied by Prof. H. Brunner, Prof. H van Bokhoven, Dr J. Veltman, and others in the Genomics group, resulted in the identification of several mutations associated with rare diseases; Dr B. de Vries showed that haploinsufficiency of KANSL1 is sufficient to cause the 17q21.31 microdeletion syndrome, a multisystem disorder characterized by intellectual disability, hypotonia and distinctive facial features; Dr A Hoischen identified mutations in ABCC9 as the genetic basis of Cantú syndrome, which indicates that this
Societal impact

On an individual basis genetic and metabolic diseases are considered to be rare diseases although as a group they represent a substantial health burden. Research within IGMD is designed to reduce the incidence of mortality, as well as the severity and duration of morbidity resulting from these diseases, and to raise political and public awareness of the need to develop adequate treatment, which is, in most cases, not yet available. This is why members of the IGMD participate in a number of governmental advisory boards, including the Dutch Health Council, and in numerous national and international patient organizations. They frequently promote research at meetings involving the general public as well as at conferences and other forums. The Institute actively encourages collaboration between pharmaceutical companies and academia.

Several clinic studies were performed, the outcomes of which have direct implications for clinical practice. Prof. A. Hermus and colleagues identified the optimal surgical strategy for MEN1-related primary hyperparathyroidism and described a genotype-dependent probability of recurrence. Prof. J. Drenth provided an update on the diagnosis and management of polycystic liver disease. Diagnostic exome sequencing has been implemented in daily clinical practice for several genetic disorders, such as inherited blindness, deafness, mitochondrial disorders and intellectual disability.

Khondrion, a spin-off company founded by Prof. Smeitink, received a large PM-Rare grant from ZonMw. This grant is used by the consortium of Khondrion, RUNMC, the company Mercachem, other subcontractors and three mitochondrial patient organizations to develop a treatment for MELAS syndrome, a rare mitochondrial disease. Research is carried out in the state-of-art laboratory of Khondrion, which was officially opened by the Dean Prof. Paul Smits in November 2012.

A taskforce was set up to combine knowledge and expertise in clinical research, diagnosis and treatment of rare diseases. In line
Key publications


In the context of periodical evaluation of research performance and science policy, IGMD was assessed by a site-visit committee of internationally renowned scientists in January 2012. The committee noted the high to excellent quality of IGMD research groups, the overall high relevance, the satisfaction of PhD students and the added value of IGMD for the visibility of clinical/translational research and collaborations. Recommended improvements in research and education policy are being implemented.

Researchers working on IGMD themes will continue to elucidate the pathophysiology of specific rare diseases in an attempt to develop novel diagnostic methods and innovative forms of treatment. Examples of new projects include: research on the development of genetic therapy for inherited blindness (Dr R. Collin, Foundation Fighting Blindness grant); a study of the role of hepcidin as a novel treatment for kidney injury (Dr R. Masereeuw, Prof. D. Swinkels and Prof. J. Wetzels, Dutch Kidney Foundation Innovation grant); a study testing anticalins that fight anaemia by influencing iron metabolism (Prof. D. Swinkels and several companies, EU grant); the role of the renal Mg2+ channel TRPM6 in the development of Diabetes Mellitus Type 2 (Profs. J. Hoenderop and C. Tack, IGMD grant); the role of physical fitness and exercise training in changing the endocrine function of fat tissue in humans (Profs. M Hopman and A. Hermus, IGMD grant); a study of the modification of glucocorticoid receptor transactivation by steroid hormone precursors to gain more insight into the mechanisms underlying Congenital Adrenal Hyperplasia (Drs. K. Kleizen, Sengers Stipendium); and Dissecting the mechanism of mitochondrial-stress-induced deafness (Drs. J. Nouws, EMBO fellowship).
The main aim of the Research Institute for Oncology (RIO) is to promote innovation in translational research in oncology and to reduce the morbidity and mortality rates of cancers. Researchers in several disciplines work together to unravel the pathology of tumours, develop new diagnostics and therapeutic strategies, and improve standards of care.

The Institute was founded in 2008 to coordinate and strengthen research in oncology and oncology-related topics. Built on a long-standing tradition and the strong reputation of existing research groups, the Institute operates in close collaboration with the Radboud University Centre for Oncology (RUCO; the clinical centre).

The guiding principles of the Institute are:

- Research should be both patient-centred and relevant to patient care
- Research should be arranged in themes that are multi-disciplinary and offer added value beyond existing structures
- Close collaboration with other University research institutes such as NCMLS and NCEBP is considered essential.

In 2012 new research themes were defined to enhance cooperation among researchers (beyond existing clinical collaborations). These themes are:

**Theme 1. Imaging and Biomarkers**
The focus of this theme is the diagnostic/prognostic efficacy and effectiveness of biomarkers, imaging techniques, cancer screening (general population) and routine follow-up policies (clinical population). Because the validation of diagnostic and prognostic tests extends from development to clinical and public health evaluation, the theme includes early stage (development) research as well as clinical and public health efficacy.

**Theme 2. Genetics and Heredity**
Assessing genetic factors is becoming increasingly important for personalized treatment of cancer. Factors in the germline that
predispose people to cancer as well as tumour-specific genetic and epigenetic changes are studied to understand the aetiology and clinical behaviour of tumours with the aim of optimizing diagnoses and surveillance as well as selecting and monitoring the most effective treatments.

**Theme 3. Local Therapies**
These include the diagnostic and therapeutic challenges associated with a variety of treatment options, including surgery, minimal invasive interventions, radiotherapy and combinations of these options. There is close collaboration with groups working on optimizing local therapy by using advanced imaging techniques and biomarkers. There is also close interaction with researchers working within the theme Targeted Therapies, since there is overwhelming evidence that the results of local therapy may be substantially enhanced by targeted drugs and chemotherapeutic agents. Together this makes it possible to develop predictive profiles based on tumour characteristics which may ultimately provide a mechanistic basis for optimizing multimodal treatment.

**Theme 4. Targeted Therapies**
The aim of targeted therapy is to improve the selection of optimal systemic therapies while minimizing side effects for individual patients. This is achieved through a multidisciplinary approach to the diagnostic and therapeutic phase of treatment, and by translating basic research into treatments in the clinic and vice versa. In the groups working on this theme, research may focus on specific tumour types, but it also addresses targets and molecular pathways which are present in a variety of tumours. The idea is to create synergy from existing knowledge and expertise across different tumour types and new targets for therapy. In addition, cellular therapies using immunological cells (including T cells, NK cells and DC cells) are being developed and tested in clinical trials.

**Theme 5. Innovation in Care and Epidemiology**
This theme includes research on measuring and improving the quality of life and care for cancer patients and their families during all phases of cancer, including the evaluation of effectiveness, the economic implications of health care interventions, shared decision making and epidemiological research into lifestyle and molecular/genetic factors for cancer aetiology, diagnosis and prognosis. By definition, this highly multi-disciplinary theme overlaps with the other research themes within the Institute.

In 2012, the second Science Day at the Institute was entitled *Towards A Personalized Oncology*. This event, which provided an opportunity to meet with colleagues and PhD students and discuss new ideas, was received again with great enthusiasm.

**Research facilities**
The Institute supports platforms that are crucial to its research, while serving the needs of other research institutes, including the

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**Staff**

Prof. T. van Achterberg (o)  
Prof. G.J. Adema (o)  
Prof. J.O. Barentsz (o)  
Prof. S.J. Berge (o)  
Prof. O.C. Boerman (o)  
Prof. J. Damen (o)  
Prof. P.N.R. Dekhuijzen (o)  
Prof. C.G. Figdor (o)  
Prof. P.H.A. Friedl (o)  
Prof. A.H.M. Geurts van Kessel (o)  
Prof. B. van Ginneken (o)  
Prof. B.M. Goraj (o)  
Prof. W.T.A. van der Graaf (o)  
Prof. J.A. Grotenhuis (o)  
Prof. A. Heerschap (o)  
Prof. P.M. Hoogerbrugge (o)  
Prof. N. Hoogerbrugge-van der Linden (o)  
Prof. J.H.A.M. Kaanders (o)  
Prof. N. Karssmeijer (o)  
Prof. L.A.L.M. KiemeneY (o)  
Prof. A-J. van der Kogel (o)  
Prof. J.H.J.M. van Krieken (o)  
Prof. C.J.H.M. van Laarhoven (o)  
Prof. J.W.H. Leer (o)  
Prof. H.A.M. Marres (o)  
Prof. L.F.A.G. Massuger (o)  
Prof. M.A.W. Merix (o)  
Prof. P.F.A. Mulders (o)  
Prof. W.J.G. Oyen (o)  
Prof. J.B. Prins (o)  
Prof. W.M. Prokop (o)  
Prof. C.J.A. Punt (o)  
Prof. M. Ritskes-Hoitinga (o)  
Prof. J.A. Schalken (p)  
Prof. L.J. Schultze Kool (o)  
Prof. P.J. Slootweg (o)  
Prof. C.G.J. Sweep (o)  
Prof. A.L.M. Verbeek (o)  
Prof. M.J.F.J. Vernooy-Dassen (o)  
Prof. L.J.M. de Vries (o)  
Prof. P. Wesseling (o)  
Prof. G.J. van der Wilt (o)  
Prof. J.A. Witjes (o)  
Prof. T.J.M. de Witte (o)  
Prof. G.A. Zielhuis (o)  

FTE 1st  FTE 2nd  FTE 3rd  
17.8  
4.6  
27.5  
22.6  
82.9  
79.1  
89  

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Collaboration
Given the increasing importance of collaborations for translational, clinical and population research in oncology, researchers at the RIO collaborate with colleagues at many other centres and institutes in the Netherlands, Europe, USA and in developing countries. RIO promotes participation by RUNMC oncological researchers in national and international consortia in order to fully exploit the strengths of oncological research within RIO and to secure funding from national and EU programmes as well as from private sources. Some examples of partners are listed below (for an extended list, go to www.radboudoncology.eu).

• The Head and Neck Oncology group has a long-term collaboration with many other centres and institutes.
• The department of Medical Oncology actively participates in national and international consortia in order to fully exploit the strengths of oncological research within RIO and to secure funding from national and EU programmes as well as from private sources.
• A long-standing collaboration with the Wisconsin Institutes for Medical Research, Medical Physics and Human Oncology, Madison, WI, USA.
• The department of Medical Oncology actively participates in the World Sarcoma Network, a cooperative group that brings together the main reference centres for sarcomas around the world (it is dedicated to developing and supporting innovative and collaborative clinical trials as well as drug development in sarcomas and participates in a number of global RARE CANCER Initiatives).
• The Head and Neck Oncology group has a long-term collaboration with Aarhus University Hospital in Denmark, the Institute of Cancer Sciences at the University of Manchester, UK as well as with the Muhimbili University Health and Allied Services in Dar es Salaam, Tanzania, and in Singapore there is collaboration within the field of mandibular constructions with the National Dental Centre Singapore of Sing Health University.

Awards and acknowledgements
In 2012, the achievements of a number of scientists within the Institute were recognised by both national and international organizations. The Institute was highly successful in acquiring competitive research funds from the Dutch Cancer Society (KWF), the NWO and the EU.

• Prof. Nico Karssemeijer received an EU grant for the project Adapting Breast Cancer Screening Strategy Using Personalised Risk Estimation (ASSURE).
• Prof. Nico Karssemeijer, Dr Ritse Mann and Dr Jeroen van der Laak received an EU grant for their project Virtual Physiological Human: Personalized Predictive Breast Cancer Therapy through Integrated Tissue Micro-Structure Modeling.
• In collaboration with UMCG and VUmc, Prof. Winette van der Graaf, Prof. Otto Boerman and Prof. Wim Oyen received a grant from Alpe d’HuZes. for their project IMPACT (Imaging for Cancer Patients drug selection).
• Prof. Jolanda de Vries received a ZonMw grant for work in close collaboration with the departments of Medical Oncology, Surgery and Pharmacy.
• Dr Harry Dolstra, and Dr Michel Schaap received a ZonMw grant for Vaccination with minor histocompatibility antigen-loaded donor DC vaccines to boost graft-versus-tumor immunity after allogeneic stem cell transplantation.
• Dr Marieke Gielissen, Prof. Judith Prins, and Prof. Anne Speckens received a KWF grant for The sword of Damocles. Managing fear of cancer recurrence with the SWORD intervention study (Survivors’ Worries of Recurrent Disease).
• Prof. Nico Karssemeijer, and Dr Mireille Broeders received a KWF grant for Towards an independent automated reader of screening mammograms.
• Dr Hans Knoop, and Dr Stans Verhagen received a KWF grant for a multi-centre trial entitled Fatigue in palliative care: are graded exercise and cognitive behaviour therapy effective treatments and what mediates the treatment response?
• Prof. Judith Prins together with Prof. Nicoline Hoogerbrugge, Prof. Winette van der Graaf, and Dr Nelleke Ottevanger have been awarded grants by the Pink Ribbon Foundation for the projects Increased risk of hereditary breast cancer, do I have that?, From online to onlife: the power of online community AYA4 for young women with breast cancer and their caregivers, and Digital care for partners, respectively.
• Dr Marieke Gielissen and Prof. Judith Prins received a Pink Ribbon grant for the project The sword of Damocles. Understanding and managing fear of cancer recurrence.
• Within Alpe d’HuZes’ Food and Cancer Programme, Prof. Ellen Kampman received a grant for the project Predicting and preventing changes in body composition during breast cancer treatment.
• Dr Esme Waanders, Dr Marleen Ansems and Dr Manuel Koppe received KWF fellowships for their projects Cancer at young age: Coincidence or Consequence? and The impact of TAM receptor signaling in anti-tumor immunity, and Peritoneal carcinomatosis of colorectal origin; hyperthermic intraperitoneal chemotherapy, respectively.
• Dr Theo Plantinga has received a Veni grant for the project New treatment for thyroid cancer.
• KiKa (Children Cancer-free) awarded a grant to Drs. Jeroen Middelbeek, Dr Frank van Leeuwen, and Prof. Peter Hoogerbrugge to study mechanisms of neuroblastoma metastasis formation.
• Dr William Leenders, and Dr Bastiaan Tops received grants from the STOP Brain Tumours fund for projects entitled Improving delivery of therapeutic compounds to invasive glioma and Rapid and targeted genetic profiling of gliomas for identification of alternative therapeutic options, respectively.
• A number of PhD students received various national and international prizes for their thesis.
Research results

A publication in *The Lancet* reported the results of the EORTC PALLETTE study – led by Prof. Winnette van der Graaf, which demonstrated that pazopanib prolongs progression-free survival in soft tissue sarcoma patients by three months.

The results of a large multicentre study on advances in the treatment of laryngeal cancer led by Prof. Hans Kaanders was published in the *Journal of Clinical Oncology*.

The group led by Dr Nelleke Ottevanger published an observational study on prenatal exposure to chemotherapy in *Lancet Oncology*.

The group ‘Multicenter validation of a gene expression profile for neck node metastasis’, led by Dr Rober Takes, Prof. Piet Slootweg, and Dr Frank Holstege, was published in *The Journal of Clinical Oncology*.

Scientists at the Institute have characterised mutations and deletions in a substantial number of genes for their potential to improve diagnostics or provide predictive value in treating cancer.

The group led by Dr Harold Tjalsma published a paper in *Molecular and Cellular Proteomics* suggesting that tumour cell metabolites facilitate the survival of *S. gallolyticus*, favouring its local outgrowth and providing a possible explanation for the specific association of *S. gallolyticus* with colonic malignancy. In a review in *Nat.Rev. Microbiol* they proposed a bacterial driver-passenger model for microbial involvement in the development of colorectal cancer and suggest that this model should be incorporated into the genetic paradigm of cancer progression.

In the *Journal of Immunology and Blood*, the research team led by Dr Harry Dolstra published a research article and a review of the influence of co-inhibitory molecules in suppressing T cell-mediated immunity against haematological malignancies.

Societal impact

As a major health problem cancer places enormous physical and mental burdens on patients and their families. Improving the prevention, diagnosis, and therapy of cancer, as well as psycho-social assistance is therefore essential. Researchers at the Institute serve as active members of various boards and committees, both nationally (e.g. the Dutch Cancer Society, ZonMw, Dutch Medical Oncology Society, Netherlands Foundation for the Detection of Hereditary Tumours, Biobanking and Biomolecular Resources Research Infrastructure, Dutch Haematology Society, Dutch Federation of University Medical Centre’s Committee for Child Oncology, Dutch Society for Surgical Oncology, Dutch Workgroup for Head and Neck Tumours) and internationally (e.g. a large number of European scientific societies, International Agency for Research on Cancer, World Institute of Pain, EORTC, ECCO and the editorial boards of several cancer journals).

