

NETHERLANDS INSTITUTE FOR NEUROSCIENCE
Master the mind

Self-evaluation report

of the Netherlands Institute for Neuroscience (NIN)

2018-2024





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Colophon

This report was a joint effort thanks to the many NIN colleagues that contributed to it by writing texts, collecting and analyzing data, or supplying pictures and images, and also thanks to the KNAW colleagues and NIN's Scientific Advisory Board members who provided valuable feedback during the writing process.

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Table 1.1 Funding & Expenditure							
in K€	2018	2019	2020	2021	2022	2023	2024
Direct funding[1]	10,021	10,225	10,497	10,934	11,608	12,296	12,586
Research grants[2]	2,766	2,364	1,905	2,875	3,479	3,409	3,947
EU and contract research[3]	2,531	2,859	2,368	3,515	3,248	3,719	4,276
Other[4]	1,538	1,423	1,535	1,581	1,692	2,653	2,262
Total Revenues	**16,856**	**16,871**	**16,306**	**18,905**	**20,027**	**22,078**	**23,071**
Personnel expenses	-9,354	-10,630	-10,652	-12,294	-12,192	-12,795	-14,620
Other costs	-5,869	-6,234	-5,304	-6,450	-5,723	-7,446	-7,180
Total Expenses	**-15,223**	**-16,864**	**-15,956**	**-18,744**	**-17,915**	**-20,240**	**-21,800**
Financial income and expenses[5]	-3	-2	-2	-1	0	482	735
Result	**1,630**	**5**	**348**	**161**	**2,112**	**2,319**	**2,006**

[1] Direct funding (KNAW lump sum budget), [2] Research grants obtained in national scientific competition (e.g.,grants from NWO and KNAW), [3] Research grants and contracts obtained from other organizations, such as EU, industry, government ministries, and charitable organizations, [4] Other income (e.g., Netherlands Brain Bank), [5] Interest

1 Introduction

1.1 About the NIN

The history of the Netherlands Institute for Neuroscience (NIN) began in 1909, when the Central Institute for Brain Research (NIBR) was founded as the first institute of the Academy (which later became the Royal Netherlands Academy of Arts and Sciences, KNAW). In 1972, the Netherlands Ophthalmic Research Institute (NORI) was founded, focusing on vision research. The Netherlands Brain Bank (NBB) was established at the NIBR in 1985 by Dick Swaab, to study brain disorders through postmortem brain tissue. In 2005, the NIBR and NORI merged to form the NIN. In 2014, the Spinoza Centre for Neuroimaging was established to advance brain imaging; this is a collaboration between the Amsterdam University Medical Center (AUMC), Vrije Universiteit (VU Amsterdam), and the NIN. The present-day NIN has approximately 200 staff members excluding guest researchers and students, and an annual turnover of ~€ 23M (*Table 1.1*).

The NIN aims to understand how neural circuits create our mental functions and how these circuits change in brain disorders. Combining advanced neurotechnologies and unique facilities like the NBB, Non-Human Primate (NHP) Unit, Sleep Lab, and Spinoza Centre, the NIN investigates the brain at multiple levels using a cross-species approach (from mice to NHPs and humans). By linking insights from human Magnetic Resonance Imaging (MRI) and post-mortem studies to knowledge about neural circuits and molecular mechanisms, the institute aims to unravel how brain activity shapes mental processes in health or disease. Research topics span from visual input via the retina to the brain's output (action), such as behavior, sleep, eating, and endocrine activities. The levels of investigation range from the molecular to the social, including brain-to-brain analyses. In addition, many research groups at the NIN use in silico simulations to interpret their data and generate new, testable hypotheses.

The NIN is one of the 12 institutes of the KNAW. The KNAW serves as the forum, the conscience, and the voice of science in the Netherlands. Its institutes are active in the humanities, social sciences, and life sciences, and act as national centers of expertise. The KNAW promotes innovation and knowledge valorization through its institutes and encourages them to cooperate with other research institutes and university research groups. The NIN does this amongst others through engaging in many collaborative research initiatives, managing the NBB and Spinoza Centre, establishing special professorships and lectorates, contributing to MSc courses and PhD training, and organizing active outreach to a broader public. NIN researchers are also active in many international networks and organizations that disseminate knowledge about the brain.

1.2 Previous evaluations

In 2018, an external international research assessment committee rated the NIN's research quality as **excellent**. The committee noted that the NIN performs world-class innovative research, is home to top scientists, and that, euro for euro, the NIN achieves significantly more than its competitors in the field. Additionally, it was mentioned that the NIN harbors world-class research facilities that support the NIN's own outstanding research but are also available to collaborators. The committee deemed the NIN's research as **highly relevant** to society, in particular for the general public, patients and patient organizations, researchers at other institutes, the Dutch and European government, and industry. The viability of the NIN was considered **good**, reflecting both the strength of its research excellence and clear added value in the Dutch and international landscape as well as challenges such as a suboptimal housing situation, lack of support from the KNAW for NHP research, operational management issues, a lack of Big Data infrastructure, and limited international visibility. To enhance the NIN's viability, the committee recommended building a new, attractive building at a central location; safeguarding the NHP facility; increasing the visibility of the NIN through (social) media; improving transparency of decision making and communication by the leadership; making support groups more service-oriented; investing in computing power; storage facilities, computational expertise and Open Science; continuing to hire groups leaders aligned with the mission; and strengthening the interaction with the Spinoza Centre. The committee also advised the NIN to take more measures to prevent unnecessarily long PhD durations, appoint confidential persons and inform employees about complaint procedures, hire more female group leaders, and be more aware of diversity and inclusiveness.

In 2019, the NIN was evaluated as part of the portfolio evaluation of all national research institutes of the KNAW and Dutch Research Council (NWO), commissioned by the Dutch Ministry of Education, Culture and Science. The portfolio analysis committee praised the NIN for its research quality, its bridging role between psychology and neurobiology, and its coordination of research across institutions in these fields. The committee also highlighted the NIN's key role in neurotechnology innovation, its success in attracting top-level young scientists, and its efforts to make facilities like the NBB sustainably and internationally accessible, contributing uniquely to research. The committee recommended that the NIN expand its engagement with institutions beyond its immediate network.

The NIN has addressed these recommendations as outlined in this self-evaluation report.

Mission

"The Netherlands Institute for Neuroscience aims to understand the neural circuits that create our mental functions and how they change in brain disorders"

Strategy

Building critical mass

Investing in advanced techniques and technologies

Strengthening the national role as a central neuroscience hub

2 Mission and strategy

2.1 Mission and strategic aims

During the assessment period, the NIN's main ambition was to establish itself as a globally competitive center for research on brain circuits, with the mission 'to explain how circuits of neurons enable us to see the world and act upon it'. To achieve this, the strategy focused on (1) **building critical mass**, (2) **investing in advanced techniques and technologies**, and (3) **strengthening the national role of the NIN as a central neuroscience hub**.

The following strategic aims were pursued during the assessment period (also addressing recommendations of the 2018 assessment committee and the 2019 portfolio evaluation committee):

- **Hosting and recruiting top-tier research groups working on diverse yet overlapping topics, employing a wide range of experimental approaches** (see Ch. 3.3, 4, and 8 for newly hired group leaders and other actions).
- **Introducing and developing innovative and important new techniques and technologies**, strengthening the position of the institute as central neuroscience hub in the Netherlands and contributing to society by developing clinically relevant technologies (see Ch. 4 and 5).
- **Optimizing NIN facilities and services.** NIN facilities are crucial for technology development and execution of (animal) experiments according to the highest standards (see Ch. 3 and Ch. 4 for improvements in the organization and communication of these facilities, Case study 1: NBB, and Case study 2: Spinoza Centre).
- **Improving external communication and informing the public about neuroscience research** (see Ch. 5 for public engagement activities).
- **Strengthening interaction with the Spinoza Centre** (actions to achieve this goal are described in Ch. 3 and Case study 2: Spinoza Centre).
- **Improving transparency of decision making and communication by the NIN leadership** (see Ch. 3.1 and Ch. 8.1 for specific actions the NIN took to achieve this).
- **Improving the housing situation**: The NIN has worked together with the KNAW to improve the housing situation, creating modern office and laboratory space that will become available starting fall 2025.
- **Training the next generation of leaders in the field of neuroscience** (actions taken to advance the careers of young scientists and group leaders are described in Ch. 6 and Ch. 8).

2.2 Strategy development during the assessment period

Later in the assessment period, two additional strategic aims emerged: (1) leveraging the NIN's unique expertise in brain circuits to advance understanding, diagnosis, and future treatments for psychiatric disorders, and (2) investing in Open Science and enhancing the sharing of technical and scientific expertise, as well as data, in the field of brain research.

Strengthening the interaction between circuits neuroscience and psychiatry

In 2022, as the NIN began its search for a new director to succeed Pieter Roelfsema, whose maximum term had ended, the institute seized the opportunity to reflect on its mission and outline a strategic path forward. During discussions among group leaders, a clear shared vision emerged: the time had come for the NIN to strengthen the connection between fundamental molecular and circuits neuroscience - the primary focus of its research – and the understanding of how certain mental functions go astray in brain disorders. At the NIN, interactions between neuroscience and neurology have always been strong (see Ch 4.1 and Ch 5.1 and appendix 2) and will remain so in the future. Interaction between neuroscience and psychiatry were less developed within the NIN, but also nationally and internationally, due to the high complexity of psychiatric symptoms and the underlying circuit mechanisms, the large interindividual variability in symptoms and potential underlying environmental and genetic causes, and the lack of biomarkers.

Collaboration between experts in neuroscience and psychiatry is crucial for advancing beyond the current limitations of diagnosis and symptom management for mental disorders. Psychiatry has historically relied heavily on subjective reports and behavioral observations. Neuroscience offers more objective measures that can complement traditional psychiatric assessments, with the potential to revolutionize mental healthcare through

Figure 2.1 - NIN initiatives aimed at understanding the neural basis of psychiatric symptoms

Sleep, vision & psychiatry

The van Someren group studies interactions between **insomnia** and **mood and anxiety disorders** in collaboration with numerous psychiatry and psychology practices. Moreover, the Siclari group joined the NIN to study **sleep-related hallucinations, delusions, and perceptual illusions**, while vision-focused labs (Levelt, Dumoulin, and Roelfsema) explore the relationship between hallucinations and generative visual processes.

MRI & psychiatry

At the Spinoza Centre, researchers from AUMC use **MRI** to study a wide range of psychiatric disorders from **functional, structural and metabolic perspectives**, often in collaboration with the group of Dumoulin at the NIN.

Donors & psychiatry

The Netherlands Brain Bank (NBB) has expanded donor recruitment to include individuals with **psychiatric disorders** over recent years, driven by research from the Huitinga and Swaab groups, and developed the Neurogenetics Database in collaboration with the University of Groningen to standardize trait assessments and integrate genotype data.

Sex differences in autism

The Dumoulin group (van der Zwaag) participates in a Dutch Research Agenda (NWA) consortium focusing on **sex differences in autistic trait** occurrence, and diagnosis and translates this knowledge into sex-sensitive diagnosis eHealth tools.

Development & psychiatry

The labs studying developmental plasticity (de Zeeuw, Lohmann, and Levelt) are investigating the pathogenesis of **neurodevelopmental disorders**, such as autism spectrum disorder (**ASD**), in collaboration with ErasmusMC and AUMC. Research on cerebellar circuit mechanisms underlying ASD done at the NIN have led to the development of an app that can diagnose ASD at a high level of sensitivity and selectivity.

Compulsive behavior

A particularly symbiotic approach is pursued by the Willuhn group, which was embedded within the AUMC's Psychiatry Department during the assessment period but performed their research at the NIN. This group conducts in vivo brain recordings in rodent models to study behaviors relevant to psychiatric disorders, with a focus on **compulsive and impulsive behavior**. In collaboration with the Denys group at AUMC, they also investigate the circuit mechanisms of **deep brain stimulation (DBS)**, an innovative therapeutic approach in psychiatry. Their work exemplifies research at the interface of psychiatry and circuits neuroscience, with the hope that these approaches will identify the circuits underlying specific psychiatric symptoms and offer new, highly targeted pathways for therapy.

Social symptoms & psychiatry

The Keysers and Gazzola labs study **social deficits** such those at the core of **psychopathy** (Keysers) and conduct disorders (Gazzola), as well as ASD, including collaborations with AUMC. These ongoing efforts highlight the NIN's ability to link neural circuits underlying mental functions to the highly debilitating social symptoms of psychiatric disorders.

Anxiety

The Heimel group has initiated work on the mechanisms underlying innate behavior related to **anxiety** and curiosity.

evidence-based approaches to diagnose and treat mental disorders. Advances in neuroscience technologies now enable exploration of the brain's circuit mechanisms underlying mental functions and how their dysfunction may cause psychiatric symptoms. Using cross-species approaches to investigate these dysfunctions could open new avenues for diagnosing and treating psychiatric conditions, which are the leading causes of diminished quality of life worldwide and impose the highest economic burden on our society. Revolutionary technologies such as single-cell and spatial transcriptomics, high-density neural recordings, optogenetics, and chemogenetics, combined with a shift in psychiatric research toward symptom-based domains rather than traditional DSM-5 classifications, have paved the way for these developments. In line with these developments in the field, **the NIN is already well-positioned to integrate** molecular and circuits neuroscience with psychiatry, because the institute is at the forefront of understanding the neural basis of key domains of mental functioning central to psychiatric disorders and is building a growing body of research and interdisciplinary collaborations aimed at uncovering the neural mechanisms underlying psychiatric symptoms (*see Figure 2.1*).

The initiatives in *Figure 2.1* signal a natural evolution of the NIN's mission, incorporating the understanding of the neural underpinnings of psychiatric and neurological disorders into the NIN's broader focus on fundamental neuroscience. This promises a future where NIN discoveries in fundamental neuroscience lead to measurable improvements in public health and quality of life. Based on this discussion and the new strategic aim, the NIN has updated its mission statement to:

"The Netherlands Institute for Neuroscience aims to understand the neural circuits that create our mental functions and how they change in brain disorders."

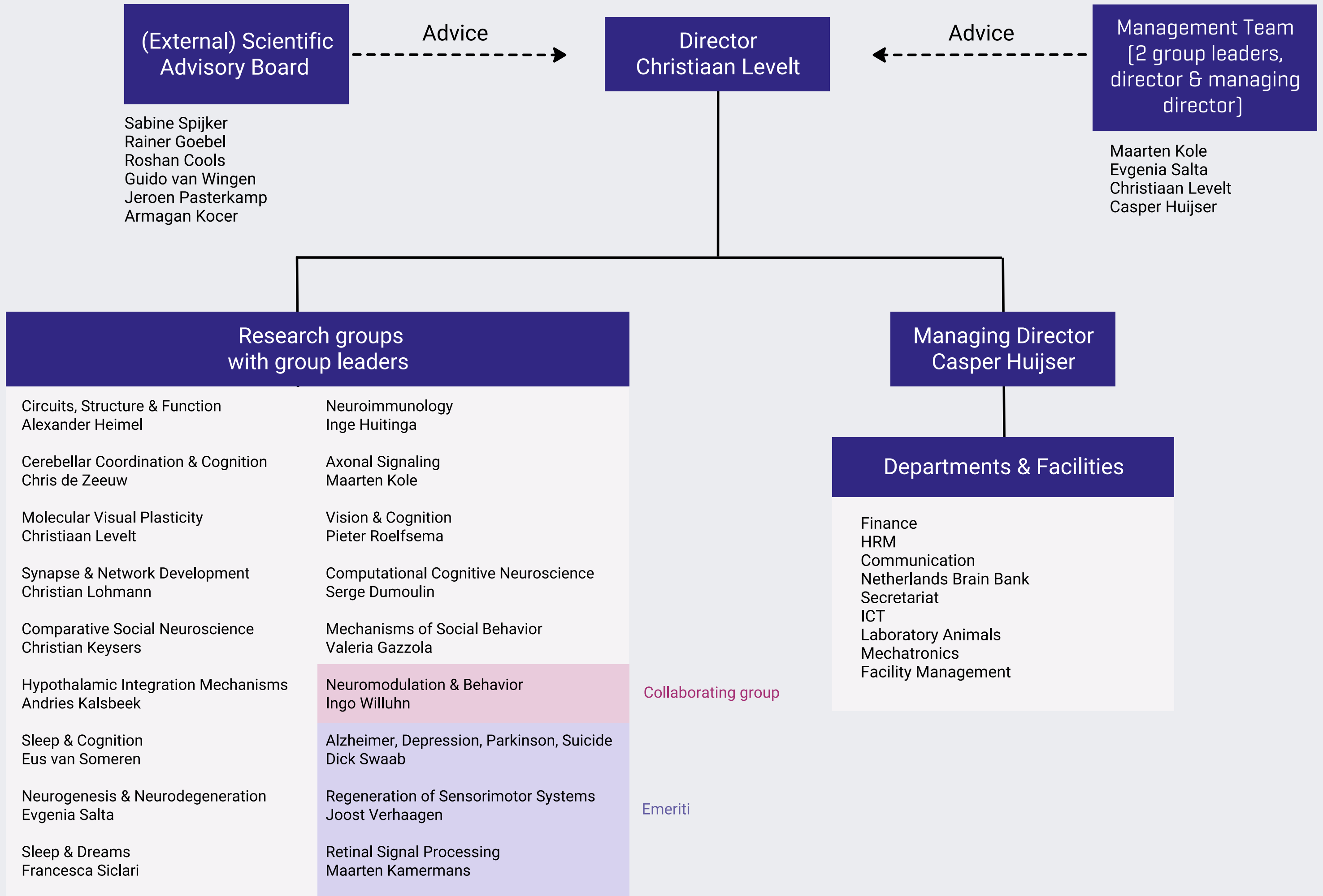
Considering its existing capital in neurological disorders, in the coming years, the NIN aims to strengthen collaboration with psychiatry departments across the Netherlands to jointly uncover biological causes of psychiatric symptoms, inspire innovative therapies, and discover biomarkers linking symptoms to treatment outcomes. The following actions have been or will be initiated, aimed at strengthening interactions between psychiatry and neuroscience:

- Willuhn's group was established as a formal collaboration between the NIN and AUMC, supported by joint investments (Ch. 3)
- Huitinga and Kole have secured significant funding through a NWO Gravitation grant to expand the use of NBB material to study molecular and cellular mechanisms underlying psychiatric symptoms (Case study 1)
- New group leaders are being recruited that will link psychiatry to neuroscience
- With input from psychiatrists and psychiatry researchers, the NIN has started an initiative which involves organizing focused interactions between psychiatrists and neuroscience researchers from the NIN. The aim of these meetings is to develop co-supervised PhD projects and foster interdisciplinary training for young professionals to establish a new generation of neuroscience-oriented psychiatrists (Supplementary document 2.1). Supported by funding from both the NIN and the psychiatry departments, this effort aims to bridge fundamental neuroscience and clinical psychiatry, advancing research and improving mental healthcare in the long run.
- A national vision document will be created with input from psychiatry departments and stakeholders, with the aim to expand this approach to other neuroscience institutions and involve national funding organizations.

Investing in Open Science and sharing of data and expertise

Over the past years, the NIN has taken various actions to stimulate open access publications and share data, code, and scientific and technical expertise, which aligns with its role as a national neuroscience hub (see Ch. 4.4 and 4.5). Key actions include developing a NIN data storage protocol, offering a centralized location to share code, implementing a databasing approach to make all data on NIN servers machine-readable (Follow Your Data, FYD), and developing tools to share data according to the FAIR principles (Findable, Accessible, Interoperable, Reusable, Case study 3). While these efforts have yielded positive results (see Ch. 7), the NIN will further improve the coordination of data sharing as a core institute policy and reduce the current barriers that make data sharing a time-intensive process with limited immediate benefits. Moreover, data protocols for sharing privacy-sensitive human data need improvement to increase opportunities to publish human neuroscientific research and apply for relevant grants.