Some recent appointments of RIO members in major national and international oncological societies and communities are listed below:

- The United European Gastroenterology Federation (UEG) identified Dr Iris Nagtegaal as one of the eight European Rising Stars in 2012. She is the only Dutch rising star and her background as a pathologist make this award particularly special. Her scientific work has made significant contributions to improving the quality of pathological diagnosis of cancer, particularly regarding factors that play a role in TNM classification.
- Prof. Wim Oyen was appointed to the Boards of the European Cancer Organizations (ECCO) and the European Association of Nuclear Medicine (EANM).
- Prof. Jelle Barentsz received a Lifetime Achievement Award from The Society of Uroradiology for his outstanding achievements and innovations in the field of MRI research in bladder, ovarian, cervical and prostate cancer over a period of 20 years. He is the youngest person and the second non-American to receive this award.

Winnette van der Graaf (Professor of Translational Medical Oncology) focuses on the translation of results from research into new therapies for patients and vice versa. She investigates the effectiveness of new drugs and their potential adverse effects on patients suffering from cancer.
Key publications


• Prof. Judith Prins was appointed as a member of another KWF Scientific Committee: for Alpe d’HuZes, Dr Iris Nagtegaal and Prof. Jolanda de Vries became members of the KWF Scientific Committee for Applied and Translational Research, and Prof. Winette van der Graaf became a member of the KWF signalling committee.
• Prof. Hans Kaanders became a member of the Committee of ESTRO.
• Prof. Winette van der Graaf became the chair of the EORTC Soft TISSUE and BONE SARCOMA Group for the period 2012-2014.

Future research
This will concentrate on:
• cancer-related target genes and pathways
• anti-cancer nano-vaccines in patients’ immune system
• the associations between genetic variants and cancer susceptibility, prognosis, and response to therapy
• diagnosis through molecular analyses, including the potential for personalized therapies
• the efficacy of functional imaging with respect to diagnosis, prognosis, and therapy, using the Preclinical Imaging Centrum PRIME
• the mechanisms underlying invasion and metastasis
• novel molecular markers for imaging
• the efficacy of novel metabolic and epigenetic drugs for therapy and novel vaccine-based therapeutic strategies

• genetics, epidemiology and pharmacokinetics
• predictive factors and late effects of treatment
• psychosocial and quality-of-life issues.

Special attention will be paid to personalized oncology:
• The study that is known by the acronym IMPACT (Imaging for Cancer Patients drug selection), led by Prof. Winette van der Graaf, Prof. Otto Boerman and Prof. Wim Oyen, will investigate the value of molecular imaging in the personalized treatment of cancer. This tailored treatment not only provides health benefits for the patient, but also benefits society.
• The two EU grants received by Prof. Nico Karssemeijer will allow his group to investigate the personalized strategies for risk estimations and predictive breast cancer treatment.
• Improving surgical treatment by developing innovative techniques designed to obtain adequate resection margins (this has major implications for prognosis and further treatment).
The Nijmegen Institute for Infection, Inflammation and Immunity (N4i) brings together research groups that focus on infectious diseases, inflammation and immunity – areas that are closely connected. N4i’s ambition is to achieve national and international leadership in research in these areas. This research, which is inspired by observations at the bedside, is designed to improve the diagnosis, treatment and prognosis of patients with infections, as well as inflammatory and immunological disorders.

The research focuses on four themes that link Infection, Inflammation and Immunity.

**Theme 1. Pathogenesis and modulation of inflammation**

Although infectious agents are the prime causes of inflammation, any tissue damage will induce an inflammatory response. Issues that are addressed in this theme include host recognition of pathogens, inflammasome activation and cytokine responses during infection and auto-inflammation, the pathogenesis of infection by bacteria (e.g. pneumococci, staphylococci, meningococci, *Coxiella*) and viruses (picornaviruses, dengue virus), molecular imaging tools for visualizing infection and inflammation, mechanisms of tissue damage in common inflammatory diseases (COPD, psoriasis and eczema), therapeutic interference with pattern recognition and signalling, strategies for preserving mucosal integrity in cancer chemotherapy and developing tools for monitoring inflammation and response to treatment.

**Theme 2. Invasive mycoses and compromised host**

Within this theme, invasive fungal infections are studied in relation to sophisticated medical treatments for immune-compromised and frail patients. Research focuses on understanding host defence mechanisms, in particular the recognition of fungal pathogens by the host, the immunogenetics of fungal infections, the immunotherapy of fungal infections, exploring the epidemiology and management of invasive fungal infections, designing better diagnostics and therapies for invasive aspergillosis, candidemia and other invasive fungal infections, and exploring the epidemiology, mechanism and consequences of resistance to antifungal drugs.
**Theme 3. Poverty-related infectious diseases**

In developing countries infectious diseases are still a major cause of mortality. Poverty is a crucial factor in vulnerability to infections such as tuberculosis, HIV and malaria. Within this theme the following issues are addressed: clinical development of vaccines and drugs for treating malaria, the pathogenesis and host defence against malaria, innate host defence against Mycobacterium tuberculosis and the role of mycobacterial genotypes, optimal diagnosis and treatment of tuberculosis (TB) – with a focus on complicated TB, evidence-based prevention and treatment of HIV/AIDS in the context of intravenous drug use in resource-poor countries, as well as optimal anti-HIV and anti-TB treatment in resource-poor settings, particularly in children.

**Theme 4. Auto-immunity, transplantation and immunotherapy**

Research on the inflammatory response is designed to obtain new insights into the pathogenesis of infectious diseases and non-infectious inflammatory disorders. Within this theme investigations focus on the phenotypes of autoimmune diseases of the skin, prediction of the course of chronic inflammatory rheumatic diseases, the mechanisms of tissue damage and optimal treatment strategies in systemic lupus erythematosus, developing biomarkers for monitoring immune status and the efficacy of immunosuppressive treatment, immunological tolerance and immunosuppressive treatment after transplantation and transfusion, exploring the use of dendritic cells, regulatory T cells and NK cells for autoimmune diseases and transplant-related immunotherapy, designing new immunostimulatory drug treatments, developing vaccines for pneumococci and *Plasmodium falciparum*, and assessing the severity of psoriatic phenotypes and response to treatment.

**Research facilities**

The core components of the Institute are clinical departments (General Internal Medicine, Paediatrics, Nephrology, Dermatology, Rheumatology, Haematology, Pulmonary diseases, Intensive Care Medicine and Nuclear Medicine), which provide access to patients and clinical material, and dedicated research laboratories (those directly connected to the clinical departments as well as the laboratories of Medical Microbiology, Clinical Pharmacy, Medical Immunology and Tumour Immunology). Furthermore, RUNMC has several technology platforms which are available for researchers: the Central Animal Facility, the Microscopic Imaging Centre (MIC), the Preclinical Imaging Centre (PRIME), the facilities for Genomics, Proteomics and Glycomics, the Centre for Molecular and Biomolecular Informatics, the Clinical Research Centre Nijmegen, a GMP facility for cellular therapy trials, and a Malaria parasites and mosquitoes breeding facility (for details see: www.ncmls.eu/technology-platform).

**Collaboration**

The research at N4i takes place within national and international research networks that focus on infection, inflammation and immunity. Collaboration is designed to ensure synergy, recruitment of talent and financial stability through (EU) consortium grants. There are partnerships with outstanding laboratories such as Harvard University and the University of Colorado (USA), the Universities of Manchester and Aberdeen (UK), the University of Barcelona (Spain), the University of Tromsø (Norway), the University of Erlangen (Germany), Hadassah University, Jerusalem (Israel) and Iuliu Hatieganu University, Cluj-Napoca (Romania). Researchers at N4i also engage in fruitful long-standing partnerships with institutes in developing countries, in particular in Tanzania (KCMC, Moshi) and Indonesia (Eijkman Institute and the University of Indonesia). Researchers at N4i also engage in fruitful long-standing partnerships with institutes in developing countries, in particular in Tanzania (KCMC, Moshi) and Indonesia (Eijkman Institute and the University of Indonesia and Bandung).

Two N4i research groups collaborate in new 1 EU-FP7 consortia projects. The first is the TANDEM project, which was set to study the intertwined epidemics of tuberculosis (TB) and diabetes mellitus (DM) as well as the mechanisms underlying the effect of DM on TB susceptibility and treatment outcomes. In this project Dr Reinout van Crevel (overall scientific coordinator), Prof. Mihai Netea and Dr Rob Aarnoutse work together with partners from...
Nijmegen Institute for Infection, Inflammation and Immunity

the London School of Hygiene & Tropical Medicine (UK), the Max Planck Gesellschaft zur Förderung der Wissenschaften in Berlin (Germany), Stellenbosch University (South Africa), St George’s University of London (UK), the University of Otago (New Zealand), the University of Craiova (Romania), Universidad Peruana Cayetano Heredia (Peru), and Padjadjaran University (Indonesia).

The second project is COBRA, which focuses on co morbidities, such as cardiovascular and metabolic disease, as well as COPD and neurocognitive co morbidity in HIV/AIDS patients. Prof. David Burger collaborates with Dutch and international partners, including the University of Gothenburg (Sweden), University College London (UK), the University of Bologna (Italy), the Free University of Brussels (Belgium) and the University of Konstanz, (Germany).

Prof. Dorine Swinkels – together with nine international partners – was awarded an EU grant to test new substances (anticalins) that fight anaemia by influencing iron metabolism. The consortium consists of Pieris AG (Germany), Technische Universität München (Germany), the Medical University of Innsbruck (Austria), Covance Laboratories Ltd. (UK), Antitope Ltd. (UK), Fujifilm Diosynth Biotechnologies UK Ltd. (UK), Coriolis Pharma Research GmbH (Germany), FGR Clinical Research GmbH (Germany), and ConsulTech GmbH (Germany).

Prof. Mihai Netea started intensive collaboration with the laboratory of Prof. Ramnik Xavier at the Broad Institute of Harvard University and MIT, Boston (USA) to study the relation-ship between the gut microbiome and functional genome of the host.

Dr Teun Bousema received the prestigious EU Merial Award for young researchers in the field of parasitology for his work on the epidemiology of the malaria parasite Plasmodium falciparum. He and Prof. Andrea Evers have been elected as Young Academy members of the Royal Netherlands Academy of Arts and Sciences (KNAW).

Dr Johan Mouton was appointed professor of Pharmacodynamics and kinetics of antimicrobial agents on 1 February 2012.

Internist Dr Anna Simon was awarded the Radboud Prize for outstanding female researchers by the Network of Female Professors at the University.

Four young N4i researchers received a prestigious Veni grant from the Netherlands Organization for Scientific Research: Hans Jacobs (Regulatory T cells in cancer; from foes to friends), Theo Plantinga (The elucidation of the interplay between autophagy and inflammation in the pathogenesis of non-medullary thyroid cancer), Hilde van der Schar (Viral redesign of the cellular interior: how enteroviruses exploit host factors to build replication organelles) and Jeroen Strating (Greasing the viral life-cycle: the role of lipids in picornavirus replication).

Research results

Awards and acknowledgements

Emeritus Prof. Jos van der Meer, former director of the N4i, has been elected as President of the European Academies Science Advisory Council (EASAC) for a period of three years. EASAC is one of the most influential independent EU advisory boards. Furthermore, he received the “Zeldzame Engel Award” from the Dutch Foundation for Rare Disease for his efforts for people suffering from immune deficiencies.

Prof. R. De Groot was awarded the prestigious Gorter medal of the Netherlands Paediatric Society, for the successful way he combined excellent fundamental research with clinical work as a medical specialist.

Prof. Wim van den Berg received the IAIS Lifetime Achievement Award for significant scientific contributions in the field of inflammation research over a sustained period.

Prof. Mihai Netea was awarded an ERC Starting Grant worth €1.5 million to investigate the interaction landscape between microbial colonization and functional genome of the host.

Prof. M.G. Netea, Jessica Quintin and colleagues demonstrated that IFN- is a promising treatment option for reversing sepsis-induced immunoparalysis in humans.

Internist Dr Anna Simon was awarded the Radboud Prize for outstanding female researchers by the Network of Female Professors at the University.

Four young N4i researchers received a prestigious Veni grant from the Netherlands Organization for Scientific Research: Hans Jacobs (Regulatory T cells in cancer; from foes to friends), Theo Plantinga (The elucidation of the interplay between autophagy and inflammation in the pathogenesis of non-medullary thyroid cancer), Hilde van der Schar (Viral redesign of the cellular interior: how enteroviruses exploit host factors to build replication organelles) and Jeroen Strating (Greasing the viral life-cycle: the role of lipids in picornavirus replication).
ness of the value of research results and innovative concepts for valorization, and smooth the route towards filing (more) patents.

The N4i 2012 Science Day was attended by colleagues from the valorization office to ensure early identification of promising (patentable) research results and discoveries that are eligible for valorization in spin-off companies. In addition, N4i researchers are encouraged to publish about infectious disease and related subjects in traditional and new media and to become actively involved in national and international organizations, such as the Royal Netherlands Academy of Arts and Sciences, Academia Europaea, the European Academic Scientific Advisory Council, the Health Council of the Netherlands, the Centre for Infection Control, ZonMw committees, the European and Developing Countries Clinical Trial Partnership, the Dutch Working Party on Antibiotic Policy, the European Society of Clinical Microbiology and Infectious Diseases, the Dutch Working Party on SLE and several other professional societies.

Several clinical studies were carried out, the outcomes of which have direct implications for clinical practice. The group led by Prof. J. Berden demonstrated that previous unknown renal outcomes of segmental and global subclasses of class IV lupus nephritis are similar. Prof. Kullberg and others demonstrated that two treatment factors are associated with improved survival of patients with candidemia: the use of an echinocandin and removal of the central venous catheter. Prof. A. van der Ven and Prof. R. de Groot contributed to a large study on the impact of antiretroviral therapy on tuberculosis incidence among HIV-positive patients in high-income countries. Dr van Crevel coordinated a seminal clinical trial on the treatment of tuberculous meningitis. Prof. P. Hermans’ group has demonstrated that the combination of CD4+ T-cell counts, IL-8 and CCL-5 plasma concentrations correlates with disease severity in RSV-infected children. In addition to clinical features, these markers may be useful for guiding clinical management.

Dr Ronald van Rij, Dr Walter Bronkhorst and colleagues demonstrated that the invertebrate Iridovirus 6 (a DNA virus) is targeted by an RNA-based immune response: the Drosophila RNAi machinery. These results provided new insights into the mechanisms of virus transmission by blood-feeding insects.

Dr H. Tjalsma and colleagues investigated bacterial responses to a simulated colon tumour microenvironment. The results suggest that tumour cell metabolites facilitate the survival of S. gallolyticus, favouring its local outgrowth, and provide a possible explanation for the specific association of this bacterium with colonic malignancy.

Major comments and reviews were published in top journals, including the Lancet, Nature Immunology, Nature Reviews in Drug Discovery and PLoS Medicine.

Societal impact

The N4i focus on Infection, Inflammation and Immunity represents a research profile with considerable societal impact; infectious diseases are a major cause of morbidity and mortality worldwide. Research is inspired by observations at the bedside and, through fundamental and translational research, the N4i aims to improve the diagnosis, treatment (including guidelines) and prognosis of patients with infection, inflammatory and immunological disorders. Clinical centres offer an excellent way to valorize research results and knowledge (e.g. the Nijmegen Centre for Immunodeficiency and Autoinflammation) and the N4i strategy is to establish additional clinical centres, raise awareness of the value of research results and innovative concepts for valorization, and smooth the route towards filing (more) patents.

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Key publications


TropIQ Health Sciences – a spin-off of RUNMC together with co-founder N4i Prof. Robert Sauerwein – received a grant from the Bill & Melinda Gates Foundation for groundbreaking innovative research with luminous parasites to accelerate the search for a cure for malaria.

A new regional collaboration was set up with Trouw Nutrition Nederland BV, Mead Johnson Nutrition BV, Wageningen University, Utrecht University and NIZO food research. Supported by EFRO and the Province of Gelderland the project ‘ImmunoForce’ is designed to develop new food products that will support the immune system and provide a defence against infections in children, resulting in lower use of antibiotics.

**Future research**

In the context of periodical evaluation of research performance and science policy, N4i was assessed by a small international site-visit committee in February 2012. The committee noted the high-to-excellent quality of N4i research groups, the overall high relevance, the satisfaction of PhD students and the added value of N4i for the visibility of clinical/translational research and collaborations. Their recommendations are being considered and necessary improvements in research and education policy and organization will be implemented.

N4i will continue to provide a platform for cross-fertilization in multidisciplinary research on infection, inflammation and immunity. Areas for future collaborative research include the role of pattern recognition in infection and inflammation, natural immunity to infection in human evolution, resistance to antifungal drugs and the implications for clinical medicine, exploring the pathophysiology of infection with major pathogens (e.g. pneumococci, staphylococci and malaria parasites), modulation of immunological responses using humoral and cellular tools (e.g. regulatory T cells), the role of epithelial barriers in disease, exploring the correlates of protection in poverty-related infections, and the role of apoptosis-induced auto-antigen modifications in the initiation of autoimmunity.

Examples of new projects include: exploring a novel anti-inflammatory therapeutic strategy for gouty arthritis through the inhibition of microtubule-inflammasome interactions (Dr L. Joosten, Reumafonds); IL-37 and phospho-Smad3 – critical for preventing chondrocyte activation and the development of osteoarthritis (Dr J. Langereis, Lung Foundation fellowship); and high-throughput research in rare kidney diseases (Prof. J. Wetzels, new European consortium for EURenOMICS).

The successful international Summer Frontiers symposium on ‘Training the innate immunity’ (organised by N4i in June 2012) will be followed up annually. The 2013 symposium will be entitled ‘When things go wrong in immunity: immunodeficiency from different angles.’
Every discovery in medical science should – given proven validity, cost-effectiveness and feasibility – ultimately be applied in clinical practice. How such a discovery finds its way into clinical practice, however, is a science in itself. This is the field of research in which the NCEBP specializes.

Three issues are central: Are findings resulting from laboratory research or laboratory animal research also applicable to human patients? Does applying them lead to a reduction in sickness or mortality? And if so, how do you introduce them as a structural part of daily clinical practice and public health? These are the questions that are being addressed in the fight against serious diseases such as cancer, chronic pulmonary disease, cardiovascular disease and dementia. The NCEBP is bridging the gap between science and society.

The NCEBP comprises four closely interrelated research programmes, each consisting of three or four research themes.

Epidemiology and Evaluation (Prof. Maroeska Rovers)
Theme: Molecular epidemiology (Prof. Bart Kiemeney)
In this theme the main focus is on identifying molecular/metabolic and genetic determinants for disease and disease outcomes. Most of the research focuses on cancer, but other multifactorial diseases, e.g. iron metabolism disorders, are studied where there are overlapping specific mechanistic pathways (e.g. the 1-carbon metabolism) or overlapping research methodologies (e.g. genome-wide association analyses). Research addresses aetiological, diagnostic, prognostic, and intervention issues.

Theme: Evaluation of complex medical interventions (Prof. Gert Jan van der Wilt)
Healthcare interventions can be complex in various ways. They may be technically complex or they may demand considerable delivery skills. They may also comprise multiple components (including contextual factors), each contributing critically to achieving the desired endpoint. Finally, they may be complex in terms of their effects, which can be multiple and varied, difficult to measure, and differentially distributed over time. These types of complexity pose considerable challenges to those evaluating healthcare interven-
tions. Appropriate methodologies for such evaluation are developed and tested. Within this theme there is a strong connection between Health Technology Assessment and clinical disciplines.

**Theme: Infectious diseases and international health**
*(Dr Rob Baltussen)*
The main goal here is to improve health in both low and high-income countries by developing the evidence needed for decision-making. To this end, research in clinical, public health and economic disciplines is integrated. The focus is on 1) poverty-related diseases, 2) public health and health systems in developing countries, and 3) general infectious diseases. Researchers also invest in building capacity, i.e. training local people to independently conduct research in low-income countries.

**Clinical Research (Prof. Sander Geurts)**
**Theme: Human reproduction (Prof. Jan Kremer)**
Advances in knowledge, an increase in demand for intervention and a growing awareness of the potential for prevention, diagnosis and therapy have made human reproduction an exciting research area. Relevant questions include the aetiology and prevention of reproductive and developmental disorders, as well as the safety, effectiveness, and patient-centeredness of reproductive and obstetric care.

**Theme: Human movement and fatigue (Prof. Sander Geurts)**
Many neurological, orthopaedic and oncological diseases affect movement ability and physical fitness and may cause excessive fatigue. By analyzing biomechanics, motor control and physical activity – as well as their interaction with cognition and emotion – this research is designed to disentangle the generic determinants from the disease-specific determinants of musculoskeletal impairments, movement disability, reduced physical fitness and fatigue. Both mechanistic and clinical research issues are addressed.

**Theme: Cardiovascular diseases (Prof. Gerard Rongen)**
The main aim researchers working within this theme is to achieve greater understanding of the pathogenesis of cardiovascular disease. The focus is on the mechanisms and consequences of vascular injury. This theme covers human in vivo proof-of-concept studies as well as studies from concept to evidence-based medicine. The genetic and metabolic causes of atherosclerosis and thrombosis – and of their risk factors – are investigated. Regulation of vascular tone in health and disease is another important research topic.

**Patient-centred Interventions (Prof. Andrea Evers)**
**Theme: Effective primary care and public health (Prof. Chris van Weel)**
This research theme was established to support healthcare in the primary care population. The main challenges are promoting and preserving the health and functioning of ageing populations. Healthcare must be provided for all patient groups in the community (regardless of health problems, gender, and age or social class)
Evidence-Based Practice

Research within this theme is designed to measure and improve safety.

Theme: Quality of hospital and integrated care (Dr Hub Wollersheim)
The focus here is on improving the diagnostics and treatment of patients with chronic somatic illnesses, in particular with regard to the psychological determinants and consequences of somatic conditions. There are two linked sub-themes: ‘Psychological factors in chronic somatic illnesses’ and ‘Cognitive dysfunction’. Both focus on the psychological and neuro-psychological risk factors, consequences, diagnostics and treatments of these conditions in adults and children.

Theme: Mental health (Prof. Anne Speckens)
The aim of researchers working within this theme is to study the determinants, prevalence, prognostic significance and treatment of mental health problems from a patient-centred perspective. The focus is on mood disorders, somatoform disorders, partner violence, Attention Deficit/Hyperactivity Disorder (ADHD) and Autistic Spectrum Disorders (ASD). Many projects involve a developmental perspective and the study of the precursors, longitudinal course and age-related manifestations of these disorders. In addition, the implementation, effectiveness and cost-effectiveness of innovative therapeutic interventions are studied.

Theme: Nijmegen Alzheimer Centre (Prof. Myrra Vernooij-Dassen)
The Nijmegen Alzheimer Centre (NAC) develops and evaluates support programmes in order to improve directly the quality of care and quality of life for people with dementia and for their families. The NAC contributes to fundamental knowledge on Alzheimer’s disease.

Quality of clinical practice (Prof. Michel Wensing)
Theme: Implementation science (Prof. Michel Wensing)
The emphasis here is on improving healthcare practice, with a specific focus on primary care. It includes developing and evaluating performance indicators, interventions to achieve sustainable change, and the factors associated with changes in performance. Research fields include the education of health professionals, pharmaceutical patient care, out-of-hours care, structured chronic care and patient safety.

Theme: Quality of hospital and integrated care (Dr Hub Wollersheim)
Research within this theme is designed to measure and improve the quality and safety of patient care in hospitals, home care and nursing homes. In addition, handovers between these three settings or handovers with general practice are studied. Research covers clinical patient care across a wide range of diseases. It involves developing and evaluating quality indicators and effective implementation strategies, including integrated care systems.

Theme: Healthcare ethics (Prof. Evert van Leeuwen)
Work within this theme involves studying the ethical aspects of change processes. On a philosophical level, a conceptual analysis is made of the theories and concepts that underlie the processes of change. Together these studies make it possible to evaluate existing care in the light of changing norms and values, and they contribute to improving decision-making and the quality of care.

Theme: Quality of nursing and allied healthcare (Prof. Theo van Achterberg)
Challenges covered by this theme include the search for scientific evidence to support clinical practice and professional development. While Medical care focuses on the diagnostics and treatment of diseases and their care, Nursing and associated healthcare focuses on disease prevention and the consequences of illness and disease for functioning, activities and participation.

Research facilities
Within the NCEBP, databases, ICT networks, registries and clinical research facilities are key because of the Centre’s research focus on clinical and population studies. Important examples of these facilities are listed below.

- Academic networks of GP sites, nursing homes, municipality health services, care facilities for homeless people and dental care sites. Specific registries relate in particular to common chronic diseases (COPD, asthma) and infectious diseases (e.g. Q fever).
- Innovative ICT application designs (E-health, E-coach and Radquest) to improve the medical and psychological care of people with somatic conditions.
- Large databases and biobanks of general population samples (The Nijmegen Biomedical Study), or of specific patient groups, e.g. congenital malformations, cancer, rheumatoid arthritis, inflammatory bowel diseases, poverty-related infections in Indonesia and Tanzania, ADHD, autism, pregnant women and a Primary Care continuous morbidity registration.
- A clinical research centre (CRCN) comprising a wide variety of human in vivo models that can be used for proof-of-concept studies (translational research).
- A pharmacology research laboratory.
- A consultation facility for statistical genetics.
- A unique multidirectional balance perturbation platform to study human postural control at the limits of stability.
- The ‘Koploper programme’, a healthcare innovation, in which professionals in primary care, public health, allied healthcare workers and the hospital jointly develop new approaches to prevention and care.
- The Minimal Invasive Technology expert Centre (MITeC) for evaluation of surgical innovations.
- A SYstematic Review Centre for Laboratory animal Experimentation (www.SYRCLE.nl).
- A psychophysiological research laboratory.
The Poverty Related Infection Oriented Research (PRIOR) network of the Department of Internal Medicine – with academic institutes in Tanzania and Indonesia – is very productive in terms of high-quality research and capacity building in these countries. The Minimal Invasive Technology expert Centre (MIteC) collaborates closely with the Universities of Twente, Eindhoven, and Groningen as well as with various industrial partners. Close connections are maintained with the CAMARADES Collaboration, a global network of researchers involved in performing systematic reviews and meta-analyses of animal studies in neurology. For Oncology research, the NCEBP collaborates closely with the Comprehensive Cancer Centre, the Netherlands (IKNLC), MD Anderson Cancer Center, Houston, the Foundation for the Detection of Hereditary Tumours (StOET) in Leiden, the National Expert and Training Centre for Breast Cancer Screening in Nijmegen, and with Wageningen University. Within the fields of primary care and public health, the NCEBP collaborates intensively with the Ministry of Health, Welfare and Sport, the National Institute for Public Health and the Environment (RIVM), the National Health Services Research Centre (NIVEL) and the World Organisation of Family Doctors (WONCA). It is also a partner in the Dutch Consortium of service providers for persons with intellectual disabilities (“Sterker op eigen benen”). The NCEBP is a partner in the National Biobank initiatives (String of Pearls Initiative, PSI) organized by the NFU with the purpose of creating a research infrastructure for selected diseases, and the national hub of existing biobanks (BBMRI).

The NCEBP collaborates for research and/or faculty exchange with more than 40 universities all over the world, but also with the European Union/ECDC, the World Health Organization, UNESCO, the Center on Birth Defects and Developmental Disabilities, various Centres for Disease Control and Prevention, INSERM (Paris), several Cochrane Centres, the Medical Research Council in London and deCODE Genetics in Reykjavik, Iceland.

Awards and acknowledgements

- Prof. Andrea Evers and Dr Teun Bousema were appointed members of the Young Academy within the Royal Netherlands Academy of Arts and Sciences (KNAW).
- The group led by Prof. Theo van Achterberg received the European Academy of Nursing Science’s Rosemary Crow award for the best European publication in nursing science.
- Dr Tjard Schermer became an adjunct professor at the University of South Australia in Adelaide, Australia.
- Prof. Roy Kessels was appointed to the Board of Governors of the International Neuropsychological Society.
Key publications


**Dissertations:** 83
**Academic publications:** 1699
**Professional publications:** 1

- Prof. Sander Geurts chairs the special interest group on postural and gait research of the World Federation for Neuro-rehabilitation (WFNR).
- Prof. Michel Wensing was appointed Editor in Chief of the journal *Implementation Science*, the leading healthcare journal in the field.
- Dr Hub Wollersheim was appointed adjunct Editor in Chief of the International *Journal for Quality in Health Care*.
- Dr Niels Riksen received a Dr Dekker Fellowship of the Dutch Heart Foundation.
- Dr Dick Thijssen received a New Investigator Award from the American College of Sports Medicine.
- Dr Thijs Eijsvogels, Dr Helma Ruijs, Dr Miluska Hevinga, Dr Roger Brüggemann, Dr Tim Olde Hartman and Dr Marieke Perry received national awards for their theses.
- The ‘Nijmegen Falls Prevention Program’ developed by Dr V. Weerdesteyn has, as the only programme in the Netherlands, received the recognition ‘proven effective’ from the Centre for Healthy Living at the National Institute for Public Health and the Environment (RIVM).

**Research results**

In 2012, a total of 81 PhD theses were successfully defended. Seven of these were considered to be of outstanding quality (*cum laude*): those written by Loes van der Zanden, Marleen van Gelder, Jasper Broen, Thomas Hambrock, Thomas Maal, Anke Snijders and Mark van den Boogaard.

In total, more than 1700 peer-reviewed papers were published by NCEBP researchers. Some highlights are listed below.

- In collaboration with deCODE Genetics in Iceland, researchers working within the molecular epidemiology theme co-authored the first genetic susceptibility locus for prostate cancer that was identified by whole genome sequencing.
- Colleagues published a study among 500,000 Europeans on the protective effect of plasma levels of carotenoids for bladder cancer.
- Researchers working within the molecular epidemiology theme showed that long-term use of hair dyes is not a risk factor for the development of bladder cancer.
- For the Dutch Cancer Society, the NCEBP co-developed a website where people can analyze their risk of cancer in relation to modifiable life-style factors.
- Prof. Ritskes and her team published several systematic reviews of animal studies that demonstrated that evidence-based choices of animal models are possible using the methodology of systematic reviews and meta-analysis.
- Researchers working within the Implementation science theme published the results of a major study in European primary healthcare, involving 6000 patients from 10 countries, showing that both structured self-management support and clinical information systems are associated with better risk management and intermediate outcomes in patients with coronary heart disease.
Nijmegen Centre for Evidence-Based Practice

• Researchers working within the theme Quality Nursing and Allied Healthcare demonstrated how investing in leadership and social influence can improve adherence to guidelines and the effectiveness of this for preventing and recognizing sepsis in hospital patients.

• Colleagues also demonstrated how the risk of delirium in patients in intensive care units can be signalled at an earlier stage and how early intervention can be effective.

• Researchers working within the theme Psychological determinants of chronic illness found evidence that specific psychophysiological factors affect physical symptoms of itch and pain. Evidence was found that screening tools for the detection of depression in patients with advanced cancer may not provide an accurate evaluation of depression, but do seem to measure the physical symptom burden. In the Lung diseases research line, it was found that assessment instruments which are commonly used in COPD, Asthma, and Q-fever measure only few aspects of health status. In particular, adaptation to a chronic illness is not measured. The Nijmegen Clinical Screening Instrument (NCSI) provides a detailed assessment of relevant health status aspects as well as of adaptation to the illness. The NCSI also helped increase patients’ motivation to change in such a way that they are better adapted to their illness.

• A trial on Mindfulness-Based Cognitive Therapy (MBCT) in 205 patients with recurrent depression showed that MBCT was effective in reducing symptoms in patients both with and without current depressive symptoms.

• A set of quality indicators for psychosocial interventions in dementia was developed. Systematic process evaluation created new insights into the causes of both the effectiveness and ineffectiveness of these interventions.

• Researchers working within the International health theme demonstrated the impact of an innovative approach to improving enrolment in health insurance in low-income countries. In a randomized controlled community trial, it was shown that implementing multi-stakeholder problem-solving groups led to an increase of health insurance uptake by some 20%; poverty levels were also reduced.

• Researchers working within this theme also showed for the first time that – with the use of innovative, highly refined mathematical models – treatment of all HIV patients with a CD4 level < 350 cells/µL would lead to the elimination of HIV in South Africa.

Societal impact

Much if not most of the NCEBP research has direct societal impact and/or is immediately implemented in clinical care or public health. Achieving societal impact is, in fact, one of its main aims. NCEBP researchers also make a significant contribution to numerous national and international guidelines and reports and they sit on important committees. NCEBP researchers develop performance indicators for primary and hospital care that are used for contracts for performance-related systems and they write evidence-based treatment guidelines and implementation plans for these guidelines. Some highlights in 2012 were:

• A patent was obtained for a permanent meniscus implant and an endosteol fixation device for amputation and revision prostheses.

• The animal facility has created more transparency in animal studies in collaboration with the Dutch organizations ‘proefdiervrij’, WUR, UMCG, UU and UMCU.

• Prof. van Weel was an advisor to the U.S. government on the organization of primary care.

• Through participation in a European project, researchers working within the Quality of Nursing and Allied Healthcare theme were able to shed substantial light on why nurses in ten European countries leave their profession and how this might be prevented.

• Thanks to work in Prof. Ritskes’ group, two bills were passed in the Dutch parliament: one calling for systematic reviews to become the norm for animal studies, as is already the case for clinical trials. The other requires all data from animal studies to be stored.

• Research and education designed to measure and improve the quality and safety of patient care in hospitals and the coordination of care across different settings have led to improvements in integrated care delivery, patient empowerment, the implementation of safe practices and the prevention of infection.

• The spin-off company MijnZorgnet (a provider of health communities) facilitates several projects that improve patient centeredness, shared care and the use of web-based tools in clinical care and public health.

• The spin-off company HaemoMagum BV – founded by Dr Van Heerde – is currently valorizing the Nijmegen Haemostasis Assay.