Figure 3.1 - Organizational chart of the NIN



3 Organization

3.1 Organization and decision making

The NIN hosts 18 research groups and several support teams and research facilities. The organizational chart of the NIN is shown in *Figure 3.1*.

The organizational structure is flat, with direct communication between the research group leaders and the director. The institute is led by director Christiaan Levelt, who succeeded Roelfsema in 2024 and has the final responsibility for the NIN and reports to the KNAW management board. In addition to his leadership role, Levelt also leads his own research group. The director is supported by a managing director. The director and managing director form the board of the NIN. The managing director supervises the NIN's support teams, which include the Finance, Human Resources Management (HRM), Communication, NBB, Secretariat, ICT, Laboratory Animal Facility, Mechatronics, and Facility Management. Each support team consists of two to seven members, led by a designated team leader. Total staff numbers can be seen in *Table 3.1 (next page)*. To enhance transparency in decision making and communication – one of the NIN's strategic aims – and to enable decision making based on timely and accurate information the following bodies are installed at the institute:

- **Management Team (MT)**: Installed during the assessment period and consisting of the director (appointed for a maximum of ten years), managing director (permanent), and two group leaders (rotating every two years), the MT meets biweekly to discuss important strategic and operational topics. Summarized notes from these meetings are shared on the NIN's intranet.
- **Group Leader Meeting:** Held monthly, this meeting includes the director, managing director, and employed group leaders to discuss various scientific, strategic, and operational topics related to the NIN. Since 2024, the team leaders of the support departments also participate twice a year. Summarized notes from these meetings are published on the NIN's intranet.
- **Operational Executive Meeting:** This meeting takes place every six weeks and includes the managing director and heads of the support teams.
- **Divisional Committee of the Works Council (OC):** The OC consists of seven NIN employees from diverse teams and groups, serving three-year terms. It represents the staff and meets with the managing director six times per year. At two of these meetings, the director is also present. By law, works councils advise on and approve or disapprove a wide range of organizational matters – such as policies, finances, reorganizations, and labor conditions – that affect the working conditions of all NIN employees. The OC is a sub-committee of the Works Council of the KNAW, which addresses broader organizational matters affecting all KNAW institutes.
- **Postdoc and PhD Councils:** These councils represent postdocs and PhD candidates at the NIN. They meet with the directors at least twice a year and sometimes conduct surveys among their respective groups. The board addresses questions from PhD candidates and postdocs and implements actions suggested by these councils if they are considered useful and feasible.
- **Scientific Advisory Board (SAB):** Composed of six reputable external scientists, the SAB advises both the NIN and the KNAW on a wide range of topics, including strategy, research output, internal and external communication, and personnel matters. The SAB visits the NIN once a year to meet with representatives from the institute, including the PhD and Postdoc Councils.

With the exception of the Works Council, the above-mentioned bodies have an advisory role and no mandate of their own. However, whenever possible, decisions are made based on consensus or by voting.

3.2 Organization of research groups

In December 2024, the NIN hosted a total of 18 research groups:

- 14 regular research groups with group leaders appointed at the NIN
- 3 emeritus-led research groups led by retired former NIN group leaders who remain very active
- 1 guest research group, led by a group leader appointed at AUMC (Willuhn)

The salaries of the 14 NIN-appointed group leaders are paid by the NIN for the hours appointed. The default is that these groups receive the same annual operational budget (€154K in 2024). Most group leaders use part of

Table 3.1 Staff numbers

Year	2018		2019		2020		2021		2022		2023		2024	
Category	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE	#	FTE
Scientific Staff[1]	16	14,3	18	16,3	18	16,3	21	17,6	20	17,1	20	17,1	19	16,1
PhD Candidates	30	28,6	30	29,1	40	38,1	50	48,6	42	40,5	48	46	42	41
Postdocs	28	25	25	21,5	32	28,5	27	24,9	27	24,6	31	29,5	37	34,6
Total Research Staff	**74**	**67,8**	**73**	**66,8**	**90**	**82,8**	**98**	**91**	**89**	**82,1**	**99**	**92,5**	**98**	**91,7**
Scientific Support Staff	49	45,9	49	46	47	41,6	44	39,4	49	45,1	54	48,8	64	55,1
Support Staff	22	19,1	24	21,5	26	23,2	27	23,6	29	26	27	24,3	31	26,9
Total Staff	**145**	**132,9**	**146**	**134,3**	**163**	**147,7**	**169**	**154**	**167**	**153,2**	**180**	**165,6**	**193**	**173,7**
Visiting Fellows	4	-	4	-	5	-	6	-	5	-	7	-	7	-

FTE: Fulltime Equivalent
[1] Researchers with a permanent position and group leaders

this budget to employ one permanent staff member (e.g., a technician or postdoc), while additional personnel are typically funded through research grants. On average, each regular group comprises 9.6 members, primarily PhD candidates and postdocs. Many groups also include 1-2 technicians or other experts depending on their research needs. The largest group currently has 23 employees. The number of individuals contributing to each research group is often higher because students (BSc, MSc, University of applied sciences), visiting scientists, and research fellows (such as PhD candidates funded by the Chinese Scholarship Council) frequently join the teams. While the three emeriti operate independently, organizationally they are guests within one of the 14 regular groups. They do not receive funding from the NIN anymore and support their research through grants or the reserves accumulated when they were still employed.

3.3 Organizational changes and staff development 2018-2024

During the assessment period, group leaders Kamermans (November 2022) and Verhaagen (April 2023) retired, but they remain actively involved in research activities. Another group leader (Kessels) left the NIN in January 2018 for a full professorship at the University of Amsterdam (UvA). These developments freed up budget to hire new group leaders aligned with the NIN's strategic aims:
One of the NIN's strategic aims was to recruit top-tier research groups working on diverse yet overlapping topics, employing a wide range of techniques and approaches. This approach promotes synergies, creating an exciting environment where groups collaborate, exchange expertise, and share equipment. The NIN's horizontal structure, which grants new group leaders full independence, combined with the NIN's highly collaborative atmosphere,

- makes the institute attractive for early- and mid-career scientists. This is exemplified by the successful recruitment of two new (female) group leaders during the assessment period. These appointments enhanced the interaction between sleep research and circuits neuroscience at the NIN (Siclari, January 2023) and between molecular neuroscience and the NBB (Salta, June 2020).
- Another strategic goal was to strengthen the interaction with the Spinoza Centre. This was supported by appointing the director of the Spinoza Centre (Dumoulin) as a part-time NIN group leader in January 2022.
- An agreement with the AUMC Psychiatry Department was signed, establishing Willuhn's group as a formal collaboration between the NIN and AUMC, supported by joint investments, starting in January 2025. During the assessment period, Willuhn was employed by and reported to AUMC, but was active at the NIN for many years. He functioned as a NIN group leader, participated in many meetings, and was supported by several support teams. However, he did not receive a budget from the NIN. As of February 2025, Willuhn will receive a part-time appointment at the NIN granting him full access to all NIN and KNAW systems. This action is a key step in advancing the NIN's strategic aim to strengthen interactions between the NIN's circuits neuroscience research and psychiatry. See Appendix 1 for more information about staff changes during the assessment period. more information about staff changes during the assessment period.

Freezers at the Netherlands Brain Bank

4 Research quality

The primary scientific goal of the NIN was and will remain to make groundbreaking discoveries about the neural circuits that underlie mental functions, reshaping perspectives and driving significant advancements in the field. This chapter presents the most exciting discoveries made during the assessment period (4.1). In addition, numerical research quality performance indicators in line with the NIN aims and strategy are presented: numbers of peer-reviewed journal articles (4.2), citation of these articles by peers (4.2), and numbers of marks of recognition from peers such as grants, prizes, and editorships (4.3). Moreover, this chapter describes the institute's efforts to advance cutting-edge techniques and technologies (4.4) and provides an overview of collaborations that increase the institute's scientific impact (4.5).

4.1 Discoveries

While each research group at the NIN determines its own research lines and interests, the institute's strategic recruitment of group leaders working in overlapping areas naturally aligns their research in overarching themes, which are however dynamic and do not have organizational implications. The key discoveries of each group are presented below, organized by research theme.

Social and affective behavior

Social and affective neuroscience explores how the brain supports social behaviors and emotions, integrating insights from psychology, psychiatry, biology, and neuroscience. By examining processes like empathy, decision-making, and reward across species—from rodents to humans—it reveals conserved mechanisms and species-specific adaptations underlying social interaction and emotional regulation.

The Keysers group and the Gazzola group, two closely collaborating research groups at the NIN, aim to understand how the affective states of others influence the state and decisions of observers. The **Keysers** group (all with Gazzola group) identified emotional mirror neurons in the anterior cingulate cortex of rats, a brain region consistently activated in humans when witnessing distress in others. Deactivating this brain region prevented emotional contagion. They further discovered that rats exert effort to prevent harm to others, which relied on the same cingulate region, establishing a causal link between mirror neuron activity and prosocial behavior. Combining depth-resolved fMRI and intracranial EEG in humans, they demonstrated that perceiving the actions of others involves predictive coding across premotor, parietal, and visual brain regions. In addition, the group published an influential introduction to Bayesian hypothesis testing for the neuroscience community.

The **Gazzola** group (all with Keysers group) developed a neuro-computational model that demonstrates that the anterior cingulate cortex plays a key role in moral decision-making by updating the expected pain another individual would experience. Using intracranial recordings, they discovered neurons in the human insula that encode the intensity of another person's pain (with Roelfsema group). Combining neuromodulation techniques and patient studies, they demonstrated that somatosensory cortices are necessary for perceiving the pain of others, while the cerebellum is essential for perceiving the kinematics of others (with de Zeeuw group).

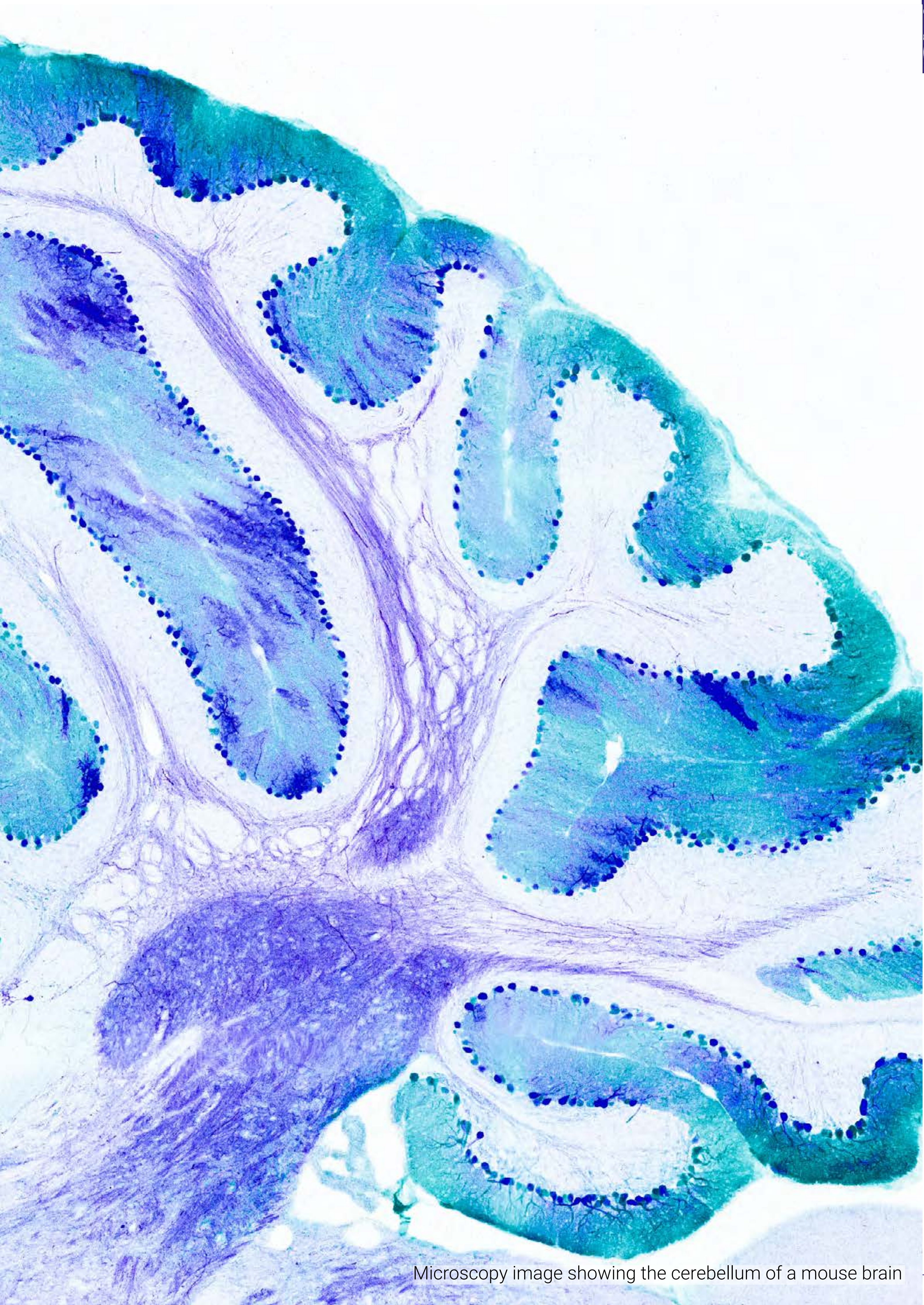
The **Heimel** group discovered a brain circuit linking the prelimbic cortex to GABAergic neurons in the zona incerta, which inhibits the periaqueductal gray and is both necessary and sufficient to trigger curiosity in rodents (with Verhaagen group)(Case study 4). They also discovered how the superior colliculus influences neural responses in the visual cortex via the thalamus. Additionally, they developed a new statistical test to determine when and whether cells respond to stimuli without arbitrary parameters (with Kamermans and Levelt groups), which is freely available on the NIN Github.

The **Willuhn** group made significant advances that shine light on how both appetitive and aversive stimuli influence the dopamine system, improving our understanding of the behavioral function of dopamine, specifically regarding its release in different brain regions. To achieve this, the group has designed and validated new behavioral paradigms for rodents and established multi-site fiber photometry as a powerful and versatile readout for neurotransmitter release. Furthermore, the group has investigated the effects of deep-brain stimulation (DBS) on brain and behavior in a genetic rodent model using a combination of calcium imaging and electrical stimulation and discovered several principles of how DBS exerts its therapeutic effects in psychiatric disorders (with Roelfsema group).

The **Swaab** group discovered molecular alterations in postmortem material of patients with major depression and bipolar disorder, schizophrenia, suicide, Prader-Willy syndrome (with Kalsbeek group), obesity, anorexia nervosa, and gender-identity disorders.

Day and night

The alternation of sleep and wake represents a basic organization of activity that is highly conserved across species. Disturbances in this process can result in major cognitive, emotional, and metabolic impairments and are increasingly linked to psychiatric disorders in humans. The NIN has made major contributions to this field in



Microscopy image showing the cerebellum of a mouse brain

recent years.
In a large genome-wide association study (GWAS) study involving over 2.4 million individuals, the **van Someren** group linked insomnia-related gene variants to their expression in specific brain regions (Case study 5). They also identified subtypes of insomnia that carry distinct psychiatric risks (with the Spinoza Centre). In a follow-up study, they traced the cause of this increased risk to inadequate silencing of the noradrenergic system, disrupting nocturnal plasticity in limbic and salience circuits (with Siclari group). This discovery highlights a novel target for preventing common psychiatric disorders.
The **Siclari** group has advanced the understanding of how the brain generates vivid sensory experiences (hallucinations) and false beliefs (delusions) during dreams, in the absence of external input. Using high-density EEG, they successfully imaged dream contents and showed how local cortical activations explain common subjective sleep-related phenomena, such as the feeling of being awake during sleep or conscious experiences in parasomnias. These findings have important implications for understanding psychotic-like states and managing sleepwalking and related conditions.
The **Kalsbeek** group, which studies how the hypothalamic biological clock regulates waking physiology and behavior, has clarified how adipose gene expression is disrupted in obesity and type 2 diabetes. They also demonstrated how glucose metabolism is affected by nighttime light exposure and identified key neuropeptide changes in the hypothalamus in affected patients (with Swaab group).

Axons

In the brain and spinal cord, neuronal output occurs through axons, which are often densely insulated by glia-derived myelin membranes. Myelination of axons is critical for long-range communication, and it is the primary cellular target in the neuroinflammatory and neurodegenerative disease multiple sclerosis (MS). Many fundamental aspects of myelin sheath organization remain unexplored, and NIN researchers are playing an internationally recognized role in this field.
For instance, the **Huitinga** group discovered that de-compaction of the myelin wraps of the optic nerve constitutes a very early indication of MS pathology (with Kole group), even before lesions have formed. In this study, the Huitinga group used postmortem material of the NBB, which houses the largest and best-documented MS archive worldwide (Case study 1).
The **Kole** group discovered a new fundamental mechanism by which electric potentials are conducted along the myelin sheath by studying key biophysical properties of myelin membranes. They also showed that axon-myelin architecture differs between pyramidal neurons and interneurons, and plays a distinct role in the axonal energy supply and neurotransmission in interneurons (with Huitinga group). The Huitinga and Kole groups also discovered that microglia-mediated loss of interneuron synapses is a surprising commonality between MS and its experimental models, with molecular components predicting cognitive impairments in patients. Furthermore, a large-scale single-cell screening of microglia showed that these cell types are inhibited in major depressive disorder. The **Huitinga** group also launched the Netherlands Neurogenomics Database in a collaborative effort with Groningen University.
The **Verhaagen** group showed that regulatable gene therapy for the enzyme chondroitinase promotes spinal cord regeneration, while regulatable gene therapy for the growth factor GDNF promotes functional regeneration of spinal ventral roots. The **Verhaagen** and **de Zeeuw** groups also found that perineuronal nets of the deep cerebellar nuclei are involved in forming associative memories. Non-invasive gene delivery to spinal cord interneurons was shown to stabilize neuronal connectivity and ameliorate motor phenotypes in a mouse model of amyotrophic lateral sclerosis (ALS), possibly opening a new avenue towards treating motor neuron diseases.

Vision and cognition

Vision is an important sensory modality for humans, and its impairment can present significant challenges. Moreover, the visual system serves as an important model system for investigating fundamental questions about the structural and functional organization of the neocortex. Researchers at the NIN contribute to the fruitful emerging interactions between the new AI-models, which sometimes surpass human visual and cognitive capabilities, and visual neuroscience. During the assessment period, NIN researchers have made significant discoveries that shed light on how visual information is processed in the cortex and the roles of specific neural cell types, by making use of advanced (high cell-count) electrophysiological recording techniques, in vivo two-photon calcium imaging, and opto- and chemogenetics. In addition, several findings with direct clinical applications are actively pursued at present.
For example, the **Kamermans group**, in collaboration with the **de Zeeuw** group, made a groundbreaking discovery regarding infantile nystagmus, a condition characterized by involuntary eye movements. Contrary to the long-standing belief that its origin lies in the brain, their research revealed that it originates in the retina, specifically due to dysfunction in ON direction-selective ganglion cells. This insight paves the way for developing new pharmacological treatments for the disorder.
The **Levelt** group provided significant insights into synaptic mechanisms and plasticity. They discovered

Table 4.1 Research output

Year	2018	2019	2020	2021	2022	2023	2024	Total
Peer reviewed articles	179	155	177	181	145	162	155	**1157**
Open access percentage peer reviewed art.	72%	72%	83%	82%	86%	87%	88%	
Book chapters	6	1	2	0	4	6	2	**21**
PhD theses	15	11	8	9	8	4	15	**70**
Total new external grants/projects	19	18	25	21	29	20	18	**150**
Of which new personal grants	3	3	2	5	3	6	2	**24**

Figure 4.1 - Prizes NIN

that fast synaptic inhibition in the thalamus plays a crucial role in adult visual plasticity and the integration of feedforward and feedback inputs in the visual cortex (with Heimel group). Additionally, they demonstrated that visual experience strengthens contextual inputs in the cortex, which are preferentially processed by a distinct subset of pyramidal cells (with Roelfsema, Verhaagen and Heimel groups). They also published the first detailed study of chandelier cell function in the visual cortex, showing that these cells respond primarily to arousal rather than visual stimuli and exert minimal inhibitory control over pyramidal cells (with Kole, Roelfsema and Heimel groups).