Future research

In the next few years, NCEBP will intensify interaction with the other RUNMC research institutes in order to improve the quality of translational research from molecule to man to population. It will do this with a greater focus on specific diseases (in accordance with the RUNMC Board’s policy). The Centre will continue to invest in research facilities such as biobanks and large national and international networks. The focus of the research will increasingly be on personalized medicine and patient-centred interventions. For example, with his ERC advanced grant, Prof. Verdonschot will focus on generating personalized diagnostic and modelling tools for patients suffering from musculoskeletal problems of the lower limb.

The ageing of the Dutch population will create enormous quality and efficiency challenges for healthcare. ‘Cost-effectiveness’ will be the keyword for healthcare policy for the next few decades. Maintaining the accessibility of health care for all will become a major challenge. NCEBP’s department IQ Healthcare started an extensive knowledge programme, funded by the Ministry of Health, to conduct research that will underpin accessibility solutions.
Healthcare networks will be one of the key areas of innovation in NCEBP’s research in the years ahead. Crucial communication and information sharing in healthcare is increasingly facilitated by new technologies. Better understanding of network-related mechanisms in the networks of both patients and health professionals can provide new targets for improving healthcare delivery. One future activity will be to evaluate the use of personal health communities by pregnant women (MijnZwangerschap) and by infertile women (Fertiscreen).

In The NCEBP’s Epidemiology and Evaluation programme will continue to shift its focus from aetiology research to research related to prognostic/predictive aspects and the quality of care. For this, the new hospital information system (HIS) EPIC, which will be launched in the fall of 2013, will be extremely important, as it will improve observational research. Patient-oriented research will be supported by large biobanks such as the ‘Radboud Biobank’. It is anticipated that whole-genome sequencing costs will go down in 2013 to such an extent that sequencing of large patients series will become possible. This will create tremendous opportunities for pharmacogenetics research.

The NCEBP aims to strengthen its scientific and societal output, in line with its dual mission. PhD grants will go to projects that are methodologically innovative in order to give a boost to the Centre’s scientific output. The Societal relevance will be strengthened by establishing strategic links with a wide range of stakeholders and research groups.
Researchers at the Nijmegen Centre for Molecular Life Sciences (NCMLS) seek to achieve greater insight into the complexity of living cells in order to obtain comprehensive knowledge of both normal and pathological processes. These goals are pursued in the interests of fundamental research and education. Another central aim is to advance innovation in translational research, based on integrating a wide range of fields of scientific expertise within the molecular and medical sciences.

The NCMLS is a leading multidisciplinary research school in the molecular mechanisms of disease and particularly in molecular medicine, cell biology and translational research, bringing together research groups from the Radboud University Nijmegen Medical Centre (RUNMC) and the Faculty of Science at Radboud University Nijmegen (FNWI). Research is structured within seven main research themes, all of which relate to understanding the molecular basis of disease. For more detailed descriptions of these themes, go to www.ncmls.eu.

1) Infection & Inflammation (Dr Frank van Kuppeveld)
This theme covers two important areas of biomedical research:
- Infectious diseases: The focus here is on the role of the innate immune system in pathogen recognition and host defence (against fungal, bacterial and viral infections), on pathogen-host interactions, vector biology, anti-microbial drugs and the development of drug resistance, vaccine development, and the role of pathogens in the development of inflammatory diseases.
- Inflammatory diseases: The aim here is to identify disease mechanisms that encompass both the innate and adaptive immune system as well as modifier genes and post-translational modifications – including auto-antigens – in order to explain...
the tissue specificity of conditions such as rheumatoid arthritis, systemic sclerosis, gouty arthritis, psoriasis and systemic lupus erythematosus.

2) **Immune Regulation (Prof. Gosse Adema)**

This theme covers immunological and haematological research in three major biomedical fields:

- Molecular and functional analysis of normal and malignant blood cell development and immune control: this theme includes analysis of dendritic cells, regulatory T-cells and natural killer cells as well as defining regulatory circuits that influence tolerance and immunity.
- Immunotherapy of cancer: the development and clinical application of vaccination and imaging strategies for solid and haematopoietic malignancies and their microenvironment.
- Organ transplantation: the development and clinical application of novel approaches to immune monitoring and interventions in kidney transplantation.

3) **Regenerative Medicine & Microenvironment (Dr Toin van Kuppevelt)**

Within this theme, the two main topics are:

- Regenerative medicine: tissue-engineered constructs – based on extracellular matrix molecules, polymers and effector molecules – are designed and fabricated, and analysed in vitro and in vivo. Smart organ-specific bioscaffolds are prepared in such a way that they provide appropriate signals to the cells (proliferate, migrate or differentiate). The focus here is on ceramics, calcium phosphates, collagens, glycosaminoglycans and effector molecules (e.g. growth factors and cytokines) in relation to a selected number of tissues, i.e. cartilage/bone, skin, kidney and blood vessels and the urogenital organs.
- Microenvironment in health and disease: the focus here is on collagens, glycosaminoglycans, matrix metalloproteinases and a number of effector molecules (e.g. BMPs and TGF beta). The role of these components in cancers, nephropathies and degenerative cartilage diseases is studied in vitro as well as in vivo. Strategies for restoring homeostasis in deranged and disease-associated micro-environments are pursued, including the use of glycomimetics.

4) **Energy & Redox Metabolism (Prof. Martijn Huijnen)**

Researchers in this area aim to improve our understanding of the principles of (biochemical) adaptation to energy and redox stress, in order to better define healthy responses within the normal physiological range and the pathophysiological thresholds for diseases whereby mitochondrial function or energy transfer pathways are compromised. This research contributes to the well-being and treatment of patients with mitochondrial disease and those with other conditions in which energy metabolism is compromised. Research is concentrated in three areas:

- ‘imaging’ of ATP/ADP/AMP and NAD(P)H concentration and fate with existing and novel biosensor reporters;
- ‘imaging’ of metabolite fate with MRS and MRI;

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**Staff**

- Prof. G.J. Adema (o)
- Prof. J.O. Barentsz (o)
- Prof. J.H.M. Berden (o)
- Prof. W.B. van den Berg (o)
- Prof. R.J.M. Bindels (o)
- Prof. O.C. Boerman (o)
- Prof. J.H.L.M. van Bokhoven (o)
- Prof. U. Brandt (o)
- Prof. R.E. Brock (o)
- Prof. H.G. Brunner (o)
- Prof. P. Buma (p)
- Prof. C.E.L. Carels (o)
- Prof. F.P. M. Cremers (p)
- Prof. P.M.T. Deen (o)
- Prof. J.H.M. van Bokhoven (o)
- Prof. J.H.J.M. van Krieken (o)
- Prof. B.J. Kullberg (o)
- Prof. N.H. Lubsen (p)
- Prof. L.F.A.G. Massuger (o)
- Prof. J.W.M. van der Meer (o)
- Prof. G.J. Meijer (o)
- Prof. L.A.H. Monnens (o)
- Prof. J.A. Schalken (p)
- Prof. J. Schalkwijk (o)
- Prof. J.P.H. Drenth (o)
- Prof. J.P. H. Friedl (o)
- Prof. W.R. Gerritsen (o)
- Prof. W.J. de Grip (e)
- Prof. A. Heerschap (o)
- Prof. P.W.M. Hermans (o)
- Prof. P.M.T. Deen (o)
- Prof. J.M.A. van Deursen (o)
- Prof. T.J.M. van der Meer (o)
- Prof. J.A. Schalken (p)
- Prof. J. Schalkwijk (o)
- Prof. R.J. Siezen (e)
- Prof. J.A.M. Smeitink (o)
- Prof. D. van Soolingen (e)
- Prof. L.F.A.G. Massuger (o)
- Prof. D. van Soolingen (e)
- Prof. J.A. Schalken (p)
- Prof. J. Schalkwijk (o)
- Prof. R.J. Siezen (e)
- Tenured Full Professors 32.2 FTE
- Associate Professors 15.6 FTE
- Assistant Professors 24.2 FTE
- Researchers 23.2 FTE
- Non-tenured Researchers 133.4 FTE
- Doctoral candidates 183.2 FTE
the use of new strategies to follow mitochondrial shape and activity as well as cellular metabolic state and viability. The integration of ‘4-D’ imaging and simultaneous recording of the behaviour of small molecules and macromolecular assemblies and cellular organelles is an important challenge.

5) Membrane Transport & Cell Dynamics (Prof. Joost Hoenderop) Membrane transporters are involved in a wide range of diseases in organs such as the brain, muscles, kidney, intestine, liver and bone. The ultimate aim of research in this area is to provide a molecular basis for the understanding, diagnosis and ultimately cure of inherited and acquired diseases of transport proteins, such as channelopathies. Transport proteins currently studied within this theme are sodium (or hydrogen) and potassium ATPases, aquaporin water channels, transient receptor potential channels, organic anion and cation transporters, ATP-binding cassette (ABC) transporters and sodium co-transporters. Research integrates fundamental and clinical studies conducted at the genetic level (gene defects, polymorphisms), molecular level (transport and associated proteins), cellular (established model systems, isolated and transfected cells) and organism (conditional) knockout models levels. In addition, new tools will be developed and implemented in order to tackle the group’s scientific goals, including real-time imaging, large scale screening assays at the mRNA and protein level, application of small interference RNA libraries, conditional knockout models, bioinformatics and functional analysis at the molecular level.

6) Genetic & Epigenetic Pathways of Disease (Prof. Hans van Bokhoven) Under this theme researchers aim to unravel the molecular basis of cell behaviour resulting from the genetic and epigenetic code contained in the nucleus in the context of health and disease. Basic and clinical research is combined to establish the molecular pathways and cellular processes in specific (hereditary) tumorigenic pathways in the normal and pathological development, in particular, of the nervous system. Members of this research group are engaged in technology development ranging from single molecule studies of reconstituted model chromatins to the elucidation of epigenetic marks on a genome-wide level and the implementation of Next Generation Sequencing (NGS) in fundamental research as well as in a diagnostic setting.

7) Chemical & Physical Biology (Prof. Jan van Hest) The structure and function of proteins and their complexes play crucial roles in virtually all NCMLS research projects.

- At the molecular level researchers working within this subtheme optimally exploit the potential of molecular and biomolecular chemistry in order to modify, design and mimic proteins and their building blocks with the aim of modulating and analyzing their activities and properties in the cellular and subcellular environment. This is best illustrated by the following examples: i) novel bio-orthogonal conjugation methods for studying and interrupting biological processes; ii) stimulus-responsive cell-penetrating peptides; iii) the use of non-proteinogenic amino acids in the diagnosis and treatment of disease; iv) mimicking cellular synthetic processes in microenvironments; and v) hybrid cell systems: incorporating synthetic components into living cells.

- This subtheme centres on the elucidation of protein structure and protein-protein interactions at the cellular and multicellular level. Research topics are: i) post-transcriptional events in gene expression; ii) cellular signalling pathways; iii) the activation and deactivation mechanisms of tyrosine kinases and tyrosine phosphatases; iv) external control of cellular proliferation and differentiation; and v) molecular probing of vascular pathology and angiogenesis.

Annemiek van Spriel (Assistant Professor of Tumour Immunology) received an NWO Vidi grant to investigate proteins in the immune system – the tetraspanines – and how they affect the membranes of living immune cells. This will contribute to a better understanding of the mechanism of immune cells in defending against infections and cancer.
Research facilities

These can be grouped in the following categories:

Animal models: The NCMLS has excellent links to the Central Animal Facility (CDL) for expert advice and access to facilities for animal testing. NCMLS has several disease-related animal models available, for example, for arthritis, cancer, kidney disease, tissue engineering, heart transplantation, neural disorders, metabolic disorders, osteoporosis, haematopoiesis, fungal and bacterial septicaemia and malaria (P. falciparum).

Flow Cytometry: This facility is part of the Laboratory of Haematology in the Department of Laboratory Medicine at the RUNMC. Flow cytometry is a sophisticated single cell analysis technique that involves simultaneously measuring and analysing multiple physical characteristics of cells. State-of-the-art equipment available includes 2 Beckman-Coulter analyzers, a Beckman Coulter and a Becton Dickinson sorter.

Genomics: DNA sequencing and micro-array technology for gene expression profiling are essential laboratory tools. The Microarray Facility Nijmegen is one of the core facilities of the RUNMC. The Department of Human Genetics also has a sequencing facility and a genotyping facility. Multiple applications such as expression profiling, genomic copy number profiling (array CGH) and high density SNP profiling are carried out, while next-generation Genome Sequencers (Roche 454 FLX Titanium and Solexa) are operational in the Departments of Human Genetics and Molecular Biology.

Molecular imaging: Imaging at the cellular and subcellular level is another essential tool. The Microscopic Imaging Centre (MIC) at the NCMLS is a state-of-the-art facility for imaging biological specimens, using light microscopy (bright-field, confocal and fluorescence), conventional scanning and transmission electron microscopy, and sophisticated digital imaging. The facility is available for researchers within and outside the NCMLS. The Centre also offers access to other techniques such as Atomic Force Microscopy, Flow cytometry, FRET and FRAP.

PRIME: This is the Preclinical Imaging Centre of the RUNMC with state-of-the-art equipment for small animal imaging: MRI (7 Tesla, 11.7 Tesla), PET/CT, SPECT/CT, bioluminescence imaging and in vivo multi-photon microscopy.

Proteomics: The growing availability of genomic sequence information – together with improvements in protein characterization using mass spectrometry – is valuable for protein research. The Radboud Proteomics Centre (NPC) was established in 2004 to exploit such opportunities. Available equipment includes 2D-electrophoresis, SELDI-TOF and Mass spectrometry (MALDI-TOF, MALDI-LTQ and nano-LC LTQ-FT MS).

Molecule-2-Man (M2M)

The NCMLS is an active participant in Molecule-2-Man (M2M), an innovative multidisciplinary imaging platform strategically located at the University and RUNMC, which both have a long history of interdisciplinary research, education and healthcare. M2M is built on the strengths and proven track record of leading Nijmegen institutes: Molecules and Materials, Molecular life-sciences, Cognitive Neuroscience and Medical Sciences. Its aim is to reinforce existing local and national infrastructures by concentrating expertise and facilities in order to create a top European health technology campus in Nijmegen, which will implement and advance imaging technologies from the molecular level to entire organs and the human body itself (i.e. from molecule to man) and take translational research from the laboratory into the clinic (from bench to bed). M2M provides an ideal platform for exchange of knowledge and for access to state-of-the art instrumentation. It also facilitates collaboration with research institutes, small and medium-sized enterprises and larger companies.

Translational research and cellular therapy: A Good Manufacturing Practice (GMP) facility with clean rooms is used for translational research e.g. immunotherapeutic cell therapy and stem cell transplantation.

Collaboration

The NCMLS is a multiparty collaboration involving specialist medical groups from the University Medical Centre and a number of groups from the Science Faculty. Technological development, alongside excellent research and education, are the key drivers for local and national and international collaboration. In line with our mission (linking fundamental and clinical science) it is an important objective to establish strong ties with European and other partner institutes with synergistic research areas. The idea is to extend translational pipelines from molecule to man to patient to population.

Locally, the NCMLS is allied with the IMM and the Donders Institute, providing a solid platform for the integration of chemical synthesis, nanoscience and neuroscience with molecular life sciences. It also interacts on a daily basis with members of the RUNMC clinical institutes (the IGMD, RIO and N4i). From 2013 onwards interaction with the NCEBP is expected to increase. Nationally, it has contacts with other Dutch UMCs and universities as well as with Dutch public-private partnerships. Within Europe, there is growing cooperation with the University of Duisburg-Essen, specifically with the Graduate School of Biomedical Science (BIOME). A third International Research Universities Network (IRUN) workshop on immunology is planned in the Spring of 2013. This will create a forum for building relationships with participants from
Key publications


Nijmegen Centre for Molecular Life Sciences
universities in Münster, Glasgow, Poland and beyond. As part of a Glasgow-Radboud Memorandum of Understanding there have been several exchanges (visiting lectureships), between the NCMLS and the Institute of Molecular, Cell and Systems Biology at the University of Glasgow in Scotland. These exchanges are an integral part of NCMLS PhD and Masters programmes.

The multi-disciplinary nature of the Centre ensures not only high quality research in Molecular Life Sciences; it also supports excellent educational programmes at the BSc, MSc and PhD level. Building inter-institutional collaboration e.g. through visiting professorships/lecturers, exchange programmes for Masters and PhD students, as well as technology workshops, will be a key focus in the years ahead.

Research results

Below some of the research within the seven NCMLS themes is highlighted.

Theme 1: Prof. Mihai Netea and his colleagues discovered that Candida albicans – a fungus that causes opportunistic oral and genital infections in humans – provides protection against re-infection in a monocyte-dependent manner (Cell Host Microbe, 2012). Immunological memory in vertebrates is often exclusively attributed to T and B cell function. This new concept of ‘trained immunity’ in mice, which is related to epigenetic reprogramming, could open up new prospects for the design of improved vaccination strategies.