The **Roelfsema** group focused on the circuits underlying perceptual organization and conscious visual perception. They uncovered how disinhibitory circuits in the mouse visual cortex contribute to perceptual organization (with Heimel and Levelt groups). They also provided proof-of-concept for a visual brain prosthesis, showing that patterned electrical stimulation of the primary visual cortex in primates can evoke the perception of shape (Case study 6). Furthermore, they demonstrated that activation in the frontal cortex determines whether a weak visual stimulus reaches conscious perception, highlighting the interplay between cortical regions in conscious awareness.

The **Dumoulin** group challenged traditional views on numerosity perception. Using high-field fMRI, they showed that both small and large ranges of items are represented within the same topographic maps in the human brain, rather than by distinct neural systems. They also identified divisive normalization as a fundamental computation in visuospatial processing, unifying various response features of the human visual system.

Lifelong learning

The brain's plasticity—its ability to adapt by modifying neuronal connections—is crucial during all life stages: for developing functional neural circuits early on, for adapting to new environments, and for compensating for injuries or age-related cognitive decline. Altered plasticity can cause neurodevelopmental disorders (NDDs) in early life and contribute to dementia and personality changes later in life. NIN research groups have made significant advances in understanding brain plasticity across all life stages using cutting-edge techniques such as single-cell RNA sequencing, iPSC reprogramming, *in vivo* patch-clamping, calcium imaging, and Neuropixels recording, and even innovative diagnostic and therapeutic apps for NDDs.

For instance, the **Lohmann** group revealed synaptic and molecular mechanisms that underlie how early spontaneous brain activity before eye opening fine-tunes cortical circuits for visual processing -a phenomenon they call "learning to see with closed eyes." They also developed a wireless optogenetic approach for neonatal mice (with Heimel group and Mechatronics team).

The **Levelt** group discovered that increased inhibitory input prematurely closes the critical period for ocular dominance plasticity in a mouse model of neurofibromatosis, a condition associated with learning deficits and autism (with Heimel, Kole, and Lohmann groups). The **Roelfsema** group showed that pronouns, like "she", activate the concept cells in the medial temporal lobe to which they refer.

The **de Zeeuw** group discovered that connections between cerebral cortex and cerebellum are involved in decision making, showing that cerebellum is involved in cognitive functions. They also discovered (with Verhaagen group) cerebellar plasticity deficits related to eye-blink conditioning in NDDs, inspiring the development of an app to help young patients and their families understand and manage symptoms. The **Dumoulin** group developed a new motion-correction method for 7.0-T MRI to derive morphologic measures from the human cerebellum, which is notoriously difficult.

As the brain ages, its plasticity declines, making learning more challenging. The **Salta** group pioneered microRNA-based methods and discovered that microRNAs can help restore adult neurogenesis and alleviate memory deficits in a mouse model of Alzheimer's disease. They established a new framework for probing human adult neurogenesis using single-cell transcriptomics to minimize the impact of methodological and conceptual confounders in such studies.

4.2 High quality, high impact output

The NIN consistently maintained a high **research output** with 140-180 peer-reviewed academic journal articles, ~10 PhD theses, and 3 book chapters per year (*Table 4.1*). In the period 2018-2024, the institute published in highly reputable scientific journals, notably 3 publications in Nature, 9 in Science, 3 in Cell, 3 in Cell Stem Cell, 2 in The Lancet Psychiatry, 1 in The Lancet Neurology, 3 in Nature Genetics, 2 in Nature Human Behavior, 30 in Nature Communications, 14 in Neuron, 9 in Science Advances, 2 in Science Translational Medicine, and 1 in Journal of Experimental Medicine. An analysis by the Centre for Science and Technology Studies (CWTS, Leiden) of 723 NIN publications that appeared in the period 2018-2022 shows that the **use of NIN research products** by peers is significantly higher than the world average (Supplementary document 4.1). The mean normalized citation score (MCNS [full], i.e., the average of citations per publication, normalized by field and year) is 1.89 times the world average, and 20% of the NIN publications rank within the top 10% of most cited publications in the field. This percentage increased from 19% in 2018 to 23% in 2022. These numbers compare well with other top neuroscience institutes in Europe of similar size and organization (see Supplementary document 4.2).

NIN Facilities

Microscopic Imaging Facility

This facility provides custom setups for intravital imaging, including multiple two-photon setups (with or without virtual reality stimulation), one equipped with spatial light modulation for single-cell optogenetics. These setups are partially supported by the facility and partially by end-users. The facility also offers a variety of light, epi-fluorescent, and confocal microscopes to NIN researchers, including an SP8 confocal microscope for spectrally flexible imaging with a white light laser, a high-throughput brightfield/epi-fluorescent slide scanner (Axioscan), a Stedycon 2D stimulated emission depletion (STED) microscope for sub-diffraction limit imaging, and a two-photon serial sectioning microscope for whole-brain imaging. Researchers from other institutes are welcome to use the facility at no cost, although usage is limited to availability. A complete equipment list is available on the NIN website. Training and maintenance are managed by a dedicated staff member (Roeland Lokhorst, PhD). Image analysis tools developed by the Levelt group, such as the SpecSeg pipeline for ROI selection in one- and two-photon calcium imaging data, chronic ROI matching, and imaging of subcellular structures, are available on the NIN Github page.

Sleep Lab & Register

The institute's human sleep lab, supervised by van Someren, features four sound-insulated bedrooms designed to manipulate sleep conditions while capturing high-density EEG data (256 channels) and monitoring performance. Study participants are primarily recruited through the Netherlands Sleep Registry, which is also coordinated by the NIN.

Animal Facility

This facility includes a mouse transgenic unit (maximum capacity of 1,300 individually ventilated cages (IVCs), with around 70 genetically altered mice strains), and an experimental rodent unit (maximum capacity approximately 400 IVCs for mice and 150 rat cages, both open and IVC), a DM-II unit for biosafety level II studies (approximately 70 mice cages and 30 rat cages). The facility staff provides support in breeding and genetic monitoring of all mice strains, and training and experimental support during surgeries or other procedures. Additionally, the Animal Facility hosts a NHP unit which pair-houses Rhesus macaques in enriched cages. It is the NHP facility for cognitive neuroscience in the Netherlands. Following the retirement of Kamermans, the zebrafish unit was discontinued in 2024. The Animal Facility is headed by Viola Galligioni, DVM PhD.

Spinoza

The Spinoza Centre for Neuroimaging (est. 2015) serves as a core research facility and knowledge hub of the Royal Netherlands Academy of Arts and Sciences (KNAW), Vrije Universiteit Amsterdam (VU), and Amsterdam University Medical Center (AUMC). The Spinoza Centre is integrated in the AUMC Research Imaging Core Center (RICC), Amsterdam Neuroscience, the VU institute for Brain and Behavior Amsterdam (iBBA), and the NIN. The NIN oversees various management functions for the Spinoza Centre, including finances, ICT, and reporting to the partner institutions (Case study 2).

Mechatronics

The Mechatronics team supports research groups and facilities at the NIN in developing and producing scientific instruments and experimental setups. The team specializes in developing, modifying, maintaining, and producing unique, high-quality technological equipment for scientific research. Expertise is provided in electronics, software development, mechanics, and microscopy/optics. The mechatronics team played a key role in developing the NIN-scope, a specialized imaging device for measurements in freely moving mice. These devices are available for purchase at cost price from the mechatronics department and have primarily been sold to other universities within the Netherlands.

Neuropixels Center of Expertise

The institute houses five high-density electrophysiology recording setups for Neuropixels probes. Open-source tools have been developed by the Heimel group for Neuropixels data acquisition (Acquipix), responsive unit selection (ZETA-test) and a neural probe finder that supports mice, rat, and macaque brain atlases. The tools and expertise are shared with the international neuroscience community via www.ephyswiki.org and GitHub.

Motion Lab

This lab features a unique combined hexapod turntable and 3D projection screen, enabling rotation and translation of vestibular and visual stimuli in any direction, while recording electrophysiological brain activity and eye movements in rodents or macaques. Coordinated by de Zeeuw, this facility serves as a training and phenotyping hub for scientists from Europe, the USA, and Asia.

Netherlands Brain Bank (NBB)

The NBB, led by Huitinga, is an internationally renowned resource for high-quality, well-characterized brain tissue, with an average postmortem delay of just 6.5 hours. Established in 1985, the NBB has collected tissue from over 5,200 donors, including individuals with neurological and psychiatric disorders and healthy controls. Donors give informed consent for the use of their brain tissue and clinical data in research.
The NBB supports approximately 200 international research projects annually, contributing to around 140 scientific publications each year. It collaborates with over 300 academic institutes and 75 industry laboratories worldwide, ensuring efficient, ethical, and legal sample sharing through material transfer agreements. Dedicated donor programs, such as those for multiple sclerosis, psychiatric disorders, and chronic fatigue syndrome, further enrich the collection.
To expand its impact, the NBB launched the Netherlands Neurogenomics Database, integrating detailed clinical, pathological, genetic, and omics data from donors to advance research (case study 1).

ICT

The ICT team facilitates the scientific work at the NIN by ensuring high-quality and reliable IT infrastructure and services. In line with the advice of the 2018 assessment committee, the team has invested in over one petabyte of central data storage and plays an advisory role in the procurement of computer systems. NIN scientists can exploit the extensive computing power provided by SURF, the ICT-cooperation of Dutch education and research institutions, with which NIN has a Research Capacity Computing Service contract. This can be combined with direct access to their local data. To this end, a secure network environment has been established, supporting SURF Research Cloud for building virtual research environments. Additionally, the KNAW has recently made SURF Research Drive and Data Archive available to the NIN researchers. SURF Research Drive enables secure and controlled data sharing with researchers both within and outside the institute. SURF Data Archive offers an affordable solution to long-term data storage using a tape drive system, providing a means to archive inactive data securely for up to ten years while optimizing active data storage capacity. NIN users have already uploaded over 100TB of data to the Data Archive. Data sharing (Open Science, see Ch. 7) remains the responsibility of individual researchers but is technically supported by the ICT team. The team also plays an important role in ensuring information security, addressing both network-level protections and raising user awareness. (Web) application development is also part of the activities, further supporting the institute's technological and scientific needs.

4.3 Funding, prizes and honors

In addition to this main research output, several other indicators such as prizes can be found in the supplementary tables:

- All new research grants and contracts (€53.2M in total, Supplementary table 1)
- Personal grants (€14.5M in total, Supplementary table 2)
- Prizes (*Figure 4.1*, *previous page* & Supplementary table 3)
- Memberships of editorial boards (Supplementary table 4)
- Memberships of committees (Supplementary table 5)
- Organization of symposia, conferences in 2024 (Supplementary table 6)

NIN scientists were successful in obtaining prestigious personal grants (Supplementary table 1). Kole, Dumoulin, and Willuhn obtained NWO Vici grants (2 x 2018, 2023); Jahanshani and van der Zwaag obtained a Vidi grant (2019 and 2021); several postdocs obtained Veni grants (Freal 2019, de Jong 2022, Michon, Papale, 2023, Westerberg 2024), ERC MSCA fellowships (Gulbinaite 2019, Vandael 2021) or other fellowships (HFSP-O, Westerberg and SNSF-PM, Osoria-Forero, both 2023, ZonMW fellowships, Dubey and Kole, both 2021, Rösler, Bial foundation 2023, Strik, Stichting MS research, 2023). Van Someren and Roelfsema obtained ERC advanced grants (2020, 2022), and Siclari an ERC starter grant (2022). Van der Zwaag and Gazolla obtained NWO Aspasia grants (2018 and 2021). In addition, NIN scientists received numerous project grants, which can be found in Supplementary table 2. Several NIN scientists obtained prizes during the assessment period (*Figure 4.1*, *previous page*).

4.4 Research infrastructure

Access to the newest techniques and technologies is essential for performing top-tier neuroscience research. Therefore, the NIN strategically aims to continuously introduce and develop cutting-edge techniques and technologies, while optimizing the NIN facilities that support and advance these technological innovations. These facilities also contribute to the national role of the NIN as a central neuroscience hub, by sharing materials, access, expertise, software, and designs (see overview facilities on the left).

4.5 Research collaborations

Collaborations within the NIN: The NIN strategically stimulates internal collaboration by hosting and recruiting research groups that explore diverse yet overlapping topics using a wide range of experimental approaches. The success of this strategy is evidenced by the extensive number of collaborations between the NIN research groups (*Figure 4.2*, *next page*). These collaborations are often inspired by joint journal clubs, lab meetings or NIN symposia, and not only initiated by group leaders but also by junior researchers who are often well-informed about expertise present in other NIN groups. By partnering with and leveraging the scientific and experimental strengths of other groups, NIN researchers conduct unique studies at the intersection of various neuroscientific disciplines, leading to groundbreaking joint publications and the acquisition of prestigious grants.

Collaborations within the Netherlands: KNAW institutes are expected to have a national role. For the NIN to solidify its role as a central hub for neuroscience in the Netherlands, it is essential to foster collaborations, share scientific and technical knowhow, and lead research consortia in the NIN's core areas of expertise. This strategy is exemplified by several initiatives:

- The NeuroTechNL Consortium, initiated by Roelfsema, focuses on developing innovative neurotechnologies that enhance the understanding of brain function and improve treatments for neurological disorders. By integrating tools such as brain-computer interfaces and minimally invasive neural interventions, NeuroTechNL is part of the Topsector Life-Science and Health roadmap and includes neuroscientists, technical scientists and clinicians from every Dutch university, relevant companies and several patient organizations to addresses critical challenges and unmet needs in neuroscience and neurotechnology. The consortium played a key role in securing the INTENSE crossover grant (>€14M) and the NWO Gravitation grant Dutch Brain Interface Initiative (DBI2) (>€20M), and other grants.

Figure 4.2 - Extensive collaborations exist between NIN groups

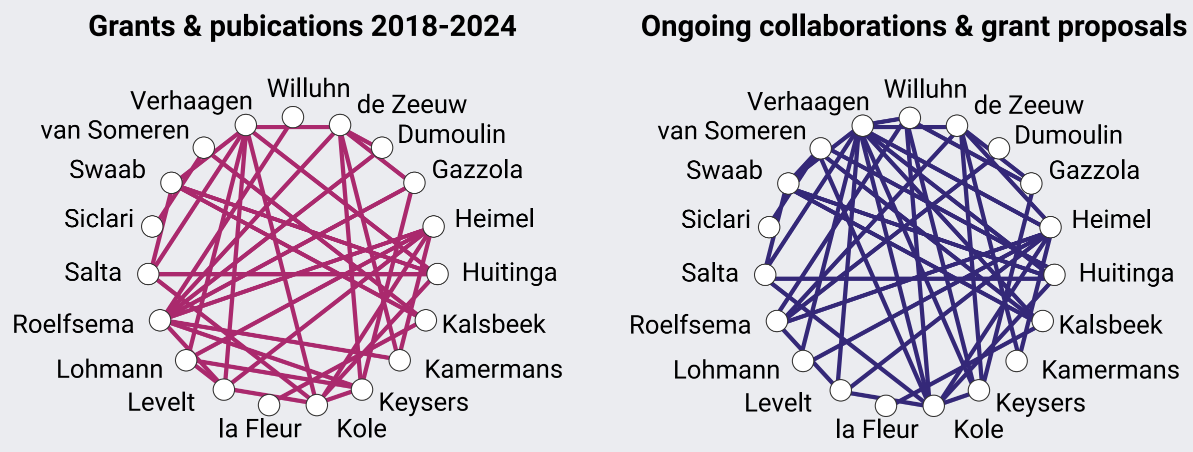


Table 4.2 - Adjunct appointments and professorships. December 2024		
Name	**Position**	**University**
Chris de Zeeuw	Full Professor	Erasmus MC
Christiaan Levelt	Special Professor	VU Amsterdam
Christian Keysers	Full Professor	University of Amsterdam
Christian Lohmann	Special Professor	VU Amsterdam
Dick Swaab	Guest Professor	Shanghai Center for Brain Science and Brain-inspired Technology Hebei Medical University
Dries Kalsbeek	Full Professor	Amsterdam UMC
Eus van Someren	Special Professor	VU Amsterdam, Amsterdam UMC
Francesca Siclari	Invited Professor	University of Laussanne
Inge Huitinga	Special Professor	University of Amsterdam
Ingo Willuhn	Full Professor	Amsterdam UMC
Joost Verhaagen	Special Professor	VU Amsterdam
Maarten Kamermans	Special Professor	Amsterdam UMC
Maarten Kole	Full Professor	Utrecht University
Pieter Roelfsema	Special Professor	VU Amsterdam, Amsterdam UMC
Serge Dumoulin	Special Professor	VU Amsterdam, Utrecht University
Valeria Gazzola	Associate Professor	University of Amsterdam (department of Psychology)

- The Institute for Chemical Neurosciences (iCNS), led by Huitinga and Kole, is a multidisciplinary national consortium to uncover the molecular and cellular mechanisms underlying brain diseases and psychiatric conditions. Supported by a NWO Gravitation grant (>€23M), the consortium brings together leading research institutions across the Netherlands to apply advanced technologies, including advanced chemical tools, molecular analyses and AI, to link human brain changes to specific psychiatric symptoms.
- The NIN is also co-initiator of DBI2. Supported by a Gravitation grant, DBI2 focuses on developing next-generation brain-machine interfaces aimed at understanding brain dynamics and their interactions with the environment. This collaboration, which involves the NIN, the Donders Institute for Brain, Cognition and Behavior of the Dutch Radboud University (DI), and other leading research groups, combines computational neuroscience, neurotechnology, and behavioral studies to develop therapeutic and cognitive tools.
- The NIN is part of the core team of GUTS, a gravitation grant exploring the neural, social and genetic factors (a) enabling young individuals to develop into flourishing members of society and (b) with the department of child and adolescent psychiatry, those influencing the persistence in antisocial behavior.
- The NIN is one of the main partners of the National Roadmap DYNAMIC 14T project (19M€) that will build the world's strongest MRI scanner with a magnetic field strength of 14 Tesla in Nijmegen.
- The NIN and DI have also launched joint funding opportunities to encourage collaboration and expertise sharing between their neuroscientists. These grants aim to produce preliminary data for future larger joint projects.
- With input from psychiatrists and psychiatry researchers, the NIN has started an initiative which involves organizing focused interactions between psychiatrists and neuroscience researchers from the NIN, developing co-supervised PhD projects, and fostering interdisciplinary training for young professionals with the goal to establish a new generation of neuroscience-orientated psychiatrists (see Ch. 2.2).