Theme 2: Acute myeloid leukaemia (AML) is a malignant blood cell disorder with a five-year survival rate of less than 40%. Identifying genetically defined prognostic factors has contributed to individualized treatment strategies and improved outcomes. Dr Bert van der Reijden (Laboratory of Haematology) reported in Blood (2012) on the identification of a novel favourable prognostic factor in AML. Not only did this work allow the researcher to identify a new molecular form of AML; it will also have implications for future risk stratification of and treatment strategies for AML patients.

Theme 3: Dr Sander Leeuwenburgh led a group of researchers who succeeded in constructing a collagen fibril membrane that mimics the 3D-architecture of the human papillary dermis. This study, which was published in Biomaterials in 2012, demonstrated that cellular characteristics can be directed by physical modification of biomaterials and allowed specific cellular niches to be formed. This knowledge may be useful for the construction of improved tissue-engineered skin constructs.

Theme 4: Drs. Peter Willems, Werner Koopman and colleagues published a study in the journal Antioxidants & Redox Signaling, which demonstrated how reactive oxygen species (ROS) act as signalling molecules in healthy cells. Their findings (published in Antioxid Redox Signal, 2012) suggest that Trolox-sensitive
sROS are upstream regulators of mitochondrial mitofusin levels, morphology and function in healthy human skin fibroblasts. This information not only facilitates the interpretation of antioxidant effects in cell models of oxidative-stress; it also contributes to a better understanding of ROS-related human pathologies, including mitochondrial dysfunction.

Theme 5: Profs. René Bindels and Joost Hoenderop – together with colleagues from Germany, Switzerland and China – demonstrated the vital role of the epithelial magnesium channel TRPM6 in diabetes type 2 (PNAS, 2012). The incidence of diabetes has increased markedly over the last 50 years and more than 300 million people have been diagnosed with the disease. TRPM6 is normally activated by insulin, but the channel seems ‘deaf’ for this hormone in pregnant women who develop type 2 diabetes, leading to disturbances in body magnesium balance. There is a strong association between magnesium shortage and the occurrence of diabetes type 2. This study provided the first mechanistic clue that explains this phenomenon.

Theme 6: The causes of intellectual disability remain largely unknown because of extensive clinical and genetic heterogeneity. In a ground-breaking study (NEJM, 2012) conducted by Lisinka Vissers and colleagues, evidence was shown that exome sequencing can be used as a diagnostic procedure for patients with severe intellectual disability of unknown cause. Improvement in methods and the identification of additional genes associated with intellectual disability are likely to further improve the diagnostic yield.

Theme 7: Stem-cell fate is regulated by signals from the microenvironment, one of the environmental parameters being the extracellular matrix (ECM) to which stem cells adhere. The ECM varies not only in composition, but also in physical parameters. Such physical properties are known to affect the micro- to-nano topography of integrin ECM receptors and to influence a range of cellular processes through changes in cell shape and the actin cytoskeleton. In this collaborative study, which was carried out by researchers at the IMM and the NCMLS and led by Wilhelm Huck, investigators showed how substrate properties influence stem-cell fate. They concluded that human epidermal and mesenchymal stem cells cultured on substrates coated with covalently attached collagen respond to the mechanical feedback of the collagen anchored to the substrate (Nature Materials, 2012). These findings will have a major impact on the design of materials used to culture stem cells for tissue engineering applications.

Societal impact
The importance of molecular life sciences-related research in society is emphasized throughout the research institute as well as in educational programmes. Training researchers in life sciences is of great importance for society, since they will form the new generation of scientists and biotechnology entrepreneurs who will develop novel diagnostics and treatments NCMLS researchers actively contribute to the dissemination of research results via public conferences, teaching in schools and colleges (e.g. via the Wetenschapsknooppunt, the Science hub at Radboud University Nijmegen) as well as in the media. Examples of media appearances in 2012 include: A new diagnostic test for Lyme disease (Bart-Jan Kullberg & Leo Joosten), How do pain-killers work? (Frans Russel), Pregnancy & diabetes (Joost Hoenderop) and The human genome & epigenome (Henk Stunnenberg). In addition to promoting public access to science, researchers at the NCMLS are also active in generating intellectual property, working closely with the Department of Valorisation in this regard.

NCMLS researchers are actively involved in enhancing disease diagnosis, prevention and treatment. Clinical groups (e.g. under leadership of Profs. Jo Berden, Mihai Netea, Theo de Witte, Bart-Jan Kullberg and Jan Smeeitink) are in daily contact with patients and their relatives at the RUNMC, have close ties with patient organizations and are involved in public and strategic policy. Of particular note in 2012, Carl Figdor’s services to medical research and education were recognised with a knighthood, Frans Russel was elected by Royal decree as a member of the Health Council of the Netherlands and Hans van Bokhoven was elected to the Central Committee on Research involving Human Subjects (CCMO). Wilhelm Huck was elected as a member of the Royal Netherlands Academy of Arts and Sciences (KNAW) and Teun Bousema and Andrea Evers became members of The Young Academy (DJA). The NCMLS is proud of these achievements and encourages all staff to make a contribution to national and international policy decision making.

Future research
The seven research themes are internationally strong and have sufficient critical mass for the institute to continue with its current research strategy (from a report of a site visit evaluation in 2011). The NCMLS has the ambition of further establishing itself as a European ‘top institute’ with a dynamic ambitious environment. Substantial investment has been made in molecular biology with a new department being set up (Developmental Molecular Biology, headed by Dr Kim Bonger, tenure track Chemical Biology, started a new Department of Valorisation in this regard. Dr Jo Huiqing Zhou (genetic and epigenetic mechanisms controlling epidermal stem cell behaviour), and Dr Leonie Kamminga (epigenetic mechanisms regulating cellular identity during development). Furthermore, Geert van den Bogaart (an RUNMC fellow) started a tenure track in 2012 within the Department of Tumor Immunology. The aim of his research is to elucidate the molecular mechanisms of cytokine release from immune cells. Dr Kim Bonger, tenure track Chemical Biology, started a new research line on chemical degradation systems. Finally, in the coming year a full professor will be sought in Cell Biology and in Regenerative Medicine.
Director: Prof. René Bindels

Prof. René Bindels – Professor of Physiology – has been Head of the Department of Physiology since 2003. His research focuses on the regulation of ion transport processes in kidney and intestine (in health and disease) and he specializes in renal TRP channels and salt transporters. Prof. Bindels is an elected member of the Academia Europaea and a recipient of the Robert Pitts Lectureship of the International Union of Physiological Sciences, the Carl W. Gottschalk Lecture-ship of the American Physiological Society and the Homer Smith Award of the American Society of Nephrology. He is also Executive Editor of the European Journal of Physiology.

The following prestigious Veni and Vidi grants from the Netherlands Organization for Scientific Research (NWO) – as well as ERC grants (from the EU) – awarded to members of the NCMLS form the basis for important future research.

- Prof. Mihai Netea (Department of General Internal Medicine) and Dr Anneke den Hollander (Department of Ophthalmology) were each awarded an ERC Starting Grant worth €1.5 million, the first to discover novel diagnostic and/or therapeutic targets for fungal infections and the second to develop reliable prognostic tests to determine who is likely to develop age-related macular degeneration.

- Dr Annemiek van Spriel (Department of Tumor Immunology) and Dr Richard Bartfai (Department of Molecular Biology) were each awarded an NWO Vidi Grant worth €800,000 to i) investigate the role of tetraspanin proteins in the immune system and ii) to dissect gene regulatory mechanisms in the human malaria parasite, respectively.

- Nine young researchers, who are affiliated with the NCMLS, have each received a Veni grant worth €250,000 from the NWO. Topics include 1) renal ciliopathies, 2) Plasmodium epigenetic acetylome 3) PcG protein regulation in vertebrates 4) regulatory T cells in cancer 5) iodide uptake in thyroid cancer 6) enterovirus replication 7) hearing impairment 8) role of lipids in picornavirus replication and 9) retina degeneration.

In 2012, a number of large prestigious (consortium) grants were awarded. For full details see the NCMLS website, but particular highlights include €12 million for developing innovative diagnostic tools, biomarkers and efficient screening strategies for rare kidney disorders and €6 million for developing new formulation strategies for biopharmaceuticals and cancer immunotherapies involving non-invasive administration. In 2012, the NCMLS Graduate School was re-accredited for a period of six years by the Royal Netherlands Academy of Arts and Sciences, a prestigious accomplishment which confirms the strong link between scientific research and education.
The Institute for Water and Wetland Research (IWWR) encourages interdisciplinary cooperation among scientists engaged in microbial, animal, plant and environmental sciences. Its intention is to integrate these disciplines and stimulate joint research in order to enhance our understanding of interactions between different life forms and their interactions with the environment.

The research at the IWWR is carried out by complementary, closely interacting research groups, which study the stress responses and adaptation mechanisms of cells, organisms and ecosystems. The research spans a wide range of approaches and clear research goals provide excellent opportunities for interdisciplinary collaboration as well as finding solutions to a wide variety of environmental problems.

The availability – or excess – of water will be the main environmental problem in the world in the 21st century. Water shortages are likely to increase in many regions, while flood plains will increasingly suffer from flooding at certain times of the year. In addition, poor water quality is challenging human populations and natural ecosystems alike. Organisms and ecosystems adapt to specific water regimes, but changes in water quantity and quality lead to stress responses.

Research at IWWR focuses on water, wetland and associated terrestrial systems in which there is considerable variation in environmental conditions in space and time. The specific relationships between the organisms living in these fluctuating environments – as well as the regulatory mechanisms used to maintain homeostasis – are studied under both natural and experimental conditions.

Research themes
IWWR research takes place within four themes.

Microbial ecology
Ecology, physiology, and the genomics and metagenomics of micro-organisms play a key role in the nitrogen and carbon cycles of aquatic ecosystems. In research carried out within this theme there is a strong connection between microbial ecology and ecophysiology on the one hand and biochemical cycles of lakes
and wetlands on the other. The symbiosis of microorganisms with aquatic plants and animals is also studied. IWWR research groups are at the forefront of developing and applying the latest genomic techniques in order to unravel the inherent genetic constraints and opportunities of ecosystems. This allows the researchers to make predictions about how systems respond to environmental change, and form the basis for novel applications in ecosystem management as well as in water and wastewater treatment.

Conservation biology
Researchers working on this theme focus on understanding the mechanisms and the impact of threats on populations and ecosystems, on the responses of species and populations to these threats and on the countermeasures that can be taken within conservation management. IWWR researchers study responses to a variety of stress factors by engaging in integrated collaborative research, from the physiology of individuals to changes in ecosystems. Collaborative research among IWWR research groups integrates approaches at the ecosystem, population and genetic level in order to answer urgent conservation questions related to promoting biodiversity and the management of threatened and invasive species. Novel fundamental insights are applied to conservation practice in close collaboration with nature conservation, NGOs and consultancies.

Plant stress adaptations
The study of the way plants adapt to abiotic and biotic environmental factors is the central focus in this theme. Stress adaptations are studied at all organizational levels – the molecular-genetic, physiological, chemical and organismal as well as at the ecological level. This research provides fundamental knowledge about how and why individual organisms respond to environmental stressors the way they do and identifies the ecological and evolutionary opportunities for, and constraints to adaptation. Drought and/or flooding adaptations may interfere with responses to biotic stresses such as those made by herbivores and pathogens. Research increasingly focuses on a common model system (Solanum dulcamara). The IWWR Solanaceae collection encourages integrative research in this highly diverse and important plant family and new insights are applied in collaborative projects with biotechnology and breeding companies.

Ecological stressors
The natural environment is increasingly exposed to multiple stressors, including changes in land use, extreme drought and flooding, and pollution. Within this theme, research focuses on the interaction between these stressors, from the ecosystem to the global scale, with an emphasis on riverine and estuarine systems. Mathematical models are used to integrate the data, to understand the response mechanisms and to simulate future changes. The impact of new measures and technologies is evaluated using life-cycle assessment. Research groups closely collaborate with companies and NGOs, applying their recent insights.

Research facilities
All research groups at the IWWR are located in the Huygens Building, where they have state-of-the-art modern laboratory facilities – and a central analytical service. The equipment used includes:

- Light microscopy and electron microscopy facilities for detailed analysis of the ultrastructure of micro-organisms, animals and plants.
- Extensive molecular biological facilities, such as quantitative RT PCR, RNA interference and in-situ hybridization techniques.
- Analytical equipment such as a High Pressure Liquid Chromatograph with photodiode array detector.
- A Gas Chromatography Mass Spectrometer equipped with a direct thermodesorption unit.
- Extensive culture facilities.
- Large aquarium facilities for freshwater and seawater fish; for zebrafish research modern equipment, expertise and permits for producing transgenes are all in place.
- PHYTOTRON – a unique national research facility for detailed ecological research on the sub-surface processes affecting terrestrial and semi-aquatic vegetation.
- New greenhouses will be built in 2013.
Collaboration
Collaboration within the IWWR opens up avenues for novel interdisciplinary research as well as opportunities for funding that cannot be achieved by a single research group. New initiatives have been started for collaborative research in the context of the ‘top’ sectors for scientific innovation identified by the Dutch Government. Researchers working on plant stress adaptation have interested several companies in new integrative research on multiple plant stressors within the ‘top’ sector Agrofood and Horticulture. The Microbial ecology and Aquatic ecology groups have been involved in plans for regional development in which provinces, water boards and companies (including the IWWR spin-off company B-Ware) interact. These plans have considerable relevance for the ‘top’ sector Water.

To join forces with complementary research groups outside IWWR and achieve successful valorisation, IWWR research is also conducted in close collaboration with over a hundred national and international research groups, research institutes, companies and governmental as well as Non-Governmental Organizations (NGOs).

Research results
In 2012 the microbiologists at IWWR investigated the genome and transcriptome of marine anammox bacteria that contribute significantly to the loss of fixed nitrogen from the oxygen minimum zones. The genomes of several (anammox) micro-organisms were determined, including that of Jettenia asiatica. Together with the aquatic ecologists at the IWWR, the nitrogen and methane cycle in a minerotrophic peat land were investigated.

The aquatic ecologists were able to unravel a number of exciting new plant-environment interactions, including the extreme oxygenation of peat by vascular plants in pristine Patagonian peatlands, neutralizing methane emissions to the atmosphere. Together with colleagues from environmental scientists, it was shown that mega-herbivores are vital for the resilience of tropical seagrass systems (in relation to eutrophication).

The environmental scientists developed several systems, which are used to assess substances and products, including scarcity (metals) and risk (pharmaceuticals). Models have been developed to describe diffusion and, for the first time, active transport of (polar) substances as function of their chemical properties. Physical stressors and extreme events, such as temperature and desiccation, were demonstrated to contribute most to regional extinction of species.

The plant geneticists are finalizing their analysis of the MADS-box gene subfamilies. Recent results indicate that these subfamilies have all maintained the same basic set of functions, but that they are not always conserved between the orthologs. The group identified additional layers of gene expression control. In the Meiosys project, they have found that chromosome structure may modulate meiotic recombination frequencies.

The Organismal animal physiology group is increasingly focusing on fish welfare-related topics. The idea of creating facilities for studying fish behaviours (zebrafish phenotyping) is being explored together with commercial companies. A PhD position subsidized by the University of Bergen in Norway will address the mechanisms of intestinal transport of lipophilic feed components.

IWWR’s plant molecular physicians generated the first genetic linkage map of the new model species Solanum dulcamara, using AFLP and SNP markers identified by next-generation sequencing of S. dulcamara transcriptome. These new tools will strengthen the collaborative research of the Plant Science group.

The Ecogenomics group found that drought-stressed plants are more resistant to insect herbivory than plants that are waterlogged in S. dulcamara. Using Proton Transfer Mass Spectrometry, novel insights were obtained into the different types of volatile organic compounds that are emitted as a result of root herbivory on Brassica species.

IWWR plant ecologists reviewed the latest insights into how responses of plants to nutrients and soil biota determine plant community productivity and plant species coexistence. With the riverine plant species Rumex palustris they showed how plasticity depends on conditions experienced previously and how this can explain apparently labile or inconsistent responses. A Biology Letters publication by the molecular ecologists showing how epigenetic modifications have a large impact on inbreeding depression received press attention worldwide.

The Organismal Animal Physiology group published on thyroid hormone transporters, deiodination kinetics and thyroid function in the larval and adult stages of aquaculture-relevant species, sea bass and sole. They also contributed to the development of a high-throughput assay for drug screening in relation to osteoporosis in transgenic zebrafish.

In ectotherms, metabolism increases with temperature and it has been argued that a shortage of oxygen sets thermal tolerance limits, rather than temperature effects per se. This oxygen limitation hypothesis provides one of the few mechanistic frameworks that can be used to understand and predict the vulnerability of species to global warming. The animal ecologists established for the first time that aquatic nymphs do heat harden and that such a hardening effect was elicited most strongly by hypoxia, not heat.
Societal impact
The mission of the IWWR is to carry out innovative research on the way biological systems adapt to stress. There is cross-fertilization of the knowledge and insights thus produced with industry and nature & water management. Discoveries are translated into innovative applications and challenges encountered in applications serve as a source of inspiration for IWWR research.