NIN group leaders actively participate in various collaborative program grants with researchers from universities throughout the Netherlands. In addition, the NIN group leaders hold (special) professorships at these universities (*Table 4.2*). While NIN research groups have many collaborations with academic institutions in Amsterdam (37 joint projects), they also have extensive collaborations with other Dutch universities including Nijmegen (16), Leiden (15), Rotterdam (9), Utrecht (9), Groningen (7), Maastricht (5), Delft (3), Twente (2), and Tilburg (1). In addition, there are 11 collaborations with companies and organizations throughout the Netherlands (situation in 2024).

International collaborations: Apart from collaborations within the Netherlands, NIN groups also collaborated with more than 80 international partners in 23 countries during the assessment period, in smaller or larger joint programs funded by for instance FlagEra grants, Wellcome Trust grants, and the Human Brain Project. Countries with which the NIN most were performed collaborative projects include USA (19), Switzerland (18), France (14), UK (14), and Germany (10).

NIN activities during the Weekend of Science

5 Societal relevance

The NIN is dedicated to curiosity-driven research, producing fundamental scientific insights with significant societal relevance. Although the institute did not implement an explicit overarching societal impact strategy during the assessment period, its researchers and management took numerous strategic actions to ensure that the NIN's scientific insights and expertise benefited society. These efforts included collaborating with clinicians (Ch. 5.1), involving patient organizations (Ch. 5.2), enhancing public outreach (Ch. 5.3), advising policymakers and funding agencies (Ch. 5.4), and collaborating with industry (Ch. 5.5). Moreover, the NIN trains the next generation of neuroscience experts, many of whom will pursue careers with societal impact beyond academia (see Ch. 6). The following sections highlight how the NIN strategically engages with its key societal stakeholder groups to ensure that the NIN research output results in actual societal impact.

5.1 Collaborating with clinicians and clinical researchers

Fundamental brain research has a profound societal impact. Brain disorders are devastating for patients and their friends and relatives. They account for 25% of all healthcare costs and cause significant additional economic burdens. Therapies remain in their infancy due to the limited understanding of brain function, making it extremely challenging to study pathophysiological processes, identify biomarkers, or develop treatments. Fundamental neuroscience research is essential to changing this situation. During the assessment period, NIN researchers collaborated with clinicians to better understand neurological and psychiatric disorders, identify biomarkers, develop novel therapeutic approaches, and develop clinically relevant technologies. Examples of these collaborations are described in Appendix 2.

5.2 Collaborating with clinicians and clinical researchers

NIN researchers maintain regular interactions with patient organizations. For instance, the NeuroTech-NL consortium unites key players in the development of next-generation brain implants. NIN researchers collaborate with organizations supporting individuals with visual impairments, including Visio, Bartimeus, and the Oogvereniging (the organization that represents people with visual impairments in the Netherlands), advising on the required functionality of visual brain prostheses. Through its sleep registry, the NIN has supported the establishment of a patient organization for people with chronic insomnia. The institute also interacts with patient organizations related to psychiatric disorders, including Nedkad and the ADF stichting, which focus on prevalent psychiatric disorders such as depression, anxiety, obsessive compulsive disorder, and phobias. A dedicated panel of individuals with lived experience in these disorders visits the NIN approximately three times per year. Moreover, researchers at the NIN and Spinoza collaborate closely with researchers from Radboud University (Nijmegen) to study patients represented by the Ataxia Foundation.

The NBB collaborates with multiple patient organizations and clinical cohorts to recruit donors and improve procedures based on patient perspectives. NBB representatives regularly attend events such as Stichting Plus Minus (bipolar disorder) patient days, National MS days, MS Research patient days, and Narcolepsy Contact Day. In addition, the NBB partnered with (ME/CVS) Nederland and the ME/CVS Vereniging (patient organizations for myalgic encephalomyelitis) to establish a brain donor program for ME/CVS research.

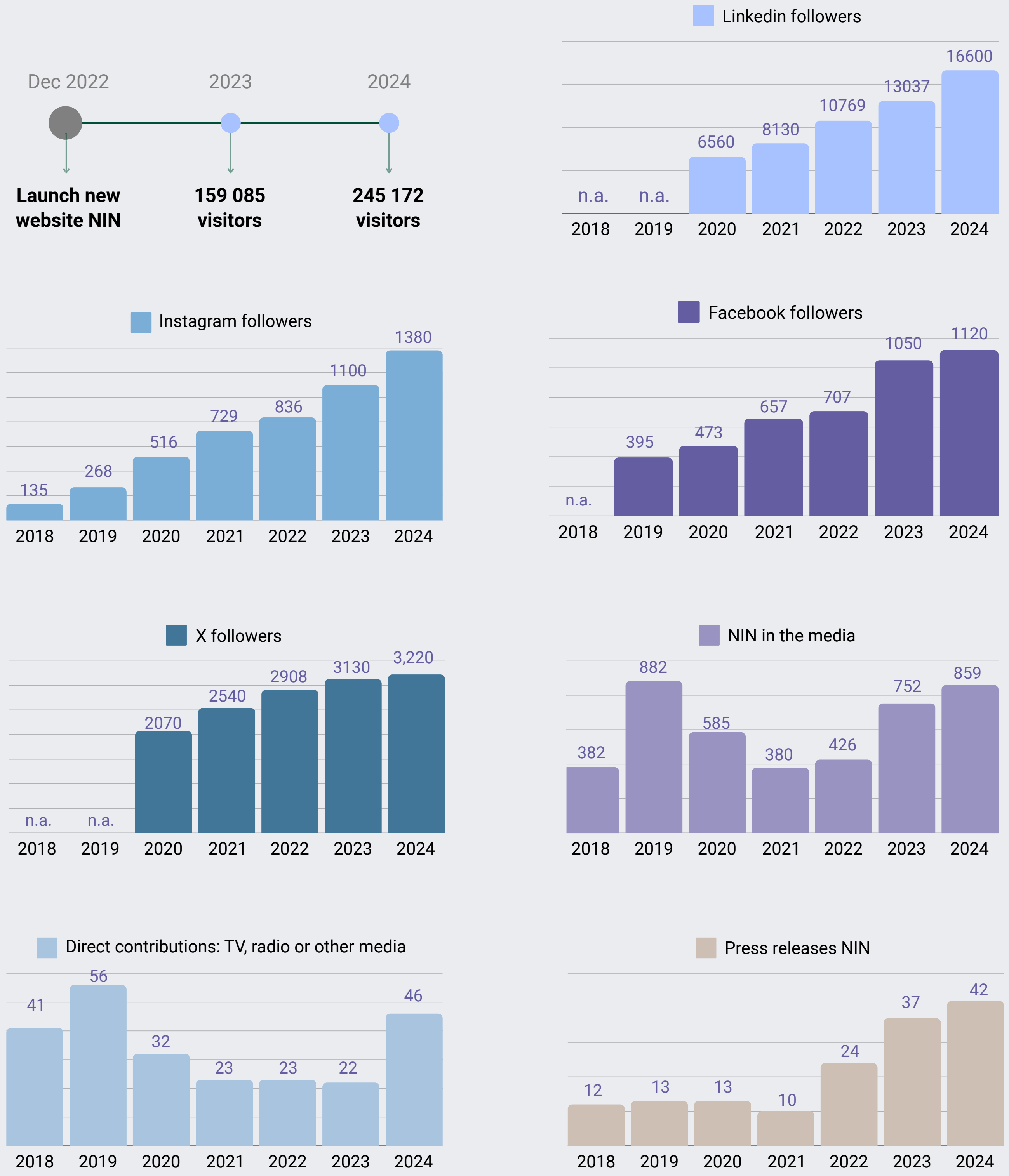
5.3 Engaging with the public

The general public shows a strong interest in brain research, and awareness that psychiatric disorders originate in the brain is not yet widespread. Therefore, informing the public about brain function is an important part of the work of the NIN. During the assessment period, the NIN strategically increased its efforts to share knowledge with the public, bridging the gap between science and society and raising awareness about the importance of brain research. Among other things, this was done by launching a new NIN website, increasing social media presence, and publishing more articles aimed at the general public (*Figure 5.1*). Examples of other public engagement initiatives are given in Appendix 3.

5.4 Advising policymakers

New insights emerging from NIN research hold significant value for national and international policy. Annually, NIN researchers actively participate in societal organizations and policy advisory committees that align with their research activities. Several NIN researchers have contributed to policy reports, including advice on animal experimentation and the ethics of brain prostheses. Policymakers also actively consult the NIN. Examples are provided in Appendix 4. In addition to these direct interactions, analysis by the CWTS (Supplementary document 4.1) shows that 4% of NIN publications are cited in policy documents, matching the global average in the NIN's fields of research. In some fields, this impact is greater, such as sleeping disorders (10% of NIN publications on

Figure 5.1 - The new NIN website (launched in 2022) attracts around 245,000 visitors annually. The NIN actively engages with a growing audience across multiple social media platforms, including LinkedIn (16,600 followers), X (formerly Twitter, 3,220 followers), Facebook (1,120 followers), and Instagram (1,380 followers), with follower numbers steadily increasing on all channels.



this subject, compared to a 6% global average) and multiple sclerosis (8%, compared to 7% average).

5.5 Interacting with industrial partners

NIN research has resulted in several patented technologies and products, and professional practices that have been licensed to industrial stakeholders. The KNAW's Knowledge Transfer Office (KTO) supports researchers and institutes with patent applications, setting up interactions with industrial partners and obtaining funding for private-public partnerships. Examples of interactions with industrial partners can be found in Appendix 5.

Table 6.1a - Current positions of (former) NIN-employed PhD candidates		
Job category	#	%
Academia	17	53
Industry	9	28
Medicine	1	3
Education	1	3
Government	1	3
Other	3	9
Total (former) PhD candidates with new job	32	100
PhD in progress	15	-
Stopped and current position unknown	7	-
Total PhD candidates who started at the NIN between 2015 and 2020	54	-

Table 6.1b - Current positions of (former) NIN postdocs		
Job category	#	%
Academia	32	58
Industry	9	16
Medicine	2	4
Education	3	5
Government	3	5
Other	6	11
Total (former) postdocs with new job	55	100

6 PhD candidates and postdocs: policy and training

To ensure high quality research, the NIN recruits highly talented PhD candidates and postdocs, and trains them to become the next generation of leaders in neuroscience.

6.1 Organization of PhD trajectory

To attract top candidates, the NIN recruits PhD candidates internationally, advertising positions openly. Applications are reviewed by an ad-hoc committee based on the candidate's application letter, CV, and reference letters. Shortlisted candidates are invited for interviews, with final selections made based on their qualifications, competencies, and expected fit within the team. Successful candidates enroll at a Dutch university affiliated with their promotor (typically the NIN group leader holding a special professorship), where they obtain their PhD.

Most NIN PhD candidates (~40-50 in total) participate in the Graduate School Neurosciences Amsterdam Rotterdam (ONWAR), a collaboration between neuroscience departments at UvA, AUMC, VU Amsterdam, Erasmus University Rotterdam (EUR), and the NIN. Others may enroll in different graduate schools, such as VU Amsterdam's Graduate School of the Faculty of Behavioral and Movement Sciences, depending on their research focus and the affiliation of their promotor. At all Dutch universities, PhD candidates are required to follow a research integrity course.

At the start of the PhD trajectory, research goals and training plans are outlined in an education plan (Supplementary document 6.1). The training program comprises 404 hours over four years, including ONWAR activities, with flexibility for international courses (e.g., CSHL or FENS Cajal courses) or personal development/soft skill courses offered by the KNAW or other organizations. ONWAR provides a comprehensive training program, including hands-on courses in molecular and cellular imaging, programming and grant-writing, as well as advanced neuroscience topics, from clinical and cognitive neuroscience to neurogenomics and electrophysiology. General courses (e.g., statistics) are also offered. Courses are evaluated and improved through student feedback, and new offerings are developed as needed. The program is enriched with the Swammerdam lecture series, organized by ONWAR, featuring eminent researchers, often paired with masterclasses that allow PhD candidates to discuss their work with renowned international scientists. ONWAR also organizes an annual PhD retreat with networking and research presentation opportunities. NIN scientists actively participate in ONWAR committees and course organization.

Each PhD candidate is assigned an ONWAR tutor positioned at a different institution to address potential issues. Apart from their primary supervisor (the NIN group leader), each candidate also has a second supervisor (co-supervisor), which can be a collaborator, another NIN group leader and/or the promotor in case the NIN group leader does not hold a (special) professorship. Progress of the PhD trajectory should be monitored annually in a discussion between the candidate, supervisor, and co-supervisor. This process follows the NIN PhD Evaluation and Monitoring Schedule, which describes the planning, purpose, participants, and expected results of all evaluation moments (see Appendix 6). The outcomes of these discussions are documented as amendments to the education plan. Although strict KNAW/GDPR privacy rules have complicated this monitoring process, new procedures have been implemented in 2024 to address these challenges. Appraisal interviews are held after four and nine months, with the latter serving as a go/no go decision point. Mid-term evaluations involve the supervisor, co-supervisor, and an external scientist, with HR monitoring the process.

The NIN, ONWAR, and the KNAW organize career events to help PhD candidates explore post-graduation opportunities, connecting them with professionals in academia and industry. *Table 6.1a* lists the current employment positions of 32 former NIN-employed PhD candidates who started between 2015 and 2020 and whose current position is known.

6.2 Duration and success rates of PhD trajectories

The NIN-employed PhD candidates who started between 2015 and 2020 required an average of 5.8 years to graduate (time of start until date of graduation, *Table 6.2*).

This is similar to the previous assessment period, despite efforts to shorten the duration such as introduction of a mid-term evaluation and (slightly) reduced quantitative publication or experimental chapter demands by the universities. Delays were partially caused by COVID-19 disruptions resulting in significant delays (~3-6 months). COVID-delays were mitigated by the NIN, partially through bridging funds provided by the Ministry of Science

Table 6.2 - Duration of PhD trajectories

PhD candidates with a contract at the NIN:				Graduated in:													
starting year	enrolment			<4 yr		<5 yr		<6yr		<7yr		total graduated		not finished yet		discontinued	
	male	female	total	#	%	#	%	#	%	#	%	#	%	#	%	#	%
2015	2	8	10	0	0%	2	20%	2	20%	1	10%	7	70%	2	20%	1	10%
2016	2	7	9	0	0%	1	11%	3	33%	1	11%	7	78%	2	22%	0	0%
2017	4	3	7	0	0%	0	0%	0	0%	1	14%	1	14%	2	29%	4	57%
2018	3	4	7	0	0%	1	14%	3	43%	0	0%	4	57%	3	43%	0	0%
2019	1	6	7	0	0%	1	14%	0	0%	0	0%	1	14%	3	43%	3	43%
2020	3	11	14	0	0%	3	21%	0	0%	0	0%	3	21%	9	64%	2	14%
Total	15	39	54	0	0%	8	15%	8	15%	3	6%	23	43%	21	39%	10	19%

Guest PhD candidates*				Graduated in:													
starting year	enrolment			<4 yr		<5 yr		<6yr		<7yr		total graduated		not finished yet		discontinued	
	male	female	total	#	%	#	%	#	%	#	%	#	%	#	%	#	%
2015	2	2	4	0	0%	2	50%	0	0%	0	0%	4	100%	0	0%	0	0%
2016	2	2	4	0	0%	2	50%	1	25%	0	0%	4	100%	0	0%	0	0%
2017	1	6	7	1	14%	2	29%	4	57%	0	0%	7	100%	0	0%	0	0%
2018	4	6	9	1	11%	0	0%	3	33%	1	11%	5	56%	3	33%	1	11%
2019	1	1	2	0	0%	1	50%	0	0%	0	0%	1	50%	0	0%	1	50%
2020	0	3	3	1	33%	0	0%	0	0%	0	0%	1	33%	2	67%	0	0%
Total	10	20	29	3	10%	7	24%	8	28%	1	3%	22	76%	5	17%	2	7%

* PhD candidates under end-responsibility of the NIN, incl PhD candidates of Willuhn, Kalsbeek, La Fleur and including PhD candidates with a scholarship (for example: from the Chinese Scholarship Council)

and Education. However, structural issues and possible research field-specific challenges also contribute to the relative long PhD trajectories at the NIN, as ONWAR students outside the NIN also require ~6 years on average (compared to the 5.1-year national average in all research fields in the Netherlands). Delays frequently occur when PhD candidates begin postdoctoral positions before completing their theses, as both the candidates and their supervisors often underestimate the effort required to finalize the work while starting a new job. Career grant eligibility deadlines exacerbate this issue by disincentivizing swift thesis completion. To address this, the NIN MT advises group leaders to ensure PhD candidates complete their theses before leaving the institute and continue to receive salaries until then.

Another factor contributing to delays is the pressure to produce multiple high-quality publications. Universities typically require ~3-4 experimental chapters, with 1-3 published as first- or co-first-author papers in international journals. The shared ambition of PhD candidates and supervisors to perform high-quality science published in highly visible neuroscientific journals further extends timelines. While many university departments are currently re-evaluating their thesis requirements, the KNAW has no authority over these decisions.

Appendix 6.1 shows that 19% of PhD candidates at the NIN discontinued their PhD track prematurely for various reasons, including termination of the contract after the go/no-go moment, underperformance, (mental) illness, or a misalignment with their skills and aspirations. To address these issues, the NIN is improving communication of expectations, better assessing the competencies of applicants during recruitment, and providing more structure and planning throughout the PhD process. The NIN also aims to anticipate illness-related issues and actively informs employees about burn-out prevention strategies (see Ch. 8).

PhD representatives conduct yearly surveys to identify and discuss issues that are important to them with each other. Twice a year, the PhD candidates meet with the NIN board to discuss concerns requiring management action and collaborate on improvements.

6.3 Postdoc supervision and training

The NIN actively supports the professional development of its postdoctoral researchers through various initiatives. Postdocs are encouraged to participate in scientific meetings and pursue relevant courses aligned with their research and career goals, supported by a dedicated training fund of the NIN (~€65K per year for the institute, including non-scientific staff). This budget covers both in-house and external courses, such as the Art. 9 laboratory animal training, programming, leadership, and language courses. Both the NIN and the KNAW also organize career-oriented training sessions.

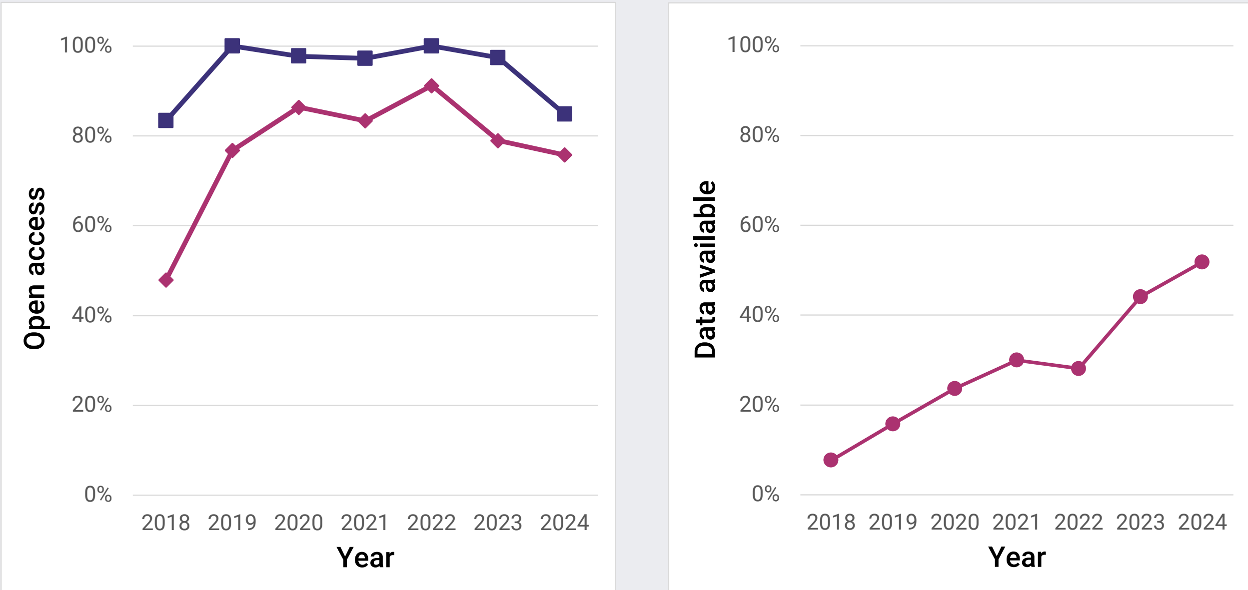
Postdocs receive tailored support for grant writing, including detailed feedback and mock interviews to improve their proposals. The NIN encourages postdocs to apply for independent fellowships, such as Veni grants, and may provide contract extensions through conditional permanent appointments (currently 9) when successful (Ch. 4.3). Applications for larger grants, including Vidi or ERC starter grants, are first discussed with all group leaders to ensure alignment with the NIN's strategic aims, as these grants may lead to tenure-track positions requiring reserved institute budgets. Currently, three former postdocs with critical knowledge or skills, essential to the viability of research groups, have obtained a permanent position.

Like PhD candidates, postdocs play an active role in NIN policy development by organizing surveys and providing feedback. Like PhD candidates, they meet twice a year with the NIN board. Recognizing the four-year non-tenured contractual limit for postdocs in the Netherlands, the NIN is implementing structured planning and training schedules to increase awareness of career opportunities and long-term professional needs. *Table 6.1b* shows the current employment positions of 55 former postdocs that left the NIN during the assessment period.

6.4 Brain Awards

Each year, the NIN presents the Brain Awards, celebrating exceptional contributions of PhD candidates and postdocs to neuroscience research. The awards alternate annually between recognizing postdoctoral researchers and PhD candidates. The Brain Awards are given in three categories aligned with the NIN's strategies: Scientific Excellence, Collaborative Excellence, and Methodological Excellence. Recipients are selected through a thorough process, involving evaluations by external reviewers and rankings by an internal committee. Winners receive a €1,000 prize and a specially designed statue, presented during a festive ceremony where awardees present their work.

Figure 7.1 - a. Proportion of publications per year with a NIN PI as last author that are currently open access (blue line) or gold open access (purple line) **b.** The proportion of these articles with accompanying data available online (purple line).



7 Open Science

Openly sharing publications, technical and scientific expertise, and data plays a key role in supporting the NIN's ambition to be a globally competitive center for research on brain circuits. Therefore, investing in Open Science and sharing of data and expertise has received more attention in the past year. The NIN aims to make (1) its journal publications open access, (2) software and hardware developed within the NIN with significant reuse potential open access, (3) datasets acquired at the NIN that have reuse potential FAIR and openly accessible. In addition, the NIN (4) aims to involve stakeholders, such as patient organizations, companies, and psychiatrists in its research projects whenever this is appropriate (see Ch. 2 and Ch. 5 for examples). To help achieve these goals, the NIN has developed an Open Science Policy (Supplementary document 7.1) that is being implemented at present, and provides guidance to NIN scientists on best practices and effective strategies for achieving them.

7.1 Open access publishing

The NIN has made substantial progress in open access publishing, as evidenced by the increasing number of open access publications with a NIN affiliation (*Table 4.1*). For papers where a NIN scientist is the last author, this number has recently plateaued, with nearly 100% of published papers being open access in 2023 (~80% Gold open access) (*Figure 7.1a*). In 2024, this percentage appears lower due to the 6-month delay associated with Green open access publishing. The percentage of Green open access in *Figure 7.1a* is higher than in *Table 4.1* because the latter also includes collaborative articles, over which NIN cannot enforce the Taverne rule. To further encourage the use of Gold open access, the NIN now expects research groups to cover the first €3,000 of article processing charges, with any additional costs covered by the central NIN budget, starting summer 2024. When Gold open access is not chosen, the NIN ensures Green open access through the Taverne agreement. In addition, the NIN strongly encourages its scientists to share the submitted versions of their manuscripts on preprint repositories (bioRxiv in particular) to provide earlier access to their work for the scientific community.

7.2 Sharing code, designs, and data

At the NIN, individual scientists and research groups actively share tools and designs with the international neuroscience community. Appealing examples include the open hardware design of a miniature microscope, Neuropixels data acquisition software, and an image segmentation tool. To facilitate sharing of software and designs, the NIN maintains a dedicated GitHub repository, which hosts 20 public repositories and links to over 60 public source repositories from individual research groups' GitHub sites. The institute is working on integrating the GitHub sites of individual researchers into the NIN GitHub in line with its Open Science policy.

The proportion of manuscripts published with accompanying open data has steadily increased over the assessment period, reaching 50% in 2024 (*Figure 7.1b*). To further enhance the sharing and findability of reusable data, the NIN has invested in both infrastructure and guidelines for data curation. The institute invested €350K in data servers, providing 1 Petabyte of storage capacity to ensure data is stored securely and organized consistently. Data and associated documents, such as ethical approvals, are stored using a standardized folder structure defined by the NIN Data Storage Protocol. This structure, which clearly links publications to the underlying data, facilitates data sharing upon publication and allows for the retrieval of unpublished data after scientists leave the institute. Currently, 87% of all data generated at the institute is stored according to this folder structure. To further increase this proportion, research groups will bear the cost of storing data that does not comply with the Data Storage Protocol starting in January 2025. In the next evaluation period, the NIN aims to ensure that all data with reuse potential is published alongside publications in **standardized formats with appropriate metadata**. Researchers are already encouraged to use the Follow Your Data (FYD) system that has been developed at the NIN to support this ambition (Case study 3).

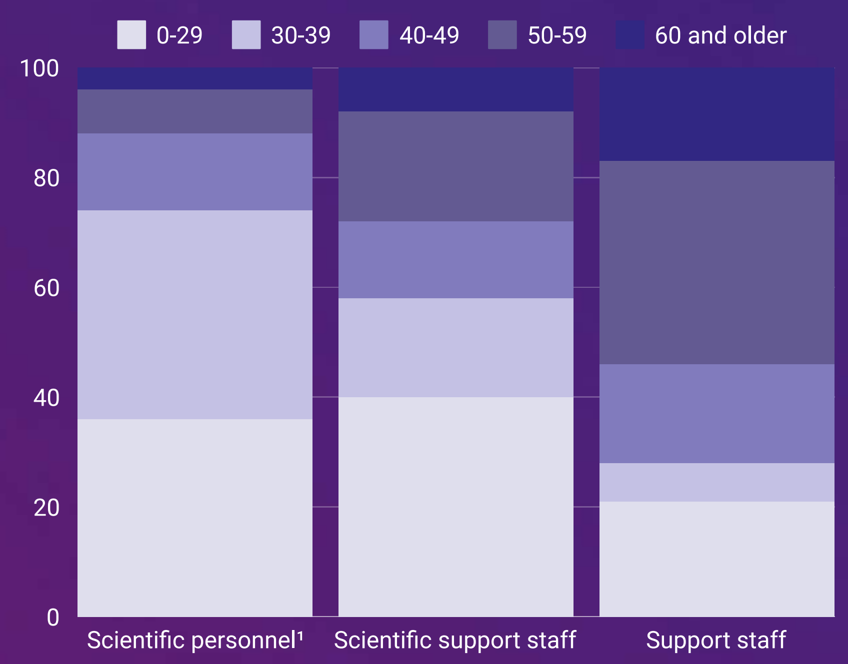
Systematic sharing of all reusable data is hindered by time and legal and privacy constraints. Currently, the NIN has limited ability to share privacy sensitive human data, affecting publications and grant applications about human neuroscience. Tasks such as determining which data should and legally can be shared, curating and converting data into standard formats, annotating metadata, and identifying appropriate sharing platforms are often complex and time-consuming. The current academic reward structure prioritizes publishing manuscripts over data, reducing the focus scientists place on data sharing. The NIN has introduced a data management award to increase the incentive. To further enhance data sharing while maintaining research productivity, the NIN is exploring ways to ease the burden on scientists by consolidating the work of its communication team, data steward, data privacy officer, and ICT team into a dedicated Open Science team. This team would support scientists in complementing their manuscripts with FAIR data and code. However, qualified experts will have to be hired within the NIN facility departments to spearhead this effort.

Table 8.1 Percentage of female employees

Year	2018	2019	2020	2021	2022	2023	2024
Scientific staff [1]	13	11	17	25	30	30	32
PhD candidate	57	67	58	52	56	56	64
Postdoc	50	48	44	37	42	42	49
Scientific support staff	39	49	45	49	52	52	61
Support staff (non scientific)	78	67	59	59	63	63	61

[1] Researchers with a permanent position and group leaders

Figure 8.1 - Age percentages for year 2024



[1] Researchers with a permanent position, group leaders, postdocs, and PhD candidates

8 Academic Culture and Human Resources Policy

The NIN's ambition to establish itself as a globally competitive center for brain circuit research relies on the efforts of the people working at the institute. Building critical mass and promoting collaborations within the institute can only be achieved when the NIN fosters an academic culture that attracts talented scientists who are eager to work together. Excellent science requires motivated staff at all levels and the highest level of scientific integrity. This calls for open communication, mutual respect, and an environment where people feel safe to provide feedback or report misconduct. Leadership should be transparent about decision making and expectations. Training the next generation of leaders in the field of neuroscience hinges on providing opportunities for personal and professional development while nurturing the scientists' passion for research and academia. Thus, academic culture and human resources policy are a cornerstone of the NIN strategy.

8.1 Openness, (social) safety, and inclusivity

Collaboration and transparency. During the assessment period, a management team was installed that included two group leaders in order to improve the transparency of decision making (Ch. 3). Last year, various additional efforts were made to improve internal communication, increase staff involvement, and enhance management-staff interactions. For instance, periodic staff surveys have resulted in initiatives such as a triannual interactive "Town hall meeting" during which ongoing issues are discussed, and all employees are stimulated to share feedback and ideas. Moreover, support team leaders now join group leader meetings twice a year. The NIN now also organizes monthly "Support each other" meetings, where support teams present their activities and services to all employees, and "Life-long learning" seminars, where NIN scientists explain their research to support staff.

Social events play a key role in creating a sense of community at the institute. A group of volunteers ("Borrel Squad") organizes Friday evening drinks after the Neuroscience Symposium, along with several other events such a summer institute outing, potluck Christmas dinner and party, and a New Year's celebration. To encourage scientific interaction, the NIN organizes a weekly Neuroscience Symposium featuring both internal and external speakers. In addition, group leader meetings start with a scientific presentation by one of the group leaders. Joint lab meetings and journal clubs also contribute to the exchange of scientific ideas and knowledge.

Diversity and inclusivity. At present, the gender distribution among most groups of NIN employees is approximately balanced at 50% (*Table 8.1*). However, the representation of women among group leaders is lower and remains a point of attention. Regarding the age distribution, young individuals are overrepresented at the NIN due to the large number of PhD candidates and postdocs (*Figure 8.1*). In contrast, more than half of the non-scientific support staff are over 50 years old. Nearly one-third of all employees are non-Dutch, representing 24 nationalities, with the majority of this group originating from European countries (Supplementary table 7).

In recent years, the NIN has placed particular emphasis on diversity and inclusion (D&I)-related topics and established the "NINclusion" team that has taken many actions. Following the KNAW's D&I project plan (2023), which proposes institute-specific action plans, the NIN has recently developed its own D&I action plan. This plan describes SMART-defined actions and goals (specific, measurable, achievable, relevant, and time-bound), most of which have already taken place or occur recurrently (Appendix 7). These include, among many others, the annual celebration of diverse inclusion and cultural events, the hiring of two female group leaders, the implementation of undesirable-behavior training for nearly 200 employees, the establishment of a fully equipped nursery/prayer/meditation room, and the organization of various workshops and training events. Reporting progress on D&I initiatives is part of the annual periodic administrative meetings with KNAW management.

The NIN's commitment to D&I aligns with a global shift in academic culture. The scientific community is increasingly prioritizing D&I due to growing awareness that more diverse workforces generate better and more creative solutions and discoveries as well as of issues such as social safety and leadership, a competitive labor market, the need for more professionalized recruitment processes, and the challenge of attracting and retaining scientific talents. In addition, external requirements, such as the European Commission's Gender Action Plan for Horizon funding, underscore the importance of D&I.

Occupational health and safety. The NIN aims to establish working conditions that minimize the risk of situations that could lead to injury, occupational or other illness, or damage. Therefore, the institute has established its own Occupational Health & Safety Committee. This committee discusses health and safety issues aimed at prevention and solving problems related to health and safety. The NIN's illness rate is low (1.9% in 2023). The NIN has intensified support for employees that are sick or at risk of illness by restarting the Social Medical Consultation (SMO) in 2024. At these quarterly meetings, the company doctor, HR advisers, and the director of operations jointly discuss options to enable and support an employee to return to work. A Risk Inventory

Collaboration and Transparecy

Diversity and Inclusivity

Occupational health and safety

Environmental sustainability

& Evaluation (RI&E) was conducted in 2018, and the associated action plan has been updated in 2023. Lab responsible persons were appointed to supervise lab safety. A new RI&E is scheduled to be carried out in 2025 or 2026, depending on the progress of relocation activities related to the renovation of the NIN laboratories and offices, which is also scheduled for 2025. To enhance awareness of occupational safety, the NIN has launched the e-learning 'Laboratory' for all new employees working in the laboratories.

Environmental sustainability. The NIN has a Green Office, which is dedicated to promoting sustainability across the institute. Its mission is to inform, connect, and inspire staff and students to adopt sustainable practices. Key goals include raising awareness, supporting sustainability initiatives, sharing information internally and externally, and embedding sustainability into research, education, and operations. Notable achievements include reducing waste through reusable materials, conserving energy, and organizing events such as the NIN Green Day and LOWvember. Recently, the Laboratory Efficiency Assessment Framework (LEAF) to enhance lab sustainability was implemented. Future plans include expanding the Green Office and further reducing material and energy use.

8.2 Research integrity

Research integrity is essential for achieving the NIN's strategic aims including scientific excellence, attracting top researchers, and maintaining credibility when advising the public and policymakers on neuroscience issues. The NIN adheres to the Netherlands Code of Conduct for Research Integrity, which addresses topics such as honesty and scrupulousness, reliability, verifiability, impartiality, independence, and responsibility. The NIN fosters a culture focused on genuine discovery rather than pursuing publications in high-impact journals. This approach alleviates pressures that might tempt researchers to unethical practices. Open discussions about results and active collaboration among researchers further reinforce a culture of transparency and collective progress.

The NIN also promotes research integrity by making research data findable on the NIN servers, accompanied by appropriate metadata for easy interpretation (Ch. 7). In addition to discouraging misconduct, this enhances reproducibility and accelerates scientific progress. The NIN also hosts a Statistics Club which provides a platform for researchers to seek advice on data analysis and statistical approaches, ensuring that findings are based on sound methodologies, thereby reducing the risk of errors or misrepresentation of data.

Research integrity is formally integrated into the NIN's annual appraisal interviews. Moreover, PhD candidates are required to take research integrity courses as part of their university programs, equipping them with a solid foundation in ethical research practices. To address concerns related to research misconduct, confidentiality officers are present at both the NIN and the KNAW. This ensures that researchers have a safe and reliable means to report and resolve integrity-related issues.

8.3 Human Resources Policy

Talent management. The NIN supports promising young scientists and aims to provide them with optimal career prospects. A key initiative is the tenure-track plan (Supplementary document 8.1), which addresses multiple levels, from junior to senior positions. The tenure-track plan offers new group leaders clarity regarding expectations and encourages them to contribute to the NIN's strategic aims, including delivering excellent science (publications and grants), fostering collaboration, training junior staff, practicing leadership, engaging in outreach, and advancing novel techniques and technologies.
NIN staff have access to the services of the KNAW Centre for Career Development, which include individual coaching and various courses, such as Successful Grant Writing and the masterclass How to organize your research journey. Staff whose temporary employment contracts are nearing expiration or who are facing partial occupational disability are offered workshops and personalized advice to help them secure alternative positions outside the KNAW.

Appreciative leadership. The NIN defines good leadership as appreciative leadership, with the core values of Development, Connection, and Clarity, in line with the vision of the KNAW. To encourage the adoption of this leadership style, the NIN director introduced and discussed the theme during the annual interviews with all scientific group leaders in 2024. To support staff and enhance their competence, the NIN provides various education and training opportunities (see Appendix 8).

Staff turnover. The temporary nature of most NIN research projects leads to a relatively high staff turnover rate. In 2024, 44 new staff members were recruited. Additionally HR took care of contracts for 5 on-call workers, 6 paid interns, and 80 contract extensions. Recruitment, selection, onboarding, and contract extensions are therefore the highest priority and largely determine the time allocation of the 2.8 FTE HR team.

9 Viability and strategy for the future

During the assessment period, the NIN's main ambition was to establish itself as a globally competitive center for research on brain circuits and its strategy focused on **building critical mass**, **investing in advanced techniques and technologies**, and **strengthening its role as a national neuroscience hub**. The institute utilized advice from the 2018 peer review committee and 2019 portfolio evaluation committee to further enhance its viability. Below, a SWOT analysis outlines the current situation of the NIN in relation to upcoming internal and external developments.

9.1 SWOT analysis

Strengths

The NIN is productive and creates high-quality scientific output in the field of brain circuits, with 140-180 articles per year, cited 1.89x more frequently than average in its field, on par with or exceeding other top European brain research institutes with similar or significantly more core funding. This is possible due to the excellence of the NIN scientists, who are able to attract significant funding and make true scientific and societal impact with their discoveries.

Thanks to the NIN's current strong financial position, the institute will be able to invest several million euros in the new strategic aims. It has performed exceptionally well in securing grants, including collaborative grants and prestigious Dutch (Veni, Vidi, Vici) and European (ERC Starting, Consolidator and Advanced) career grants. In addition, the institute fosters a highly collaborative spirit, with transparent leadership, attention to junior scientists and support staff, and efficient communication facilitated by its compact size. Investments in new techniques and technologies, high-quality facilities, and unique resources such as the Netherlands Brain Bank further enhance the institute's future capabilities. The new laboratories and facilities that are currently being built will further strengthen the research quality of the NIN.

Weaknesses

While the modest size of the NIN offers certain advantages, it also constrains organizational flexibility. Career development opportunities within the institute are limited, making it challenging to retain ambitious young researchers and support staff, particularly given the limited availability of permanent contracts. Despite considerable progress in research data management, including the establishment of a NIN Data Storage Protocol, consistent storage of 87% of data in structured formats, the adoption of the BIDS format in fMRI labs and the development of the automated databasing system FYD, further development and investments are necessary to meet evolving Open Science standards. In addition, the increasing scale and complexity of datasets result in a need for additional computational expertise and collaboration with other (KNAW) life science institutes to develop efficient approaches to standardize and share data. This expertise is difficult to recruit and requires significant additional investments.

Opportunities

The field of circuit neuroscience is advancing rapidly, yielding new insights into the neural basis of mental functions. Access to brain tissue from psychiatric patients, combined with a growing number of patient donors, creates unique opportunities for in-depth exploration of neurological and psychiatric disorders. Advances in powerful omics techniques further enable elucidation of the molecular and cellular underpinnings of neurological and psychiatric symptoms and the strong position of the NIN in neurotechnology development may help the development of neuromodulation-based treatment approaches. The rising societal burden of psychiatric and other brain disorders underscores the timeliness for the NIN to leverage its expertise in pursuit of better understanding, biomarkers, and potential treatments for these disorders. Aligning NIN research more closely with brain disorders also creates opportunities to secure external funding through private foundations and donations, for example through the Friends of the NIN foundation, amplifying the impact and reach of this research.