IWWR has structural collaborations with a large number of companies and partners in nature and water management. Its microbiologists showed that anammox bacteria can remove nitrogen compounds from wastewater at low temperatures, considerably extending the application of this process in municipal waste water treatment systems. Based on these and other findings, an ERC Proof of Concept grant was awarded to investigate this application further. The aquatic ecologists closely cooperate with the spin-off company B-Ware, which valorises state-of-the-art biogeochemical and ecological knowledge for nature and water management together with a number of governmental organizations. Two major innovation programmes were carried out, including the first successful large-scale application of iron in lakes for the abatement of eutrophication. Animal and plant population ecologists and researchers from SOVON (Natuurplaza) carried out a number of projects to improve the scientific basis for bird management and the Red List of endangered species (co-funded by Bird Life International and Faunafonds).

IWWR’s plant scientists have long-standing collaborative arrangements with seed companies. Knowledge about floral development developed by the plant geneticists at IWWR may – in the long term – contribute to the development of new crop varieties. The plant molecular physiologists cooperate with the companies Nunhems and Enza Seeds – within the context of an NWO ‘Meerwaarde’ project – on heat stress in plants as well as in a prestigious ‘top’ sector project ‘Hot Tomatoes’. The plant ecologists are involved in a European consortium on root research that was established to optimize crop production. The Ecogenomics group provided extensive information to the general public about their research on insect resistance in plants and the Solanaceae collection at Floriade 2012 in Venlo.

Fish welfare is central to research on aggression and on strategies for coping with stress. A Dutch television documentary addressed fish welfare in aquaculture and sport fishing early in 2012. Two day-long courses on fish welfare and ethics-related topics associated with the culture and capture of fish were organized, attracting considerable attention from the press.

Future research
The microbiologists will continue to investigate the role of anaerobic methane and ammonium oxidizing bacteria in marine and freshwater ecosystems, both in laboratory bioreactors and in natural oxygen-limited ecosystems. The fate of methane in various wetland and volcanic ecosystems will be assessed using stable isotopes as well as molecular and environmental genomic methods.

In 2013 the Ecogenomics group will analyze herbivore-induced responses in drought-stressed and waterlogged S. dulcamara, using a comprehensive RNAseq approach. The plant physiologists will continue to explore natural variation in Solanum dulcamara and use it to identify new traits that will allow plants to adapt better to their environment. The plasticity of genetic networks and plants’ responses to a range of environmental cues will be studied in collaboration with colleagues at IWWR, including plant ecologists. The plant genetics research group focuses on the involvement of microRNAs in floral organ definition and on the relationship between chromosome structure and recombination frequencies.
Key publications


Future research by the Organismal Animal Physiology group will focus on fish welfare, increasingly using zebrafish as a model species for which analysis facilities will be realized. A PhD position subsidized by the University of Bergen in Norway will address in-vivo and in-vitro analyses of feed toxicology.

Future Life Cycle Analysis research will focus on the global impact of products, in particular scaling aspects. Quality standards for pharmaceuticals will be subjected to an uncertainty analysis. Accumulation potential of nano-materials will be investigated and the number of climate related environmental factors determining native and invasive species success will be extended.

The Aquatic Ecology group will be strengthened in 2013 by a new tenure track position – in combination with the department of Microbiology – and five new PhD positions. Research will further focus on the effects of global change on the full range of wetland types, including peatlands, coastal marshes and lakes.

The animal ecologists will develop eco-evolutionary population models in order to study the relative importance of phenotypic plasticity and rapid evolution for stochastic population dynamics and resilience. System aquatic invertebrates and fish will be used as a model with contrasting responses to changing water temperature and oxygen concentrations. These studies will be carried out together with the Organismal Animal Physiology group. IWWR plant and animal ecologists are involved in comparative population modelling of birds and plants, based on data from Natuurplaza and other partners.

Awards
- Prof. Mike Jetten was awarded the Spinoza Prize for his discovery of new anaerobic ammonium and methane-oxidizing bacteria.
- Dr Boran Kartal was awarded a Veni grant by NWO-ALW.
- Dr Laura van Niftrik was awarded the NVH prize for most talented female scientist in the life sciences.
- Marjolein Bruijning received the 2012 Unilever Research Prize for her excellent Masters Research internships.
- Rosalie van Zelm was awarded the Best Thesis 2010-2011 Dutch Society of Chemistry and Toxicology.
- Laura Verbrugge received a Frye stipendium from the University.
The Institute for Molecules and Materials (IMM) conducts research and trains undergraduate and graduate students in functional molecular structures and materials. There is an emphasis on understanding and controlling complexity in order to design new functionality based on these structures and materials.

In physics, chemistry and chemical biology attempts to understand complexity in systems are driven by the wish to manipulate their functionality. In recent decades scientists have approached the problem of complexity from two directions. On the one hand, through the study of the smallest building blocks and using them incrementally to build larger and larger systems. In this way the structure and functions of atomic nuclei, atoms and molecules have been investigated and analysed. Combined experimental and theoretical work has extended our knowledge of the behaviour of these systems.

On the other hand, there are ongoing efforts to study macroscopic systems with well-known properties and to analyse the constituents of large systems that have already been investigated extensively. Examples include many-body problems in physics and in the life sciences that are tackled in experiments that will improve our understanding of systems on both a cellular and a sub-cellular scale.
The major challenge for the IMM is to understand complexity and functionality in the areas where these directions intersect, i.e., in the fields of Nanoscience and Chemical Biology. This interdisciplinary field – at the interface between chemistry and physics – is advanced by 19 research groups organized along three main research methodologies: 1) Synthesis and growth, 2) Spectroscopy and characterization, and 3) Theory and simulation. The main objectives of the institute are expressed in three fundamental research questions:

• What are the fundamental properties of electron-correlated systems? To understand intriguing phenomena in electron-correlated materials such as ultrafast magnetization dynamics, work on the electronic properties of oxidic and graphene materials and the fractional quantum Hall effect is currently at the forefront of condensed matter research.

• How does the process of self-organization of complex systems work? An advanced understanding of self-organization in complex molecules and nano-sized materials bridges the domain of relatively well-understood atoms and small molecules and more complex macromolecular and supramolecular structures.

• What are the fundamental properties of biomolecular systems, especially those that play an important role in problems arising in biology? The answers to many unsolved problems in cellular and sub-cellular systems lie in the behaviour and interplay of individual biomolecules and biomacromolecules. Research focuses on unravelling the fundamental properties of biomolecules in complex environments.

The national – and international – position of the IMM is underpinned by the availability of a number of large-scale experimental research facilities, including:

• A High Field Magnet Laboratory (HFML) for continuous fields up to 33 Tesla, and with funding to achieve 38 Tesla in 2013 and 45 Tesla in 2016.

• A Large-Scale Facility for high-resolution liquid NMR (Nuclear Magnetic Resonance) and a Solid-State NMR Facility for advanced material science, including an 850 MHz proton NMR instrument.

• A Scanning Probe laboratory (NanoLab) with a broad range of Scanning Tunnelling Microscopy (STM) and Atomic Force Microscopy (AFM) techniques.

• A Trace Gas Facility for the application of laser diagnostics in biology and medicine.

• A Free Electron Lasers for Infrared Experiments (FELIX) facility. The terahertz laser (FLARE) produced its first light in 2011 and the infrared lasers (FELIX/FELICE) was moved from FOM Institute Rijnhuizen to Nijmegen in 2012. The whole facility will become operational in 2013.

Other specialized facilities include:

• A Solar Cell Research Facility with dedicated growth, processing and analysis equipment for solar cell research, including clean rooms and an Outdoor Calibration Facility.

• A Thin Film Growth Laboratory, in which materials and thin films can be grown with atomic precision.

• A computational facility for electron structure calculations of materials, which is used to help design new materials and structures based on first principle quantum mechanical calculations.

In November 2012 collaboration between FLARE and HFML reached a new milestone. For the first time, far-infrared photons from FLARE were guided into a 33 Tesla magnet and, as a result, transmission spectra could be recorded. The power entering the magnet during the 10 µs pulses exceeded 100 watts, four orders of magnitude more than what was previously possible. This paves the way for many exciting experiments that can only be performed at the IMM.
**Collaboration**

National and international partnerships are crucial for realizing the ambitions of the IMM, e.g. for scientific interaction with high-profile research groups, forming of consortia for EU applications, strengthening the international reputation of the IMM, exploiting the institute’s large-scale research facilities and signalling job opportunities for PhD students and postdocs.

The organic chemistry groups of the IMM have a longstanding partnership with the Institute for Complex Molecular Systems (ICMS) at the Technical University Eindhoven. In 2011 the two institutes formed a Centre of Excellence for Organic Chemistry. This year scientists from the IMM and ICMS were the main players in a successful NWO ‘Gravitation’ grant application.

The IMM also collaborates intensively with the University of Leuven in Belgium on single molecule spectroscopy. This partnership involves the exchange of PhD students and postdocs as well as the use of the special equipment at the two locations. Several of the organic chemistry groups at IMM collaborate with the University of Barcelona. Within the field of graphene research, the groups at the IMM led by Prof. Katsnelson and Maan collaborate closely with Profs. Geim and Novoselov of the University of Manchester. Prof. Katsnelson also works closely together with scientists at the universities of Uppsala, Hamburg, and Moscow.

The IMM is partner in two formal collaborations with the Foundation for Fundamental Research on Matter (FOM): one involving the relocation to and the 10-year exploitation of the free electron lasers ‘FELIX and FELICE’ in Nijmegen, and the other the joint operation of the HFML and the promotion of materials research in high magnetic fields. In both cases both the partnerships are jointly financed by IMM and FOM. Moreover, in 2012 the Engineering and Physical Sciences Research Council (EPSRC, UK) decided to transfer its research contract on solid-state physics with free electron lasers – the basis for the successful UK user group at FELIX – from FOM Rijnhuizen to Nijmegen.

The EU-FP7 project on the European Magnet Field Laboratory (EMFL) was established to investigate all of the legal, financial, organisational and employment issues required for a Founding Agreement for the EMFL. This agreement will be signed by the three partners (Radboud University Nijmegen, Helmholtz Zentrum Dresden-Rossendorf (HZDR), and le Centre National de la Recherche Scientifique (CNRS) in Grenoble/Toulouse), plus any other stakeholders that may get involved. This project is coordinated by the HFML.

On 26 September the University, FOM and the Helmholtz-Zentrum Dresden-Rossendorf (HZDR) signed a Cooperation Agreement designed to strengthen scientific and technological collaboration in two areas: high magnetic fields and free electron lasers. As the HFML focuses on continuous fields and the Hochfeld Labor of HZDR on pulsed fields, these two laboratories complement each other very well. The same is the case for the free electron laser facilities (ELBE in Dresden and FELIX in Nijmegen).

In August 2012 a delegation from the chemistry department of the Sungkyunkwan University (SKKU, South-Korea) visited the IMM. A two-day symposium on Advanced Nanomaterials took place and a cooperation agreement between the two institutes was signed.

**Research results**

Research highlights are listed below under the three main themes of the institute.

**Electron-correlated systems**

Prof. Kirilyuk and colleagues have investigated the electronic structure of atomic gas-phase clusters using the Free Electron Laser for Intra-Cavity Experiments (FELICE). The novel technique they used provides a way to simultaneously obtain information on both the electronic and the geometric structure of the clusters.

In the group led by Prof. de Groot calculations were performed on the role of surface magnetism in catalysis of water electrolysis. Surface magnetism has important consequences for the catalysis and the efficiency of the electrolysis.

Dr. Engelkamp from the HFML and a group of international scientists have used phosphorous doped silicon as a laboratory analogue for hydrogen on high magnetic field white dwarf stars. This analogue provides an excellent opportunity for studying effects of atomic physics that were only available for study in extreme astrophysical phenomena. (Nature Comm.)

Prof. Rasing and his colleagues have developed a general theory for ultrafast laser-induced dynamics in multisublattice magnets. When these are brought far from equilibrium, highly counterintuitive effects become possible, e.g. a 1000 times faster reversal of magnetization driven by the exchange interaction. (Phys. Rev. Lett.)

The group led by Prof. Katsnelson has calculated the Coulomb interactions between Dirac electrons in two parallel graphene sheets that are separated by a 1 nm thick and atomically flat insulator. This detailed comparison with experiment makes it possible to extract the transport scattering time related to impurities in graphene – an important characteristic for many applications. (Nature Phys.)
Self-organizing systems
In the Applied Materials Science group the arsenic formation on GaAs wafers during etching in HF solutions was studied. The wafers are used for growing thin-film solar cells using the Epitaxial Lift Off technique (ELO). The characterization of the contamination on the wafers after ELO helps to develop a cleaning procedure.

Prof. Parker and his group have observed quantum-state-specified product angular distributions for OH collisions with helium and argon using velocity-map imaging in a crossed-beam arrangement. The measured angle-speed distributions compare favorably with theoretical predictions, hence opening possibilities to understand OH collisions for a much wider range of chemical processes. (Nature Chem.)

Dr Kouwer and Prof. Rowan have developed synthetic gels that mimic – in nearly all aspects – gels prepared from intermediate filaments, which govern the mechanical properties of biological systems. These gels are prepared from polyisocyanopeptides grafted with oligo(ethylene glycol) side chains. The helical polyisocyanide polymer plays a crucial role in providing an intrinsically stiff backbone and controlling the bundling process. (Nature)

The Scanning Probe Microscopy group has investigated the strong self-assembly of bimetallic salen complexes at the single molecule level. An ‘edge-on’ orientation of the salen complexes in highly defined stacks, in which the aromatic planes of the molecules are arranged in an off-set geometry with respect to each other, was revealed. (J. Am. Chem. Soc.)

Prof. Vlieg and colleagues have investigated using anticaking agents (salt additives preventing agglomeration) to block crystal growth at the nanoscopic and molecular level. The aim of this work is to develop metal-free anticaking agents for NaCl.

The solid-state NMR group – along with their collaborators – have studied fast chemical reactions using novel ‘microfluidic stripline’ NMR. The required volume for NMR experiments is reduced by three orders of magnitude. Based on these experiments a reaction mechanism for the acetylation of benzyl alcohol is proposed.

Dr van de Meerakker, Prof. Groenenboom and colleagues have studied theoretically and experimentally the collision of two molecular radicals, the hydroxyl radical (OH) and nitric oxide (NO). It is possible to control the motion of these radicals with electric fields in a Stark decelerator in order to prepare them in a single quantum state and thus determine absolute collision cross sections. The coupled electronic and nuclear quantum dynamics of the OH+NO collision were accurately calculated and there was surprisingly good agreement with the results of the experiment. (Science)

Biomolecular systems
Prof. Buydens and her group have proposed a new method for identifying complex diseases in individuals. Statistical health control provides a new tool for diagnostic support that is both more objective and flexible, i.e. more useful in a clinical setting compared to current practice.
Key publications


Dr Wilson, Prof. Nolte and Prof. van Hest performed a supramolecular assembly of catalytic nanomotors. The supramolecular nanomotors were fuelled and their propulsive movement was demonstrated using tracking analysis techniques. These nanomotors can provide a simple and versatile solution for next-generation nano-engined delivery systems. (Nature Chem.)

Prof. Pruijn has demonstrated that Inclusion Body Myositis (IBM) is associated with disease-specific autoimmunity and his group has also identified the first molecular marker for this type of myositis. Identifying the target protein of these autoantibodies makes it possible to develop highly specific blood tests. (Patent)

Dr Rijs (Molecular and Biophysics group) performed a far-IR/UV experiment to collect precise details on the interactions in a microhydrated peptide chain. The characteristic low-frequency modes of the water motions are covered by the free electron laser FELIX.

Prof. Nolte and colleagues have based a bio-hybrid artificial enzyme on the T4 clamp protein and conjugated a cationic manganese porphyrin catalyst to it. This experiment shows that using concepts from nature, the performance of catalytic reactions can be influenced and guided.

The group led by Prof. Huck has demonstrated the formation of well-defined crowded coacervate compartments composed of cell lysate using microfluidic technology. Coacervation creates an artificial cell-like environment in which the rate of mRNA production is significantly increased.

Prof. Rutjes and his group have synthesized new fluorogenic peptide-based substrates, which are used to monitor the activity of the Thrombin enzyme in clotting blood or plasma. The well-defined thrombin generation curves obtained on these new substrates make them highly appropriate compounds for replacing the substrates currently in use.

Awards and grants
Under the leadership of Prof. van Hest, the organic chemistry cluster of the IMM has acquired a highly prestigious NWO ‘Gravitation’ grant worth €26.9 million, involving the alliance of three figureheads in organic chemistry in the Netherlands: Profs. Meijer (TU/e en RU), Nolte (RU), and Feringa (RUG). One of the main aims of this Functional Molecular Systems research programme is to develop self-healing materials.

IMM had two important successes in the call for the National Roadmap of large-scale research facilities by NWO. The HFML – under the direction of Prof. Maan – maintained its position...
on this roadmap and was awarded a grant worth €11 million for further investments in the laboratory and for increasing its scientific exploitation by internal and external users. The uNMR-NL programme – a consortium led by University of Utrecht established to locate a 1.2 GHz NMR spectrometer in the Netherlands (for chemical research) – received €18.5 million from this call. The group led by Prof. Kentgens is one of the partners.