Over the past year, organizational changes within the KNAW board and management board have enhanced interactions between KNAW institutes and strengthened their representation to policymakers and political stakeholders. These changes create new opportunities to boost the visibility and societal impact of the NIN.

Threats

Substantial reductions in research and education budgets by the current Dutch government present a significant challenge to maintaining high-quality research in the Netherlands. Additionally, increasing regulatory requirements—e.g., concerning privacy, CO_2 emissions, and animal testing—along with overlapping oversight processes by the IVD, DEC, and CCD, lead to a heightened administrative burden. Misconceptions about the feasibility of entirely replacing animal experiments, including viewpoints from organizations like the Dutch Advisory Committee for Animal Research (NCAD) add complexity. Moreover, decisions by the KNAW board

regarding NHP research may restrict valuable scientific avenues in the near future. Finally, prolonged review times from medical ethical committees and legal processes at partner institutions further delay progress. Addressing these challenges requires streamlining approval processes, safeguarding the 3Rs in animal research without increasing the administrative burden, and advocating for science-informed policies.

9.2 Future strategy (2025-2030)

The NIN aims to continue the strategy that it has followed during the assessment period including the two new strategic aims that were added in 2024. Based on the SWOT analysis, extra attention will be paid to particular elements of the strategy.

Supporting and training a new generation of neuroscientists

A key responsibility of the NIN is training the next generation of brain researchers who will shape the scientific landscape and pursue impactful careers in academia, industry, science policy and consultancy, or healthcare. To fulfill this societal mission and support NIN trainees in building successful careers, the institute aims to enhance the quality and structure of its training and education programs, particularly for postdocs. This includes establishing clear mutual expectations between mentors and trainees and clarifying the skills and competencies that future employers will expect. Additionally, the NIN aims to encourage a dialogue between the KNAW and universities to align PhD requirements for NIN PhD candidates, ensuring they are rigorous yet achievable within a four to five-year timeframe.

Strengthening the interaction with psychiatry

While neurology and psychology are well-integrated with neuroscience research, psychiatry remains less connected to this scientific foundation. To bridge this gap, the NIN aims to foster a stronger mutual understanding between neuroscientists and psychiatrists. The NIN will invest in collaborative research projects that bring together neuroscientists at the NIN and psychiatrists across the Netherlands. This initiative will include specialized training for medical doctors (MDs) in both neuroscience and psychiatry, building a generation of MD-PhDs capable of conducting research at the intersection of these fields. This program, developed in collaboration with all stakeholders, may serve as a model for national initiatives focused on understanding the biological underpinnings of psychiatric symptoms, identifying biomarkers for psychiatric disorders, and developing innovative treatments. By facilitating interdisciplinary research and training, the NIN aims to contribute to a more cohesive approach to understanding and treating mental health conditions.

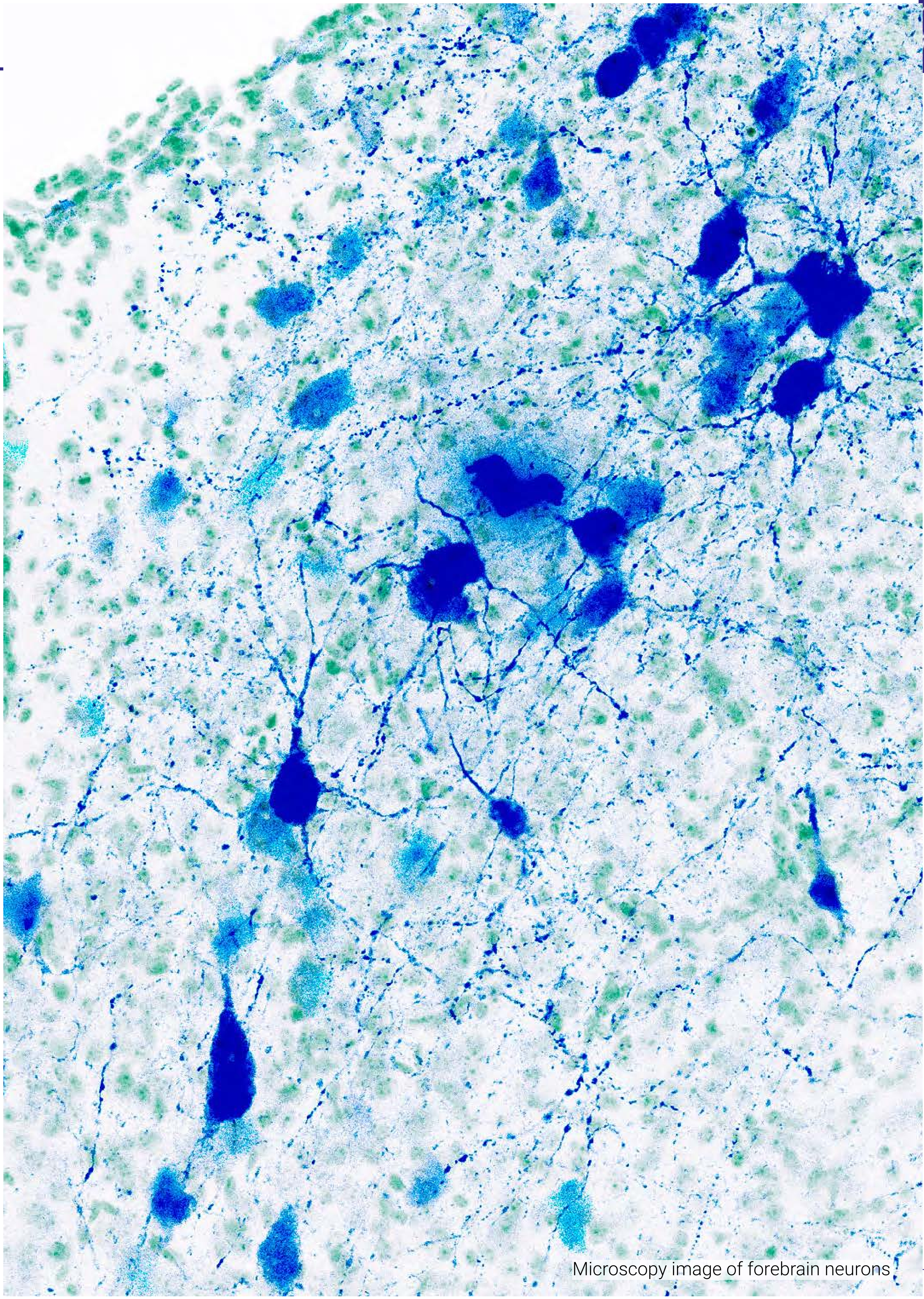
Outreach

Enhancing the visibility of the NIN has been a priority over the assessment period, and the results of these efforts are now evident. However, it is important to continue strengthening the outreach to the public and policymakers. Improved visibility can facilitate addressing emerging challenges that require stronger engagement with the public, governmental bodies, and policymakers. The KNAW life science institutes (Hubrecht Institute, Westerdijk Institute, NIOO, and NIN) are collaborating to present a unified identity as leading KNAW institutes. Together, they aim to more effectively communicate and advocate their shared priorities (such as the importance of animal experimentation) to both political leaders and policymakers. This initiative is strongly supported by the new KNAW management board. For topics more specifically related to neuroscience, the NIN will seek strategic collaborations with other institutions and universities to amplify its impact.

Increased visibility also supports the Friends of the NIN Foundation's efforts to secure additional private funding, which will be crucial as science and education are facing potential budget reductions from the current government. Finally, educating the public on neuroscience, and emphasizing the critical need for research to combat neurological and psychiatric disorders remains a central mission for the NIN.

Open Science

To strengthen its national and international role in neuroscience, the NIN will place greater emphasis on several key strategic goals and capitalize on opportunities to address various threats and weaknesses. Playing a central role in the field requires actively sharing knowledge, data, and expertise. As part of this commitment, the institute will increase its investment in Open Science initiatives, including privacy issues currently prohibiting sharing of human data. The NIN has started making all its publications openly accessible. Additionally, it aims to store all data on NIN servers in a findable and machine-readable format and will establish more pipelines to facilitate data sharing in alignment with FAIR principles. Wherever practical and beneficial, the NIN also aims to share hardware designs and code to support high-quality research in the broader scientific community. In addition, the institute



Microscopy image of forebrain neurons

aims to continue modernizing the NBB to expand its impact and enrich its collection through the development of the Netherlands Neurogenomics Database in collaboration with the NBB partners.

Excellent science and collaborative culture

To consolidate its strengths, the NIN will continue prioritizing excellent fundamental research in circuits neuroscience, which is the core of its strategy. This focus enables both the NIN and others in the field to develop innovative approaches to understand and treat brain disorders in the future. The institute will proactively adopt emerging techniques and technologies while recruiting group leaders with essential expertise aligned with its evolving goals. The NIN's success is built on the institute's collaborative culture and its transparent, inclusive leadership, which motivates scientists and support staff alike. Maintaining this culture will enable the NIN to tackle complex, interdisciplinary research questions in the rapidly developing field of neuroscience.

11 Glossary

3Rs in animal research: Replacement, Reduction and Refinement.
AAV: Adeno-associated viral vectors.
ADF stichting: A patient organization that focuses on prevalent psychiatric disorders such as depression, anxiety, obsessive-compulsive disorder, and phobias.
AI: Artificial Intelligence.
ALS: Amyotrophic Lateral Sclerosis, a motor neuron disease.
ASD: Autism Spectrum Disorder.
AUMC: Amsterdam University Medical Center.
BSc: Bachelor of Science.
BIDS: Brain Imaging Data Structure, an initiative for data sharing in neuroscience.
CCD: Central Committee for Animal Experiments.
CCNN: Computational Cognitive Neuroscience and Neuroimaging group at the NIN.
COVID-19: Coronavirus disease 2019.
CSHL: Cold Spring Harbor Laboratories.
CWTS: Centre for Science and Technology Studies, Leiden.
D&I: Diversity and Inclusion.
DBI2: Dutch Brain Interface Initiative.
DBS: Deep Brain Stimulation, a therapeutic approach in psychiatry.
DEC: Animal Experiments Committee
DI: Donders Institute for Brain, Cognition and Behavior of the Dutch RadRboud University
DM-II: Designated Modular-Level II.
DSM-5: The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders.
EEG: Electroencephalography
ErasmusMC: Erasmus Medical Center.
ERC: European Research Council.
EUR: Erasmus University Rotterdam.
FAIR principles: Findable, Accessible, Interoperable, Reusable.
FENS: Federation of European Neuroscience Societies.
Friends of the NIN foundation: Foundation that finances various scientific projects of the NIN.
FTE: Full-time equivalents.
FYD: Follow Your Data, a data management platform at the NIN.
GABAergic neurons: A type of neuron that uses the neurotransmitter gamma-aminobutyric acid.
GDNF: Glial cell line-derived neurotrophic factor, a growth factor.
GDPR: General Data Protection Regulation.
GUTS: Growing Up Together in Society, a Gravitation grant exploring neural, social, and genetic factors influencing the development of young individuals.
GWAS: Genome-wide association study.
HD-EEG: High-density electroencephalography.
HMM: hidden Markov model.
HRM: Human Resources Managment.
iBBA: VU institute for Brain and Behavior Amsterdam.
iCNS: Institute for Chemical Neurosciences, a multidisciplinary national consortium to uncover the molecular and cellular mechanisms underlying brain diseases and psychiatric conditions.
ICT: Information and Communications Technology.
iPSC: Induced pluripotent stem cells.
ISMRM: International Society for Magnetic Resonance in Medicine.
IVC: Individually ventilated cages, used in animal facilities.
IVD: Animal Welfare Body.
KNAW: Royal Netherlands Academy of Arts and Sciences.
KTO: Knowledge Transfer Office of the KNAW.
LEAF: Laboratory Efficiency Assessment Framework, to enhance lab sustainability.
LGN: Lateral geniculate nucleus, a relay station for visual information traveling from the eye to the visual cortex.
LUMC: Leiden University Medical Center.
MCNS: Mean normalized citation score.
MDs: Medical doctors.
ME/CVS: Myalgic Encephalomyelitis/Chronic Fatigue Syndrome.
MRI: Magnetic Resonance Imaging.
MS: Multiple sclerosis, a neuroinflammatory and neurodegenerative disease.
MSc: Master of Science
MT: Management Team.
National Roadmap: National Roadmap for Large-Scale Research Facilities
NBB: Netherlands Brain Bank.
NCAD: Dutch Advisory Committee for Animal Research.
NDDs: Neurodevelopmental disorders.
Nedkad: A patient organization related to psychiatric disorders.
NeuroTech-NL: Consortium that focuses on developing innovative neurotechnologies that enhance the understanding of brain function and improve treatments for neurological disorders.
NIBR: Central Institute for Brain Research.
NIN: Netherlands Institute for Neuroscience.
NIOO: Netherlands Institute of Ecology.
NORI: Netherlands Ophthalmic Research Institute.
NOS: Dutch public broadcasting organization.
NWA: Dutch Research Agenda.
NWB: Neuroscience Without Borders, an initiative for data sharing.
NWO: Dutch Research Council.
NWO Gravitation grant: Dutch Research Council consortium grant
OBP: Support staff
OC: Divisional Committee of the Works Council.
ONWAR: Graduate School Neurosciences Amsterdam Rotterdam.
OWP: Support scientific staff
PAG: Periaqueductal gray
PhD: Doctor of Philosophy.
PI: Principal Investigator.
PID: Persistent Identifier.
PL: Prelimbic region
pRF: Population receptive field.
REM: Rapid Eye Movement.
RI&E: Risk Inventory & Evaluation.
RICC: AUMC Research Imaging Core Center.
RNA: Ribonucleic acid.
ROI: Region of Interest.
SAB: Scientific Advisory Board.
SMART: Specific, Measurable, Achievable, Relevant, and Time-bound.
SMO: Social Medical Consultation.
STED: Stimulated Emission Depletion microscope.
SURF: ICT-cooperation of Dutch education and research institutions.
UvA: University of Amsterdam.
V1: Primary visual cortex.
Veni grant: A personal NWO grant for researchers at the start of their career.
Vici grant: A personal NWO grant for senior researchers.
Vidi grant: A personal NWO grant for experienced researchers.
VU: Vrije Universiteit Amsterdam.
VUMC: VU University Medical Center.
ZIm: Medial zona incerta
ZImGAD2: Glutamate decarboxylase 2 neurons in the medial zona incerta

Table 10.1 - The Netherlands Brain Bank in numbers

Year	2019	2020	2021	2022	2023	2024
Number of brain autopsies	132	123	128	145	147	130
Number of distributed brain samples	6,006	5,646	6,665	6,906	6,558	6,299
• of which for not-for-profit clients	4,636	4,610	5,111	5,122	5,251	5,088
• of which for for-profit clients	1,370	1,036	1,554	1,784	1,307	1,211
Number of projects receiving brain samples	199	227	242	238	254	225

Case studies

Case study 1: Netherlands Brain Bank

International position and uniqueness. The NBB is an internationally renowned resource for high-quality, well-characterized brain tissue. For nearly 40 years, it has operated a national prospective donor program to increase the availability of brain samples for scientific research. With over 5,200 collected brains from donors with neurological and/or psychiatric disorders as well as control donors, and currently more than 5,000 donors registered (2450 controls, 1447 psychiatric diseases and 1284 neurological diseases), the NBB has established an impressive autopsy collection that is clinically and neuropathologically well-characterized.

The NBB has been a leader in drafting an ethical code of conduct for brain banking ratified by all European Brain Banks, for the collection and distribution of brain tissue. It is one of the few biobanks globally that makes material available to external researchers under open access policies. The NBB is highly valued by researchers worldwide.

- The NBB tissue quality is exceptionally high, with an average post-mortem delay of just 6.5 hours, making it suitable for the latest highly sensitive molecular (omics) techniques.
- Donors are extensively characterized both clinically and neuropathologically.
- The NBB has developed optimal donor recruitment strategies and efficient tissue distribution processes, and it has implemented a business plan with a cost recovery system to ensure financial sustainability.

Organization and funding. Led by Huitinga, the NBB team comprises 16 staff members and approximately 10 autopsy team members who handle donor registration, communication, administration, autopsy coordination, collection management, and sample distribution. The NBB collaborates with four (neuro)pathologists and four mortuary assistants at the AUMC, location VUmc, enabling 24/7 autopsy services and state-of-the-art neuropathological diagnoses. To manage the growing complexity and volume of tissue applications and to ensure financial stability, the NBB has adapted its organization by appointing a business developer, data coordinator, and overall NBB coordinator, who now handles operational management tasks. The NBB budget has grown from €1.3M in 2019 to € 1.6M in 2023. To cover the growing expenses, the NBB receives financial support from various sources, including KNAW funding, subsidies for operating costs from patient organizations, and cost recovery from tissue distribution (75% of revenue from industry and 25% from academic institutions).

Scientific impact and outreach. On average, 150 publications annually are based on NBB-provided tissue (identified in the acknowledgements) and include groundbreaking findings using single cell spatial transcriptomics analyses of pathology in Alzheimer's Disease elucidating the state of microglia near A-beta plaques and MS elucidating molecular mechanisms of demyelination and ultrastructural analyses of Parkinson's disease elucidating the content of Lewy bodies. *Table 10.1* shows annual numbers of brain autopsies, distributed samples to for-profit and not-for-profit clients, and projects receiving samples.

The NBB collaborates with national stakeholders, including patient organizations, clinical research cohorts, and national media, to raise awareness for the donor program and research enabled by NBB materials. Outreach activities include patient days (e.g., National MS days), interviews in patient magazines, radio interviews, podcasts, and documentaries (e.g., VRT). In 2024, the Gravitation program iCNS, awarded €23.23M (see below), received substantial media attention, including a primetime feature on NOS news.

Database development and enrichment of NBB. The NBB is in the process of renewing its ICT and database systems by expanding its web-based interface to streamline the tissue selection- and distribution process. This renewal includes workflows for administrative, legal, and financial administration tasks, enhancing operational efficiency and user-friendliness. In parallel, the NBB and collaborators have initiated the Netherlands Neurogenomics Database (NND), which aims to integrate detailed clinical, pathological, genetic from NBB donors, making this information accessible to the research community. This allows calculation of polygenic risk scores of clinical and pathological features, analyses of clinical symptoms cross disorder and visualization of disease trajectories of NBB donors in time.

Future plans. To further enhance its impact, the NBB will prioritize enriching its donor and tissue data rather than increasing numbers of autopsies, emphasizing quality over quantity. This includes recruiting well-phenotyped

The Spinoza Centre for Neuroimaging

donors from research cohorts, in particular those with MS, psychiatric diseases, and control groups. The NBB also plans to invest in digitizing neuropathological images for research applications and diagnoses upon request. In collaboration with a Dutch consortium of medical centers and universities, the NBB started the NWO-funded 10-year Gravitation program "Institute for Chemical Neuroscience" (iCNS) in December 2024. This program aims to map molecular changes in the brain associated with neuropsychiatric symptoms and ultimately develop a brain atlas of psychiatric symptoms. The NBB will make the genetic, clinical, and pathological donor data collected by the NND and iCNS available for research purposes and tissue selection by its clients.