Dr Wilson (Bio-Organic Chemistry group) received an ERC Starting Grant for her work on the construction of biocompatible nanomotors using supramolecular assembly of amphiphilic block-copolymers for the design of the engine and catalysis as the driving force for autonomous movement. Prof. Kirilyuk and Dr Bakker received a FOM ‘Projectruimte’ subsidy for the study of electron-phonon coupling in atomic clusters with short terahertz pulses from FELIX and femtosecond UV pulses. Dr van der Meerakker from the Molecular and Laser Physics group has also acquired a FOM Projectruimte subsidy for his work on scattering resonances in both the integral and differential cross sections in cold molecular collisions. A VENI grant has been awarded to Dr Wiedmann (HFML) for unveiling the topological quantum state in high magnetic fields.

In November 2012 Prof. Buydens (Analytical Chemistry) received the EAS award for outstanding achievements in Chemometrics at the Eastern Analytical Symposium (EAS) in New Jersey (USA).

Societal impact
The valorisation of knowledge through university research and the societal impact of science are becoming increasingly important as indicators of scientific success. The IMM actively encourages scientists to cross this bridge. There are cooperative arrangements with major companies in the Netherlands, including DSM, Philips, NXP, Solvay, Unilever and AkzoNobel. In addition, the large-scale relations with medium-sized technology-oriented enterprises in the Nijmegen area.

During the past years the IMM has produced many spin-off companies, such as Chiralix, Encapson, FutureChemistry, Mercachem, ModiQuest, Noviotech, ReRa Systems, SensorSense, Sphere Fluidics, Spinovation, SynAffix, Syntarga, Synthon, TeraOptronics, and tf2 devices. This year Prof. Rasing acquired a STW Valorisation Grant for the potential application of Magneto-Optical Switching to data storage at the speed of light.

In November 2012 Prof. Vlieg and Dr Schermer signed the first innovation contract within the Dutch ‘topsectorenbeleid’ (Top sector Energy) for further development and exploitation of high-efficiency solar cells. As part of a large ‘Innovation 2 Industrialisation’ project, they also received a grant to develop novel solar cell structures that are suitable for the process of epitaxial lift-off. In collaboration with a number of industrial partners – including the spin-off company ‘tf2 devices’ – the aim is to demonstrate a machine that automatically and reliably performs epitaxial lift-off. This project is subsidized by the European Fund for Regional Development (EFRD).

In 2012 the German company EUROIMMUN decided to integrate a discovery from Prof. Pruijn (IMM) and his colleagues from RUNMC in a simple blood test for diagnosing the chronic muscle disease Inclusion Body Myositis (IBM). IBM is an incapacitating disease that can now only be diagnosed with a muscle biopsy. A treatment for the disease is not yet available.

Future research
A continuing challenge is provided by the €25 million grant from the national investment in large infrastructures (NWO-BIG) in 2006 for the Nijmegen Centre for Advanced Spectroscopy (NCAS). This grant enabled IMM to construct a new 45-Tesla hybrid magnet for the HFML and a Free Electron Laser for research using Terahertz radiation (FLARE). FLARE will create unique opportunities for studying magnetic excitations in inorganic and organic molecules as well as low energy spectroscopy (far-infrared) on molecular clusters and large molecules and biomolecules. The new hybrid magnet will provide new research opportunities based on the latest magnet technology.

The national Sector Plan for Physics and Chemistry (SNS) was approved in 2010 with a very positive outcome for Radboud University Nijmegen. As a result, two new initiatives in Chemical Biology and Advanced Spectroscopy of functional molecules and materials were undertaken within IMM. The focus on chemical biology puts chemistry back at the forefront of research at the interface between chemistry and biology. The focus in IMM physics is on strengthening research capacities using the HFML and the free electron lasers for the study of low-dimensional systems and strongly correlated systems. Now that most new scientific staff members have started, these new initiatives will undoubtedly produce their first scientific results in the near future.

In 2013 the move of the free electron lasers FELIX and FELICE – and associated staff – to Nijmegen will be completed. First light from these lasers in Nijmegen is expected halfway through 2013 followed by the first user experiments in autumn. The combination of these free electron lasers with FLARE creates exciting opportunities for physics, chemistry and the life sciences.
Director: Prof. Elias Vlieg

Elias Vlieg has been professor of Solid State Chemistry at Radboud University Nijmegen since 1998. After a post-doc appointment at AT&T Bell Laboratories, he was a group leader at the FOM Institute AMOLF from 1990-1997. With a background in physics, his profile illustrates the combined chemistry and physics approach of the IMM. His research focuses on understanding crystal growth and, as head of the Applied Materials Science group, on the use of thin film deposition for solar cells and electronic devices. He is vice-president of the International Organization for Crystal Growth.

The steady increase in the operational hours of the HFML will continue, reaching 2,000 hours per year in 2014. This increase is enabled by a partnership between the University and FOM and by a €11 million National Roadmap grant. Another on-going challenge is the search for (structural) funding for operating the HFML at the ultimate level of 3,000 hours per year.

The successful implementation and exploitation of the granted ‘Gravitation’ research centre for Functional Molecular Materials – in collaboration with partners in Eindhoven and Groningen – is of the utmost importance for the IMM.
The Institute for Mathematics, Astrophysics and Particle Physics (IMAPP) conducts fundamental research in mathematics, high-energy physics and high-energy astrophysics, with a special focus on interdisciplinary topics. The overarching research theme is the origin and evolution of the universe and its underlying mathematical structures. The Institute is also actively engaged in outreach.

Mathematics
This department focuses on three interdisciplinary themes, which have are closely related to computer science and physics: Mathematical Physics, Algebra & Logic, and Applied Stochastics. The traditional areas – algebra, logic, analysis, geometry and stochastics – are studied in the context of these themes.

Astrophysics
Researchers in this department focus on observational and theoretical research in three areas of astronomy: astroparticle physics, compact objects and the structure and stellar populations in galaxies. Their main goals are to unravel the sources of the highest-energy particles in the universe, to understand the physics and populations of compact objects including gravitational waves, and to explain the evolution and structure of galaxies and their stellar populations.
High-energy physics
This group carries out and analyzes experiments in the field of elementary particle physics at the smallest distances and highest mass scales attainable. This work includes both accelerator-based and cosmic ray experiments and the theoretical foundations of elementary particle interactions, including gravity. There is a particular focus on electro-weak symmetry breaking and the Higgs boson as part of an attempt to gain more insight into the structure of the vacuum.

Research facilities
Experimental groups make use of leading national and international astronomical and astroparticle observatories (ESO, La Palma, LOFAR, Virgo, HST, Kascade-Grande and Pierre Auger) and high-energy particle accelerators (Large Hadron Collider [LHC] and Tevatron). The LHC is producing exciting new results including the discovery of the Higgs boson. The Institute itself houses two optical telescopes and a radio interferometer, which are used for educational activities and to encourage public participation. It also makes use of the faculty's mechanical and electronics' workshops and the facilities of the Amsterdam-based National Institute for Nuclear and High-Energy Physics (Nikhef).

Collaboration
The research facilities and collaborations at IMAPP are of an international nature. Moreover, the institute has many international staff members.

Mathematicians based in Nijmegen are involved in the NWO mathematics clusters DIAMANT (Discrete, Interactive & Algorithmic Mathematics, and Algebra & Number Theory), GQT (Geometry and Quantum Theory) and STAR (Stochastics - Theoretical and Applied Research). Mathematical physicists at the IMAPP make a major contribution to GQT.

The elementary particle physics group – a partner in the Nikhef – is associated with the European Laboratory for Particle Physics (CERN) in Geneva, Switzerland and the Fermi National Accelerator Laboratory (FNAL) in Chicago, USA. Astronomical research is carried out within the framework of the Dutch ‘top’ research school NOVA and in association with ASTRON, SRON and ESA. The Nijmegen group co-leads the EGAPS survey, is the expertise centre for cosmic ray detection with LOFAR, and is a member of the Virgo consortium. IMAPP particle physicists and astronomers are joint members of the Pierre Auger Observatory Collaboration in Argentina, and of Nikhef.

All researchers at the Institute are members of one of the following Dutch national research schools: Wonder, which is a merger of the former research schools in mathematics MRI, Thomas Stieltjes and EIDMA, OSAF (elementary particles), LOTN (theoretical physics) and NOVA (astronomy) – all of which are accredited by the Royal Netherlands Academy of Arts and Sciences (KNAW).

Awards and acknowledgements
• Prof. Moerdijk won the NWO Spinoza prize
• Prof. Moerdijk won the Descartes-Huygens prize
• Prof. Aerts won the Francqui Prize
• Dr Körding received a Vidi grant from the NWO
• Dr Haverkorn was elected to the Young Academy (DJA) of KNAW
• Dr Coumans received the Faculty of Science Education Award 2012
• PhD-student Rutger Kuyper received the Turing Centenary research scholarship.

Research results
In December 2012 IMAPP’s Scientific Advisory Committee (SAC) – consisting of Profs. Wim de Boer (KIT, Karlsruhe), Richard Gill (UL), Michiel van der Klis (UvA), Tom Koornwinder (UvA) – made a site visit. Their preliminary oral SAC report was very positive about recent developments in IMAPP.

In 2006 the cluster Geometry and Quantum Theory was established as a collaborative venture for mathematicians from Amsterdam, Utrecht and Nijmegen, with a leading role for the latter. The GQT cluster was rated as excellent (5) by an international committee in
In the study of the Generalized Vanishing Conjecture, and of the exploiting dendroidal sets. In logic, Prof. Moerdijk made progress and deepened the research in the department. The department incoming members from Utrecht University, which both broadened

In 2012 the Department of Astrophysics was strengthened by but for n=5 has an infinite number of extreme points. in a subset of state space which forms a polytope for n=3 and n=4, metric quantum states on n particles are separable (not entangled) In quantum information theory, it was found that completely sym-

functions and prediction of future payments on insurance portfolios. In the Applied Stochastics group, Prof. Eric Cator was appointed as the new head in September 2012. His research covers a broad
type theory and set theory. Dr van den Essen made advances in the construction of topological models for predicative systems of type theory and in the foundations of quantum theory relates to both Applied Stochastics and High-Energy Physics. In 2012 there were three outstanding PhD theses: by Pieter Naaijkens, Martijn Caspers, and Maarten van Prijssen.

The research within the Department of Algebra & Logic received an important stimulus with the Spinoza Prize 2012 awarded to Prof. Moerdijk. Prof. Moerdijk and his colleagues have been successful in the study of the homotopy theory of operads by exploiting dendroidal sets. In logic, Prof. Moerdijk made progress in the construction of topological models for predicative systems of type theory and set theory. Dr van den Essen made advances in the study of the Generalized Vanishing Conjecture, and of the related Image Conjecture, through the study of Mathieu subspaces of rings. Dr Bosma found complex algebraic numbers of every even degree over the rationals that have bounded partial quotients in their continued fraction expansion; this is surprising, since that phenomenon was perviously thought not to exist for real numbers. Dr Terwijn characterized finite intervals of the Muchnik lattice, a structure from computability theory that is relevant for computation on the reals, among other things. The result was subsequently used to produce a factor of the lattice that captures intuitionistic logic.

In the Applied Stochastics group, Prof. Eric Cator was appointed as the new head in September 2012. His research covers a broad spectrum of subjects within stochastics, including interacting particle systems, last passage percolation, randomly forced Burgers equation, epidemics on networks, estimation of shape constraint functions and prediction of future payments on insurance portfolios. In quantum information theory, it was found that completely symmetric quantum states on n particles are separable (not entangled) in a subset of state space which forms a polytope for n=3 and n=4, but for n=5 has an infinite number of extreme points.

In 2012 the Department of Astrophysics was strengthened by incoming members from Utrecht University, which both broadened and deepened the research in the department. The department became the first astronomy institute to participate in the Virgo gravitational wave detector. Prof. Falcke was one of the first European astronomers to receive time on the new ALMA submm interferometer in Chile to study the supermassive black hole in the centre of our Milky Way Galaxy. LOFAR started regular operations, and, together with the Nijmegen-built LORA particle detector array (Hörandel), is continually detecting high-energy cosmic rays. Dr Haverkorn collaborated on a Nature paper that revealed a radio outflow from our Milky Way Galaxy driven by young stars. Prof. Groot published the first of many journal articles on the collaboration with Caltech, in particular on the AM CVn-type binaries discovered in the Palomar Transient Factory. In 2012 the southern part of the European Galactic Plane Surveys also started on the ESO VST telescope.

For the ATLAS group 2012 was truly an annus mirabilis. On 4 July the ATLAS and LHC experiments presented the discovery of a new particle with properties that are compatible with the Higgs boson. One month later we published the discovery paper, which has collected over five hundred citations in five months. The discovery is based on three different decay modes of the Higgs boson. In one, the so-called WW channel, IMAPP researchers played a leading role and in another, the ZZ channel they have made important contributions. The national effort on Higgs search was led by Dr Frank Filthaut. In October he also took up the position of coordinator of the ATLAS heavy flavour group. Marcel Raas defended his thesis on W production at the LHC. The search for new phenomena has greatly benefited from the arrival of Dr Sascha Caron in November 2011. The higher energy of the LHC in 2012 made it possible to cover a larger part of the parameter space for supersymmetric models and produce more stringent limits on new physics processes. Folkert Koetsveld’s PhD thesis was the first on supersymmetry using real collision data from the LHC. Together with the theoretical high-energy physics group a paper was produced on the consequences of the measured mass of the Higgs boson on possible models of supersymmetry. ATLAS published 116 articles in 2012 and submitted another 49 for publication. In January IMAPP hosted an ATLAS Heavy Flavour workshop with around 50 participants.

The IMAPP group concluded its activity in the DØ experiment at the Tevatron accelerator in 2012 with the completion of Melvin Meijer’s PhD in June. As in the ATLAS experiment, the focus was on the search for the Higgs particle, in particular in the event where the Higgs boson decays into two b quarks or two tau leptons. An improved analysis, together with the CDF experiment at the same accelerator, provides the strongest evidence to date of the existence of these decay modes. Within the Auger experiment Harm Schoorlemmer completed his thesis on the measurement of a radial polarization of the radio signal of air showers. This provides the first quantitative measurement related to the amount of negative charge excess at the front of air showers. IMAPP and Nikhef have also been very active in designing and producing electronics for the upgrade of the current radio array to a detector.
with an effective surface of 20 km². IMAPP also contributes to research on shower development using surface detector information. Measurements of the radius of the curvature of the shower front have improved considerably thanks to the work done in IMAPP.

The activities of the theoretical high-energy physics group mainly focused on particle phenomenology and quantum gravity. Investigation of the decomposability of two-loop Feynman integrals was successfully completed by establishing upper bounds on the complexity of decomposing multinomials. This opens up the possibility of algorithmic and automatic computations of two-loop corrections to particle scattering processes. The programme for stabilising the supersymmetric (SUSY) cross-section predictions by higher-order effects was successfully completed, in particular in Irene Niessen’s cum laude thesis. A new investigation into the high-energy behaviour of SUSY models was started, in which renormalization-group constant combinations of observables will provide insight into regimes currently out of collider reach, so as to test specific models and hypotheses of SUSY breaking. Top quark polarization as an indicator of new physics was also studied. The non-commutative SUSY Standard Model was investigated, leading to the inclusion of right-handed neutrinos; a larger theory than the minimal SUSY extension appears to be necessary. A new professor (Prof. Loll) and her group have opened up a new area of research for the IMAPP, that of quantum gravity using the Causal Dynamical Triangulation (CDT) technique, a working model for quantum space time and gravity. This type of research is unique in the Netherlands. Prof. Loll’s research group had an excellent start with the CDT & Friends conference in December 2012.

**Societal impact**

IMAPP is involved in scientific research at the forefront of science and training the researchers in academia, government and industry for tomorrow. For society it is essential to have well-trained researchers. IMAPP’s research is related to fundamental questions about the universe and the building blocks of nature. Many results will only produce their full impact in future decades, but they could then have far-reaching consequences, even changing the way we view the world. IMAPP plays an important role in national discussions on science and mathematics in secondary education, e.g. supporting the development of the new subjects Advanced Mathematics and Nature, Life and Technology, as well as having influence at the highest political level in matters concerning mathematics and physics syllabuses in secondary education. This is also reflected by the fact that Prof. Sijbrand de Jong is the first director of the Radboud Pre-University College of Science. Four members of staff teach in the prestigious honours programme at the University. The Nijmegen Annual Mathematics Tournament and the national Kangoeroe mathematics competition, both organized by IMAPP, have significantly improved the popularity and visibility of mathematics among school children.

Moreover, the Applied Stochastics group has launched a Statistical Helpdesk to advise researchers on difficult statistical or random modeling problems, including data analysis.

The Institute initiated the HiSPARC project, which involves placing air-shower array telescopes on high-school roofs (www.hisparc.nl). The Department of Astrophysics organizes monthly observation nights, and the NOVA mobile planetarium came to Nijmegen twice this year.

**Future research**

The astronomy department has submitted proposals for instrumentation both in South Africa and Chile for a coupling between optical and radio data to be obtained with the MeerKAT radio array, precursor to the Square Kilometer Array, as well as to detect the optical counterparts to gravitational wave sources with Virgo and LIGO. Also, the Event Horizon Telescope initiative to couple Pacific
Key publications


Dissertations: 13
Academic publications: 351
Director: Prof. Erik Koelink

Erik Koelink, who graduated from Leiden University and has worked at the National Aerospace Laboratory in Amsterdam, Katholieke Universiteit Leuven, University of Amsterdam, and Delft University of Technology, became Professor of Analysis at Radboud University Nijmegen in 2007. His research focuses on the interaction between the representation theory of Lie algebras and quantum groups on the one hand and special functions on the other, with applications in mathematical physics. He is a member of the NWO cluster Geometry and Quantum Theory.

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rim submm-interferometers to image the supermassive black hole in the centre of the Milky Way Galaxy got a big boost. The department is continuing to strengthen its profile in ultra-high energy cosmic rays as well as gravitational wave astrophysics, including understanding the progenitor populations to gravitational wave events (binary neutron stars, black holes and their precursors).

With the discovery of the Higgs boson a new era in particle physics has started. We will measure the quantum numbers of the new boson and focus on the measurement of the coupling strength to other Standard Model particles. These measurements provide a powerful probe for new physics. In 2013 the final appointment of a tenure track assistant professor in the framework of first tranche the Sector Plan Physics and Chemistry (SNS) is expected.

The mathematical physics department will concentrate on methods originating in the mathematical foundations and analysis of quantum theory, applying these in quantum information theory, non-commutative geometry and in pure mathematics. Research on the Higgs Mechanism will be intensified. The successful research line that combines algebra and logic, with extensions to both mathematical physics and computer science, will be continued.

Research in Algebra and Logic will receive a boost from Moerdijk’s Spinoza prize and from the appointment of the new Chair in Algebra in 2013. In the near future the Applied Stochastics group will focus on cooperation within IMAPP and within the faculty. In 2013 the Applied Stochastics group will be expanded.
Institute for Computing and Information Sciences

The Institute for Computing and Information Sciences (iCIS) was established to improve the fundamentals of software development via formal, mathematically founded theories, methods and tools that support the specification, design, analysis and evaluation of computer-based systems. Research aims include improving the quality of software, with an emphasis on enhancing reliability, security, architectures and system alignment.

Computer systems influence virtually every aspect of our lives. Sometimes these systems appear in an easily recognizable form, as in eCommerce sites such as Amazon and in pocket calculators, but they are also increasingly hidden inside public transport cards (such as the OV chip card), TV sets, multimedia devices, mobile phones, cars and washing machines, for example. However, while computing is becoming increasingly pervasive, there are growing problems with software in terms of security (breaches of information access restrictions or privacy), reliability (the system behaves erratically), safety (use of the system is harmful), trustworthiness (low reliability of system services), efficiency (the system is unable to handle problems of a particular size) and conformity with requirements. The inherent complexity of computer-based artefacts – together with the slow pace of software development, high costs and strong competitive pressures – further complicates the search for solutions. Research at the Institute is inspired by problems encountered in society as well as in other academic disciplines.
The quality of the research remains very high, and in 2012 this resulted in a large number of NWO grants, including a Veni for Dr Helle Hvid Hansen, a Distinguished Lorentz Fellowship for Prof. Henk Barendregt (NIAS) and an ERC Advanced Grant for Prof. Bart Jacobs.

Research themes

Model Based System Development (MBSD)
The approach used is to explore various formal methods for model construction, implementation, testing and validation, with the explicit aim of bridging the gap between theory and practice through collaboration with stakeholders other application areas and companies.

Digital Security (DS)
Researchers develop theories and formal methods, which they use to analyze and improve the security of the digital world. This involves investigating the security and correctness of software and other systems on the one hand, and identity-centric security and privacy on the other, i.e. developing notions and protocols for managing and protecting digital identity.

Intelligent Systems (IS)
The aim here is to develop and apply intelligent systems that are able to ‘learn’ knowledge and reason with it, with as a long-term research goal the alignment between computer-based intelligent systems and their users, answering questions such as how to optimally combine knowledge from human experts with measurement data, how to enable users to guide computerized proof assistants and how to let people profit optimally from a large repository of structured knowledge.

Collaboration
International cooperation is crucial to much of the work done at iCIS, because developments in computing take place around the globe. Partners include the Dutch Ministry of Internal Affairs for a project on business process reengineering (BPR), ST Microelectronics, Brussels, Belgium (PINPAS), Joseph Fourier University, Grenoble, France (Tarot), RWTHA, Aachen, Germany (Mobius), Makerere University Kampala, Uganda (NUFFIC), INRIA Microsoft Research Lab Paris, France (Mobius, EU FET), the Netherlands Organisation for Applied Natural Science Research (TNO), Delft, the Netherlands (PEARL), Aalborg University, Denmark (Artistz) and Océ Technologies, Venlo, the Netherlands (Octopus), the Dutch Foundation for Internet Domain Registration (SIDN), the Dutch Banking Association (NVB, Amsterdam), the Netherlands Defence Academy (NLDA, Breda) and TILT (University of Tilburg).

Research results
The E-MaLeS system, which was developed by researchers from Intelligent Systems, won several prizes at international competitions for theorem proving. E-MaLeS is an automated theorem prover, which, among other things, makes use of machine learning techniques to rank the most promising proof strategies.

Prof. Herman Geuvers’ team worked on various methods and tools relating to proof assistants. To improve communication of formal proofs to third parties, the team invented MathWiki technology, which combines a high-level mathematical document with formal proofs obtained using a proof assistant. New methods have been developed for verifying C-like programs in the proof assistant Coq. This is an important step forward, since C is ubiquitous, but programs written in C are notably hard to verify. On the more theoretical side, the team worked on powerful co-algebraic methods for proving the properties of computing systems.
The group led by Prof. Tom Heskes designed novel algorithms for causal discovery based on observational data. In causal discovery, the goal is to learn the structure of causal processes (e.g. “smoking causes cancer”) from observations (“correlation between smoking and cancer”). The method used builds on earlier work on a logical-based approach to causal discovery. It provides a first step towards computing the probability of a causal relationship. The corresponding paper won the Best Paper Award at Uncertainty in Artificial Intelligence (UAI), the main conference in the field and one of the highest rated conferences in computer sciences. The group received a new grant from the NWO to continue this research.

In collaboration with the group led by Dr Marcel van Gerven (Donders Centre for Cognition), Heskes’ team developed a novel paradigm for brain connectionism – the inference of structural brain networks from neuroimaging data. This approach, which is based on Bayesian graphical models, can naturally integrate data from multiple subjects. It significantly outperforms state-of-the-art alternative methods.

Dr Elena Marchiori’s team designed and analysed novel methods for the study of complex systems, which are described by means of networks. The focus was on a central problem in network analysis, namely how best to identify interesting community structures, a problem also known as network community detection or graph clustering. In particular, researchers performed protein complex detection in a protein-protein interaction network using a simple optimization method based on local search. Results showed that the proposed method delivers excellent accuracy and robustness performance when applies to a large collection of datasets. The corresponding paper won the Best Paper Award at the international conference Pattern Recognition in Bioinformatics (PRIB).

Experiments designed to capture the Search and Rescue activities of the Dutch Coast Guard have led to valuable new insights on how to model complicated collaboration at work. The semantics of the iTask system, which was developed by the team around Prof. Rinus Plasmeijer, have been redesigned and formally specified, and used as the basis for a new system. The big difference is that now tasks can be modelled which can inspect each other’s progress ‘on the fly’. iTask enables researchers to express arbitrary complex working collaborations in a new style of functional programming. This research has been taken up by the research and development collaborations in a new style of functional programming. This work on probabilistic graphical models in the same group led to the new notion of multi-level Bayesian networks; it supports modelling data in a way similar to the commonly used multi-level regression equations, while providing greater modelling power. Multi-level Bayesian networks appear to be very suitable for capturing interactions between diseases in large healthcare datasets. With the help of the Netherlands Institute for Health Services Research (NIVEL), the group developed a new statistical model of temporal progression of multiple diseases using multi-level Bayesian networks.

Smart cards and their uses remain an important focus of research of the Digital Security group. Dr Erik Poll’s team identified new weaknesses in these devices. These results were published after informing the producer. The same has happened for the smart-card chips used in car keys and the smart-card readers (e-identifiers) used for internet banking in the Netherlands. The possible leakage of information from smart cards (hidden channel analysis) is another specialty. In this research machine learning techniques are used in an innovative way (together with the Intelligent Systems group).

Smart cards also form an essential part of the IRMA project, which led by Prof. Bart Jacobs, in which attribute-based authentication is realized in practice (see irmacard.org). This project, which is getting increasing public attention, is supported by the UK’s Home Office. The group works on this project together with a large number of partners as part of the Privacy & Identity Lab (PI Lab), which was formally opened on 15 March 2012. This lab – a collaborative venture involving TNO, Tilburg University, the Dutch Foundation for Internet Domain Registration (SIDN) and Radboud University Nijmegen – is part of the Digital Security
Group. The aim is to find better solutions for protecting online privacy and electronic identities. Uniquely, this joint initiative will integrate the technical, legal and socio-economic aspects of privacy and identity. In one of the projects, led by Prof. Hildebrandt, the Privacy & Identity (PI) Lab in Nijmegen has done legal research on profiling. Also a start has been made on research on public-private cooperation in the fight against cybercrime.

The first FP7 project on smart grids started with the participation of a team from Nijmegen, in particular Prof. Marko van Eekelen. The Digital Security group is one of the founders of the new European Network for Cyber Security (in The Hague), which currently focuses on the security of the electrical infrastructure. In the field of intelligent (electrical) meters, Digital Security has produced reports (together with TNO and the University of Tilburg) for the Netherlands Competition Authority (NMA) and the Smart Energy Collective (SEC).

In relation to the programming language Java, techniques have been developed for determining memory use, which is important for virtualization. The theorem prover PVS has been used to develop a framework, which can be used to prove the correctness of parallel programs. Research on quantum logics and security has received an enormous impulse with the ERC Advanced Grant to Prof. Bart Jacobs. This project will start in 2013, but in 2012 initial steps were taken in formalizing quantum logics.

Societal impact

The Institute’s impact is evident in various projects designed to improve the quality of software, for instance in the medical domain (developing new tools and techniques for analyzing and describing clinical and pathological data, which can then be used to understand and improve the prognosis, diagnosis and treatment of several diseases, such as neuro-degenerative diseases, testing the impact of ‘mindfulness’ training) and model checking, together with Océ and ASML. A project plan (together with the Donders Institute, TNO, the Netherlands Aphasia Association and the Rotterdam Aphasia Centre) to design an app to help people with aphasia find words received the 2012 Quality Prize from the Dutch Brain Foundation. Computer security and privacy are increasingly important issues in a modern information society. The Digital Security group not only addresses these concerns through its research, but also takes an active role in the public debate about these issues. The group’s expertise in these matters also continues to be actively sought, especially by various branches of the Dutch government. For instance, Prof. Jacobs is a member of the National Cyber Security Council that advises the Cabinet on cyber security issues. Members of the Digital Security group are also active in issues such as privacy-friendly public transport cards, electronic road pricing, and smart electricity meters and identity cards. The group which established the PI Lab will advise business and government in making practical use of expertise in privacy & identity in cyber-space. Bayesian techniques developed at ICIS are being used to combine data with background knowledge, for instance to localize sources of activity in the brain and to improve the performance of brain-computer interfacing. The ICIS Web Deduction system (www.prover.cs.ru.nl) is used to teach logic in a number of courses at several universities. In the context of ICT for development, the Digital Security group worked on an infrastructure for basic medical assistance in rural areas where expert systems complement medical staff.
Key publications


Dissertations: 8
Academic publications: 202
Professional publications: 2
Director: Prof. Tom Heskes

Tom Heskes has been a professor since 2008, specializing in Artificial Intelligence, in particular Bayesian machine learning. Since 2007 he has been a Principal Investigator at the Institute for Computing and Information Sciences and an Affiliated Principal Investigator at the Donders Centre for Neuroscience. He won a prestigious Vici grant from the Netherlands Organization for Scientific Research in 2006 and is Editor-in-Chief of the journal *Neurocomputing*.

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Future research

Research on quantum computing and digital security will gain momentum with the start of the ERC Advanced Grant project led by Prof. Bart Jacobs and the continuation of the PI Lab and various other projects. Major pilots will be carried out with the IRMAcard and work on the security of critical infrastructures, notably the smart grid, will intensify with the EU project CDAX and other national and international partnerships. Multi-disciplinary research on e-health and bio-informatics will be further consolidated through ongoing collaboration with the RUNMC, in particular within the Centre for Systems Biology and Bioenergetics.

Several new partnerships with the Dutch brain bank (Alzheimer) and within the EU projects TACTICS (obsessive compulsive disorders) and OPTIMISTIC (myotonic dystrophy), will support the development of data mining and machine learning algorithms to gain insight into the progression of disease in general and the causes of brain diseases. Further e-health research, including that on self-management of chronic diseases, will move towards implementation in clinical practice. In collaboration with companies, modelling workflows and active learning of software components will be taken to the next level, both in theory and in practice.
Glossary

(c) Extraordinary chair
(o) Ordinary chair
(p) Personal chair
BSI Behavioural Science Institute
CLS Centre for Language Studies
CMIB Centre for Molecular and Biomolecular Informatics
CMR Centrum voor Migratierrecht – Centre for Migration Law
CNR Centrum voor Notarieel Recht – Centre for Notarial Law
DCC Donders Centre for Cognition
DCCN Donders Centre for Cognitive Neuroimaging
DCN Donders Centre for Neuroscience
DFG Deutsche Forschungsgemeinschaft – German Research Foundation
DFN Diabetes Fonds Nederland – Dutch Diabetes Research Foundation
DI Donders Institute for Brain, Cognition and Behaviour
ERC European Research Council
ESF European Science Foundation
FELICE Free Electron Laser for IntraCavity Experiments
FELIX Free Electron Laser Infrared eXperiments
FLARE Free-electron Laser for Advanced spectroscopy and high Resolution Experiments
FOM Stichting voor Fundamenteel Onderzoek der Materie – Foundation for Fundamental Research on Matter (Netherlands)
FP7 EU Framework Programme 7
FTE Full-time equivalent for research
FTE 1st Full-time equivalent for research directly funded by government (core funding)
FTE 2nd Full-time equivalent for research funded by KNW or NWO (research grants)
FTE 3rd Full-time equivalent for research funded by other public and/or private organizations (contract research)
HFML High Field Magnet Laboratory
HLCS Institute for Historical, Literary and Cultural Studies
ICIS Institute for Computing and Information Sciences
IGMD Institute for Genetic and Metabolic Diseases
IMAPP Institute for Mathematics, Astrophysics and Particle Physics
IMM Institute for Molecules and Materials
IMR Institute for Management Research
IRUN International Research Universities Network
IWWR Institute for Water and Wetland Research
KNAW Koninklijke Nederlandse Academie van Wetenschappen – Royal Netherlands Academy of Arts and Sciences
KWF Koningin Wilhelmina Fonds – Dutch Cancer Foundation
MPI Max Planck Institute for Psycholinguistics, Nijmegen
NCEBP Nijmegen Centre for Evidence-Based Practice
NCMLS Nijmegen Centre for Molecular Life Sciences
NHS Nederlandse Hartstichting – Netherlands Heart Foundation
NIAS Netherlands Institute for Advanced Study
NIH National Institutes of Health
NISCO Nijmegen Institute for Social & Cultural Research
NSM Nijmegen School of Management (i.e. Faculty of Management Studies)
NWO Nederlandse Organisatie voor Wetenschappelijk Onderzoek – Netherlands Organisation for Scientific Research
N4i Nijmegen Institute for Infection, Inflammation and Immunity
OO&R Onderzoekscentrum voor Onderneming & Recht – Business and Law Research Centre
PTR Research Institute for Philosophy, Theology and Religious Studies
RIO Research Institute for Oncology
Spinoza The most prestigious prize for scientists in the Netherlands who are at the very top of their research profession, awarded by NWO
SteR Onderzoekscentrum voor Staat en Recht – Centre for State and Law
STW Technologiestichting STW – Technology Foundation STW (Netherlands)
RUNMC Radboud University Nijmegen Medical Centre
Veni grant Personal grant from NWO awarded over a period of three years to researchers who have recently obtained their PhD, to allow them to continue to develop their ideas
Vidi grant Personal grant from NWO awarded over a period of five years to researchers who wish to develop an innovative line of research in which they appoint one or more co-researchers
Vici grant Personal grant from NWO awarded over a period of five years to senior researchers who wish to establish their own research group
ZonMW ZorgOnderzoek Nederland NWO Medische Wetenschappen – Netherlands Organisation for Health Research and Development