Case study 2: The Spinoza Centre for Neuroimaging

To understand the human brain, we must measure the human brain. Magnetic resonance imaging (MRI) is the most powerful and versatile method to measure the living human brain, providing the ability to visualize its function, structure, connectivity, and metabolism. The Spinoza Centre houses a 3 Tesla and an ultra-high field 7 Tesla MRI-scanner, the latter of which enables brain imaging at unprecedented high resolution. The Spinoza 7T MRI is the most powerful MRI machine in the Amsterdam area and the only one in the Netherlands certified for clinical use.

The Spinoza Centre for Neuroimaging (established in 2015) serves as a core research facility and knowledge hub of the KNAW, VU Amsterdam, and AUMC. The NIN oversees various management functions for the Spinoza Centre, such as finances, ICT, and reporting to the partner institutions.

As of 2022, the Spinoza Centre transitioned from its independent status within the KNAW to become part of the NIN. While the facility aspects of the Spinoza Centre remain a joint responsibility of the partner institutions, the director's research activities have been integrated into the NIN (see Ch 3.3). Principal investigators Dumoulin, van der Zwaag, and Knapen, have since joined the NIN's newly established Computational Cognitive Neuroscience and Neuroimaging (CCNN) group.

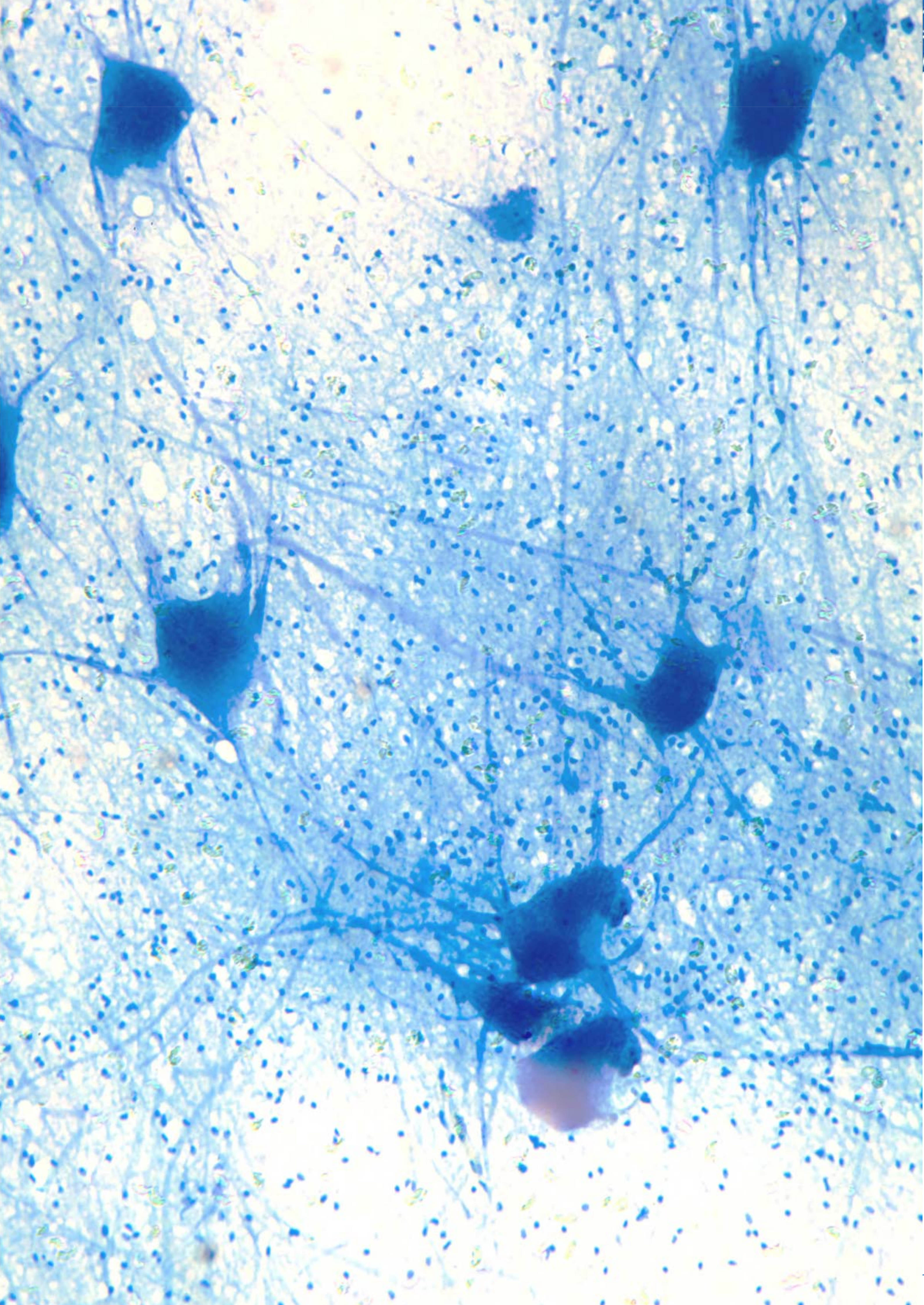
More than 400 researchers from Amsterdam and beyond utilize the Spinoza Centre's facilities to study human brain function and brain disorders. The Spinoza Centre serves as a knowledge hub, fostering connections between clinical, fundamental, and translational research. MRI is used to investigate a range of psychiatric, neurodevelopmental, and neurological disorders, such as major depressive disorder, autism spectrum disorder, psychosis, ME-CVS, and obsessive-compulsive disorder, often in collaboration with the CCNN group at the NIN. For example, Spinoza and AUMC identified decreased intracortical myelination in the lateral orbitofrontal cortex, linked to major depressive disorder diagnosis and symptom severity. These findings highlight frontocortical microstructure alterations in major depressive disorder and suggest intracortical demyelination may drive cortical disintegrity. Advances in 7T MRI capabilities have also improved the visualization of targets for deep brain surgery in Parkinson's disease, with three to five patients scanned weekly for clinical care. Another notable example is a collaboration between Roelfsema and Dumoulin groups, combining human neuroimaging with macaque neurophysiology. Their study has provided new insights into object-background segmentation, revealing that V1 neurons are tuned to perceptual borders.

The CCNN group is heavily involved in software development both for MRI data acquisition and data analysis. Their MRI data acquisition has enabled new visualizations of the living human brain, earning multiple awards from Philips and the International Society for Magnetic Resonance in Medicine (ISMRM). On the data analysis side, the group developed biologically inspired computational models, such as the population receptive field model, which is now used in more than 1,000 research institutes worldwide. Together with Netherlands eScience Center and international support, the CCNN group are going to create a unified, well-validated and open-source pRF software package that will foster innovations in psychology and neuroscience.

Case study 3: Follow Your Data

The diverse nature of research at the NIN poses a significant challenge in establishing a unified data management system. Key obstacles include data silos and inconsistent data formats, creating difficulties in sharing and collaborating on research data. To tackle these issues, the institute has introduced a data management platform called "Follow Your Data" (FYD), which includes the following components:

Data repository
A central storage space has been created to collect and store all research data, including raw data, processed data and analysis results, with a robust backup and a recovery strategy in place to protect valuable information. This includes limited version control in which copies of previous versions of files are saved up to 30 days. Appropriate security measures have been implemented to protect sensitive data. Clear access control policies have been defined to determine who can access and modify the data.



A central storage makes it possible to provide additional services. In collaboration with SURF Research Cloud, a secure network environment has been developed. This enables NIN users to exploit the extensive compute power of SURF virtual machines and still securely access their data on the NIN's central storage as if it were a local drive. Users at the NIN can back up data to SURF Data-archive for long term storage (>5jr). To make it easy for our Windows oriented users we have developed an app to upload data from our central storage directly to this archive.

Metadata standard
A custom metadata schema tailored to the NIN's specific needs has been developed and implemented in the structure of a MYSQL database, with separate databases created for each research group. This schema includes a limited set of broadly defined terms (Project, Dataset, Condition, Subject, Task, Setup, Date, Researcher) that are applicable to all types of NIN research.

For each experimental session, researchers are required to complete a metadata form with the aforementioned fields. Users enter these values though a user interface, either a webapp or an app built with MATLAB or Python, which interacts with the database to allow a selection of values from predefined choices. This approach ensures that the entered values are consistent within a dataset. The metadata is stored as a JSON file associated with a unique ID and stored alongside each data object, defined as a folder containing files from a single experimental session.

Persistent identifier (PID) system
A unique ID associated with each metadata JSON file is used as a persistent identifier for each data object, with the ID linked to a specific file name signature: "_session". The creation, deletion, and modification of these ID_session.json files can automatically be detected by a file system service that registers these metadata files in the database. For each ID_session.json file, a database record is created that includes the session ID, URL, and the associated metadata. An important feature of this system is its ability to detect folder rearrangements that would typically result in broken URLs. The system automatically updates the persistent identifiers with new URLs, maintaining consistency and ensuring the persistence of identifiers over time; hence the name "Follow Your Data". Once a valid metadata file has been saved, users do not need to manage the consistency of the system themselves.

Data integration and interoperability
Although data quality and validation fall outside the scope of this system, FYD focuses on providing researchers with tools to explore, analyze, and visualize the data. By introducing a schema for folder organization alongside the use of persistent identifiers, the data becomes machine-readable, facilitating interoperability. Researchers that can access the database can develop and share scripts to select subsets of data and access it from any desktop system in the NIN. This enables the development of data integration tools to extract, transform, and load data from various sources, develop data mapping strategies to link different data sets, and create a unified view of research data.

Data conversion and publication
Machine-readable data enables the development of scripts to convert data into internationally recognized formats. These can be used to publish datasets on certified archives such as Figshare, EBRAINS, Dandy, GIN, and enable other users to retrieve and access this data with open-source tools.

In the field of Neuroscience, the Brain Imaging Data Structure (BIDS) and Neuroscience Without Borders (NWB) are the two main initiatives with respect to data sharing. Although in its infancy, the NIN is now creating a service to convert data to the NWB data format on a session basis. Once these have been created for all sessions within a dataset, the dataset can be converted to the BIDS format, which makes the dataset publishable. An important initial step in the conversion process is verifying the presence and validity of all metadata, for which a tool is currently being developed using the FYD platform.

Maintenance and documentation
Maintaining a custom data management system can be a challenge, especially compared to commercial solutions. To address these challenges, the team implemented the following strategies.

- The system has a modular design, consisting of smaller independent modules, facilitating the update, replacement, and unit testing of these components.
- Detailed documentation on system architecture, database schema, codebase, and deployment procedures is included.
- Users are provided with clear instructions on how to interact with the system.
- Well-documented APIs for integration with other systems are available.
- Github is employed as a version control system to track changes, collaborate effectively, and revert to previous versions if needed.

Usage and compliance
In December 2024:

- 122 users were registered in the FYD database
- 13,425 ID session.json files had been created, associated with 180 projects in the FYD database
- 397.7 TB of data was associated with ID session.json files, representing 43% of the total stored data in the NIN's central storage
- 164 projects contained a short description
- 86 projects were associated with documentation

Case study 4: Neural circuit underlying curiosity

Curiosity drives organisms to explore their environment and investigate others, a behavior considered as intrinsic as hunger and thirst by many experts. Yet, the neurobiological mechanisms behind curiosity have remained elusive until recently. Like other animals, mice naturally seek out and investigate new environments, new objects and unfamiliar conspecifics. This is one of the many innate behaviors that mice share with humans.

The Heimel group studies the neuronal circuitry underlying innate behaviors, particularly those induced by visual input. In mice, defensive behaviors are easily triggered. For instance, a bird passing overhead causes a mouse to freeze or flee. The superior colliculus, a layered area in the midbrain, plays a central role in converting visual input into motor output in such behavioral responses. The CSF lab was studying how the zona incerta influences the superior colliculus in this process. The zona incerta, a region named for its uncertain function, is centrally located and bilaterally connected to the superior colliculus. It receives input from across the brain and sends output to many areas, most notably the thalamus and brainstem.

Previous research showed that activating the zona incerta reduces defensive responses in mice. At the NIN, the Heimel group applied optogenetics to temporarily activate zona incerta neurons while mice were free to explore their environment. They discovered that activating the zona incerta drove mice to vigorously investigate novel objects, sniffing, touching, biting, and carrying the objects. Through a series of behavioral observations, the researchers were able to rule out a decrease in fear or an increase in hunger as explanations for the behavior. Instead, activation of the zona incerta increased the drive to investigate novelty. Importantly, activating the zona incerta did not just initiate a sequence of sniffing, biting and carrying, but instead it induced investigating, as novel cage mates were also investigated more vigorously through behaviors like sniffing and tracking anogenital regions (i.e., the natural way for mice to investigate each other), rather than biting or attempting to carry the cage mates, .

The team carefully measured all elements of the behavior and by computationally fitting a Hidden Markov Model (HMM) to the data, they discovered that the behavioral state of the animals could be categorized as no investigation, shallow investigation, or deep investigation. They then recorded the neural activity in the zona incerta using fiber photometry, a technique in which neurons are made to express a fluorescent protein whose light intensity reflects their activity. By measuring this fluorescence through optic fibers, the researchers demonstrated that transitions from sensory input to deep investigation occurs within the zona incerta, and that the three behavioral states identified by the HMM are reflected in the activity of the zona incerta. (*Figure CS4.1*).

The **NIN Mechatronics** team played a vital role in creating the battery of environments for the behavioral

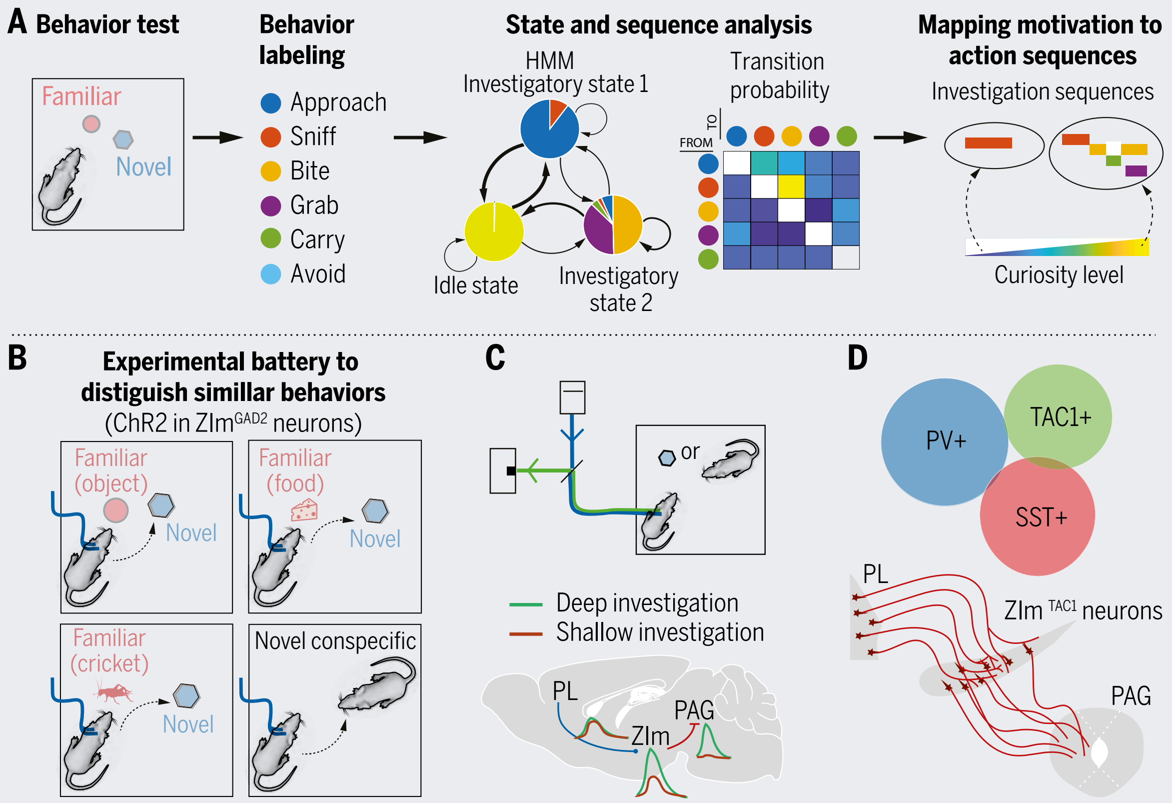


Figure CS4.1 - Brain mechanism of curiosity. (A) How motivational level was mapped to action sequences. (B) Experimental battery to distinguish novelty-seeking behavior from food eating and hunting in mice with photoactivation of ZImGAD2 neurons. (C) Schematic of calcium activity in PL-->ZIm, ZIm, and ZIm-->PAG during shallow and deep investigation. (D) TAC1+ neurons as a subpopulation of ZImGAD2 neurons receive input from PL and project to PAG. HMM, Hidden Markov model. (Image reprinted from Ahmadlou et al. Science 2021)

experiments and developing a miniature camera to track pupil dilation, an indicator of arousal, during free exploration. Further experiments revealed that inputs from the prelimbic cortex provide relevant information to the zona incerta, while its output to the periaqueductal gray is essential for driving investigative behavior. Mapping the circuitry was made possible by the **NIN Microscopy Facility,** which enabled imaging of hundreds of brain slices showing fluorescent markers in neurons and their connections.

The discovery of the zona incerta's central role in novelty-investigating behavior in mice represents a scientific breakthrough, uncovering a part of the brain that was completely unsuspected to play a role in an animal's fundamental drive for curiosity. It also shed light on the long-mysterious function of the zona incerta. The finding was published in Science and received coverage on international news channels and national newspapers. The study's impact may extend beyond novelty-seeking behavior. In an opinion article published in Science, the possible relevance of these findings for the treatment of several neuropsychiatric disorders was highlighted. Heightened novelty-seeking behaviors are premorbid risk factors for conditions like addiction and bipolar disorder, while reduced novelty-seeking is a common symptom in Parkinson's disease.

How the findings in mice translate to humans is still largely an open question. The zona incerta is buried deep within the brain and functional imaging of its activation in the human is currently very hard, if not impossible. A study in monkeys at the University of Washington, however, showed that neural activity in the primate zona incerta correlates well with novelty-seeking behavior. Combined with the NIN's findings, this suggests that changes in novelty-seeking behavior observed in Parkinson's patients receiving deep brain stimulation of the subthalamic nucleus could be related to the effects of stimulation on the adjacent zona incerta. The zona incerta itself also is a therapeutic target in Parkinson's disease. Investigating the effects of deep brain stimulation in humans may thus offer a path to corroborate the role of this ancient brain circuitry in novelty-seeking functions in both rodents and humans.

Case study 5: Sleep and psychiatric disorders

In addition to reducing patients' quality of life, insomnia is the primary risk factor for developing a psychiatric disorder. Step by step, the van Someren group at the NIN is making progress in understanding the brain mechanisms underlying this association and in developing solutions to enhance resilience and recovery.

As a first step in addressing their key question, the group initiated collaborations enabling GWAS studies involving nearly 2.4 million people, the largest sample so far. Findings revealed that insomnia is a heritable heterogeneous complex trait. Surprisingly, genetic variants associated with insomnia were primarily found in genes expressed in limbic and salience circuits, rather than in sleep-regulating parts of the brain. This discovery led to the novel idea that insomnia might be a disorder of emotional distress regulation, rather than primarily, or merely, a sleep disorder.

Simultaneously, the group developed and utilized the Netherlands Sleep Registry, an online citizen science platform enabling large-scale assessments. With the help of thousands of volunteers, the group identified different subtypes of insomnia. Notably, only some subtypes were associated with an increased lifetime risk of developing major depressive disorder or anxiety disorders. Subsequent brain imaging studies, using more sensitive techniques and focusing on less heterogeneous samples, revealed that high-risk subtypes could be distinguished from low-risk subtypes based on differences in brain white matter connectivity and EEG responses to stimuli.

With a clearer delineation of who among people with insomnia are at risk of developing psychiatric disorders, the van Someren group sought to address why these individuals carry this risk. A series of studies combining citizen science, MRI, and HD-EEG revealed a specific feature of disturbed sleep coined 'restless REM sleep', which predicted whether individuals experienced overnight relief from emotional distress. Intriguingly, individuals with the most restless REM sleep reported feeling worse upon waking than when they fell asleep. Thus, while sleep was typically regarded as universally beneficial, this finding introduced the concept of maladaptive sleep, which can exacerbate emotional distress rather than alleviate it.

The concept of maladaptive sleep was well-received by the research group's panel of representatives from psychiatric patient societies. Motivated by their recognition, the group further investigated the role of restless REM sleep. Functional MRI combined with HD-EEG sleep recording and targeted reactivation of distressing memories during sleep suggested that restless REM sleep impedes overnight neuronal plasticity in the limbic and salience circuits of the brain. Indeed, it could lead to sensitization rather than adaptation.

A systematic investigation into the underlying mechanisms pinpointed the noradrenergic locus coeruleus as

Figure CS5.1 - The NIN aims to develop a visual prosthesis for the blind through patterned electrical stimulation of the LGN. In the future device, camera images will be analyzed and transformed into maximally informative electrical stimulation patterns. These patterns will be delivered via an innovative "fountain probe", a new type of probe equipped with 1,000 or more electrodes implanted in the LGN. Using electrical microstimulation, the device will activate LGN neurons to create patterns of phosphenes that convey relevant visual information from the external world to the user.

a key player, showing insufficient silencing during restless REM sleep. This mechanistic model was recently further refined to the subcellular level, leveraging on the finding that the outcome of (re)activation-dependent synaptic plasticity strongly depends on the presence or absence of noradrenaline. This opened, for the first time, the possibility of conducting animal studies on insomnia and its consequences for mental health. Supported by nearly €7M of ERC Advanced and Wellcome Trust grants, the model is now being evaluated in international collaborations integrating human pharmacological studies with optogenetic animal models.

Meanwhile, recognizing the long timeline for drug development, the group sought an immediately applicable solution to reduce restless REM sleep. In collaboration with their patient panel, the software development company Organiq, and the University of Sydney, they developed an app and web solution designed to help people change their lifestyle and environment to reduce restless REM sleep, with convincing results.

Case study 6: A neural implant to make the blind see again

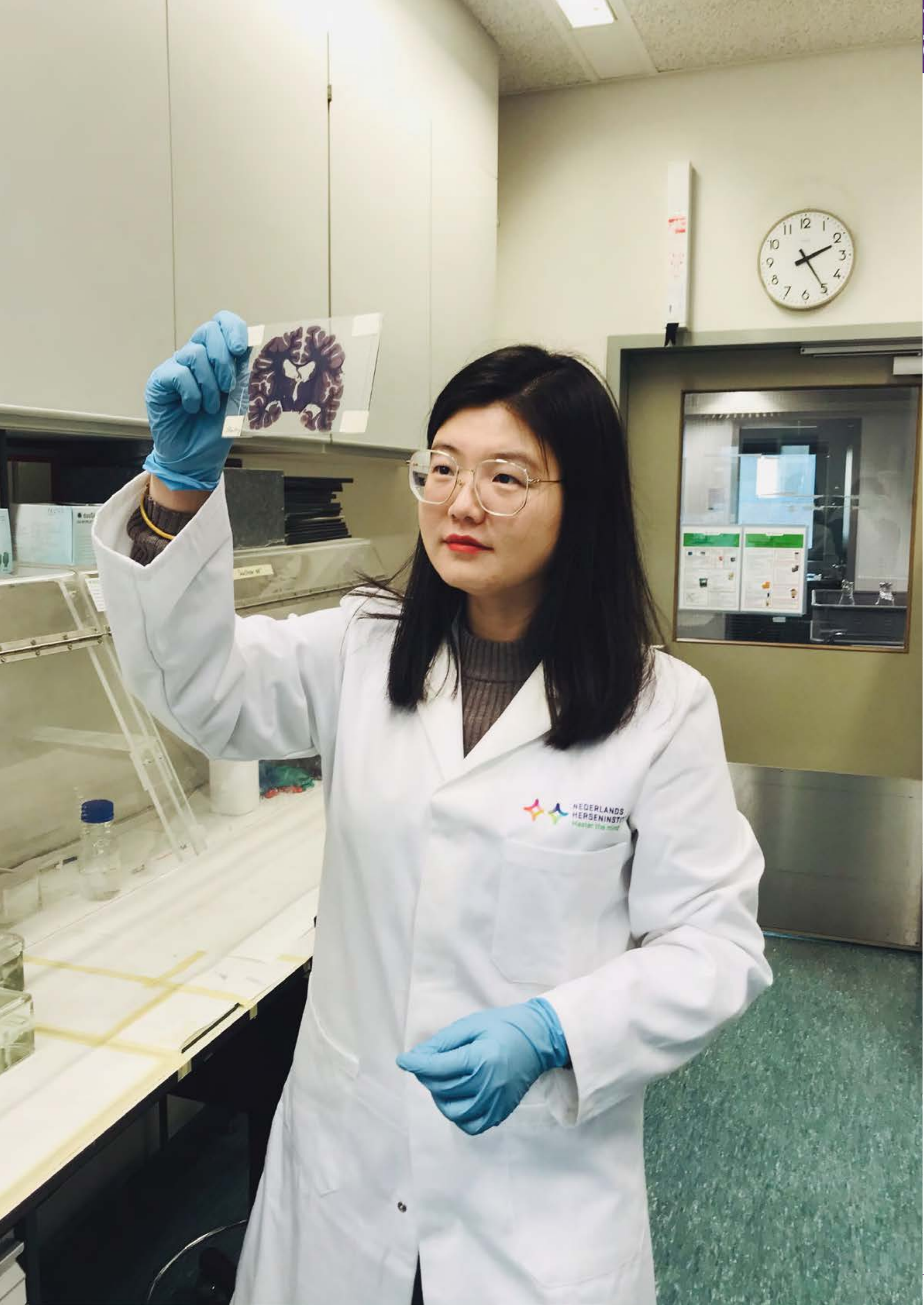
Approximately forty million people across the world suffer from blindness, a condition that seriously affects their autonomy and quality of life. Most blind individuals have experienced vision earlier in their lives. Their visual processing pathways are fully developed, but lie dormant due to the lack of input. Restoring visual function in such individuals is an important scientific goal with substantial societal benefits. For patients with severe retinal damage, restoration of a rudimentary form of vision requires activating neurons in brain pathways downstream from the retina, such as the lateral geniculate nucleus (LGN), to which the retina projects, or the visual cortex.

Researchers at the NIN collaborate with industry to develop a brain stimulation device for blindness. In 2020, the Roelfsema group demonstrated proof-of-concept that meaningful patterns can be generated in the brain. Using a 1,024-channel prosthesis implanted in the visual cortex of monkeys, the team created perceptions of light dots (phosphenes) on hundreds of electrodes. By simultaneously stimulating multiple electrodes, they were able to create visible patterns composed of multiple phosphenes. The monkeys immediately recognized these patterns as simple shapes, motions, or letters. These findings demonstrate the potential of electrical stimulation to restore functional vision, offering hope for life-enhancing visual rehabilitation for blind individuals (*Figure CS 5.1*). Building on this foundation, the team is now developing an interface with the LGN, the first relay station for visual information traveling from the eye to the visual cortex. The work builds on earlier results by Pezaris and Reid, who demonstrated that electrical stimulation in the LGN can produce visual perceptions. NIN researchers actively collaborate with organizations for blind people, including Visio, Bartimeus, and Oogvereniging, ensuring that the research aligns with the needs and experiences of potential beneficiaries.

Roelfsema and Chen co-founded Phosphoenix, a spin-off company of the NIN, to further develop this technology. The system captures visual stimuli through a camera embedded in glasses, processes the information, and projects it onto the LGN using a system of microelectrodes that are connected to an external camera and pocket processor. The goal is to generate clinically relevant visual experiences that improve the daily lives of blind people. Phosphoenix has successfully raised a pre-seed funding round and is currently raising a seed round to demonstrate the utility of the device in monkeys.

The NIN has filed three patents related to this visual prosthesis work, including one for a novel probe that can place 1,000 electrodes in deep brain structures such as the LGN.

The visual prosthesis project has secured many grants over the past eight years, including NESTOR (€1.4M for the NIN); INTENSE (€4.0M); FET-Open NeuraViper (€580K); NWO-Gravity; DBI2 (€1.0M); TKI grant POSITIONED (€211K); ERC Proof-of-Concept; PROVISO (€150K); ZonMW Open Competition and EVISION (€375K). Several of these grants involve partnerships with patient organizations and companies, including NESTOR, INTENSE, NeuraViper, and EVISION. The NIN has laid the foundations for many of these collaborative grants by starting up the NeuroTech-NL consortium, which was mentioned in Ch. 4.5.



Appendices

Appendix 1: Changes in staff

After the 2018 assessment, a management team was established following advice from the NIN's scientific advisory board with the aim to improve communication and decision-making processes. Before the establishment of the management team, the institute was managed by the general director, the vice-director and the managing director, without the involvement of group leaders. Since then, the NIN's organizational structure has remained largely unchanged. In January 2024, Levelt was appointed as the NIN director, succeeding Roelfsema, whose third term as director had concluded.

At the time of the previous assessment, the NIN referred to some of its research groups as "honorary groups". These groups were led by researchers employed at other organizations who were also involved in research at the NIN. Honorary group leaders were selected based on mutual benefit for both parties. These groups utilized NIN facilities and contributed technical and scientific expertise to the institute. In recent years, the term "honorary groups" has been gradually replaced with the more commonly used term "guest research groups", better reflecting their formal arrangement. The current status of the former honorary groups is as follows:

Kalsbeek: appointed at the NIN (0.2 FTE) and AUMC (0.8 FTE)
Willuhn: guest research group (AUMC), Willuhn to be appointed part-time at the NIN as of 1-1-2025
la Fleur: appointed full time at AUMC, still utilizing some of the NIN animal facility but mainly active at the AUMC
Forstmann: focused her work at the UvA, although the NIN still delivers services for her research

Appendix 2: Interaction with clinicians and clinical scientists

- Research in the Verhaagen group may lead to new therapies to stimulate repair of the injured central and peripheral nervous system. Their work also targets gene therapy for Parkinson's disease (in collaboration with Dr Guus Scheefhals of SyngleTherapeutics B.V.), MS (in collaboration with Huitinga of the NIN and Dr Joost Smolders of Erasmus MC) and, more recently, ophthalmic diseases (in collaboration with Professor Camiel Boon of AUMC) in the context of the Gravitation grant Life Long Vision.

- Lohmann has been collaborating with Professor Hilgo Bruining (child psychiatrist at the AUMC) to explore neurodevelopmental disorders, sensory perception, and cellular energy metabolism.

- Roelfsema works with Professor Rick Schuurman from the AUMC neurosurgery department to develop a visual brain implant for blind individuals. Schuurman, Roelfsema, and the company Phosphoenix are interacting with the local medical ethical review committee to prepare for the first-in-human trials, which are planned at the AUMC.

- Van Someren collaborates with a network of psychiatrists and psychologists from 14 clinical centers to study the interactions between insomnia and mood and anxiety disorders.

- The Spinoza center plays an essential role in the treatment of Parkinson's disease, scanning 3-5 patients per week at 7T to optimize presurgical planning for deep-brain stimulation (DBS) surgery at the AUMC. In addition, the center has engaged in research collaborations and clinical trials with clinical departments at several academic hospitals, including radiology (AUMC, LUMC, EMC), ophthalmology (EMC, UMCG), urology (EMC), neurology (AUMC), and psychiatry (AUMC). In 2024, the Spinoza 7T MRI was clinically certified (the first 7T MRI to do so in the Netherlands).

- The Siclari group has identified objective determinants of subjective sleep quality in insomnia patients and healthy individuals, which are likely mediated by the relative inactivation of noradrenergic systems. This hypothesis is being tested in animal models and pharmacological trials, in collaboration with the Van Someren group. Siclari's research on consciousness in parasomnias underscores the need for revised diagnostic criteria, a point raised in a collaborative paper with clinicians from Switzerland (Anna Castelnovo, Civic Hospital Lugano), France (Isabelle Arnulf, Sorbonne University and Salpêtrière Hospital, Paris), and the United States (Carlos Schenck, University of Minnesota, Minneapolis).

- The Gazzola and Keysers groups work with the AUMC to understand the neural and environmental factors


NIN activities during the Weekend of Science

leading to antisocial behavior, within the gravitation grant GUTS. They combine their expertise in the neural basis of empathy in humans and rodents to understand the mechanisms underpinning individual variations in empathy and increased risk for psychopathy and antisocial behavior.

Appendix 3: Public engagement

- The NIN has contributed to the Weekend of Science, in collaboration with the Science Museum NEMO. The Spinoza Centre has contributed with on-site live MRI demonstrations and lectures.
- Since 2011, the NIN has organized the 'Art of Neuroscience competition', sparking curiosity and discussion about the brain's beauty and complexity. Artworks are presented annually to the general public during an exhibition combined with a seminar. The competition has been covered by several media outlets, such as Scientific American.
- The website of the NIN provides news stories, an overview of research groups, and information about the state-of-the-art research facilities. A new website was launched in 2022, attracting almost 190,000 visitors per year.
- The NIN shares knowledge via press releases, media appearances, and social media channels. The NIN board and communications department remind NIN scientists to explicitly mention their NIN affiliation during these media appearances.
- The NIN is also exploring the impact of new media formats, including infographics and videos.
- The Podcast Master the Mind podcast series has produced 21 episodes so far.
- The NIN actively engages with a growing audience on social media platforms, including LinkedIn (15,908 followers), X (formerly Twitter, 3,292 followers), Bluesky (86 followers), Facebook (1,189 followers), and Instagram (1,317 followers), with follower numbers steadily increasing on all channels.
- NIN research has been recognized for its societal impact through prestigious awards such as the 2023 HBP Innovation Award and the Falling Walls Breakthrough of the year in life sciences awarded to Roelfsema in the same year.
- Approximately 20,000 people have subscribed to the NIN's quarterly newsletter on brain research related to sleep and psychiatry. Many subscribers have contributed to a citizen-science approach to answer questions about symptoms and their associations.

Appendix 4: Policy advice

- Van Someren was consulted by the Dutch Brain Foundation and the Wellcome Trust on the importance of sleep for brain health, leading both organizations to establish it as a pillar of their funding programs.
- Roelfsema served as a member of the Nationaal Comité advies dierproevenbeleid (NCad), the National Committee on Animal Experiments advising the Minister of Agriculture, from 2018 to 2022. In addition, NIN researchers interacted with UNESCO and the Rathenau Institute, providing advice about ethical considerations surrounding brain implants. Roelfsema also interacted with members of the Dutch parliament to discuss the ethics and importance of brain research in non-human primates.
- Heimel participated in the steering committee of the NWO Research Community Organisms in their Environment and co-authored a survey assessing the efficacy of IvD-DEC-CCD project licenses.
- Verhaagen served on the UMC Utrecht research assessment committee in 2019 and the Scientific Advisory Board of GIGA-Neuroscience at the University of Liège (Belgium, 2019), and the Scientific Advisory Board of ParkinsonNL.
- Levelt was a member of the Horizon 2020 Klankbordgroep, providing feedback to the government on EU funding programs.

Table 11. NIN PhD evaluation and monitoring schedule

Time	Time (months)	Purpose	Initiated by	Participants	Notes	Links to form
1	3	Planning of PhD	Supervisor	PhD student, supervisor	Research and training proposal planned for the PhD duraiton, ONWAR mentor is assigned	ONWAR form
2	4	Postconsultation meeting	Supervisor	PhD student, supervisor	Reflection/advice on progress and development	NIN-KNAW post-selection form
3	9	Evaluation ('go/no-go')	Supervisor	PhD student, supervisor	Reflection on research. performance and expectations	NIN annual appraisal form
	9	PhD evaluation	PhD student	PhD student, supervisor, (co)supervisor(s)	Discuss and update research/thesis. Chapter by chapter	ONWAR form
4	24	PhD Midterm evaluation	PhD student/Supervisor /HR	PhD student, (co)promotor(s), external advisor	Presentation results, discussion, thesis progress, outlook and timeline, PhD student writes meeting report	Midterm form HR
	24	Annual appraisal	Supervisor	PhD student, supervisor, (co)supervisor(s)	General working conditions, performance	NIN annual appraisal form
	24	PhD evaluation	PhD student	PhD student, supervisor, (co)supervisor(s)	Discuss and update research/thesis. Chapter by chapter.	ONWAR form
5	36	Annual appraisal	Supervisor	PhD student, supervisor, (co)supervisor(s)	General working conditions, performance	NIN annual appraisal form
	36	PhD evaluation	PhD student	PhD student, supervisor, (co)supervisor(s)	Discuss and update research/thesis. Chapter by chapter.	ONWAR form
	48					

Appendix 5: Patents and interactions with industrial partners

- Three recent patents relate to the visual prosthesis (WO 2020/043790 A1; EP2019072997), a new type of interface with the LGN and a method for determining electrode placement in this brain structure. Furthermore, the Verhaagen group filed a patent for novel capsid engineered AAV vectors for liver-directed gene therapy (P133852EP00).
- The De Zeeuw group co-founded Blinklab, a company that evaluates eyeblink responses through a mobile phone app. Using this platform, they screen adults and children for the ability to adapt eyeblink responses through Pavlovian conditioning and pre-pulse inhibition. The app has demonstrated over 90% specificity and sensitivity for diagnosing autism and ADHD without requiring additional questionnaires. To date, they have screened approximately 8,000 subjects worldwide across all continents.
- The Roelfsema group co-founded Phosphoenix, a company focused on developing a visual brain prosthesis (Case study 6). The company is currently raising a seed round after its first pre-seed funding round in 2022. Several grants have supported collaborations between the NIN and Phosphoenix, which have been mentioned in Case Study 6. NIN researchers also collaborate frequently with other companies, including Blackrock Neuro, with whom they co-developed a >1,000 channel implantable connector, and Science XYZ, a developer of electrodes.
- The Verhaagen group collaborates with four biotech companies to advance gene therapy for major brain diseases. In a collaboration with Sanagen B.V., the NIN is developing global gene therapies for a bleeding disorder and MS, leading to a patent application and three joint Health Holland grants. A collaboration with Syngle Therapeutics focuses on developing a vectorized antibody targeting a toxic form of alpha-synuclein, a protein implicated in Parkinson's disease, supported by a grant from Parkinson-NL. Two other collaborations aim to develop advanced inducible adeno-associated viral (AAV) vectors for the brain: one with Starfish B.V., to generate a novel immune-evasive AAV vector (funded by the Leiden Regenerative Medicine Platform), and another with Annogen B.V., to develop an inflammation-inducible vector for MS. A Health Holland grant application was submitted in October 2024 to support this project.
- The van Someren group collaborates with Organiq, a software development company, to create an app and web solution to help users achieve better sleep and circadian behavior for maintaining brain health.
- One of the molecules identified by the Salta group is currently part of Janssen Pharmaceutica's preclinical assessment portfolio as a therapeutic target for Alzheimer's disease.
- The group of Levelt sold the design of their magnetic head-fixation device to Neurotar.

Appendix 6: Evaluation and monitoring schedule

Table 11 offers an overview of the NIN's evaluation and monitoring schedule.

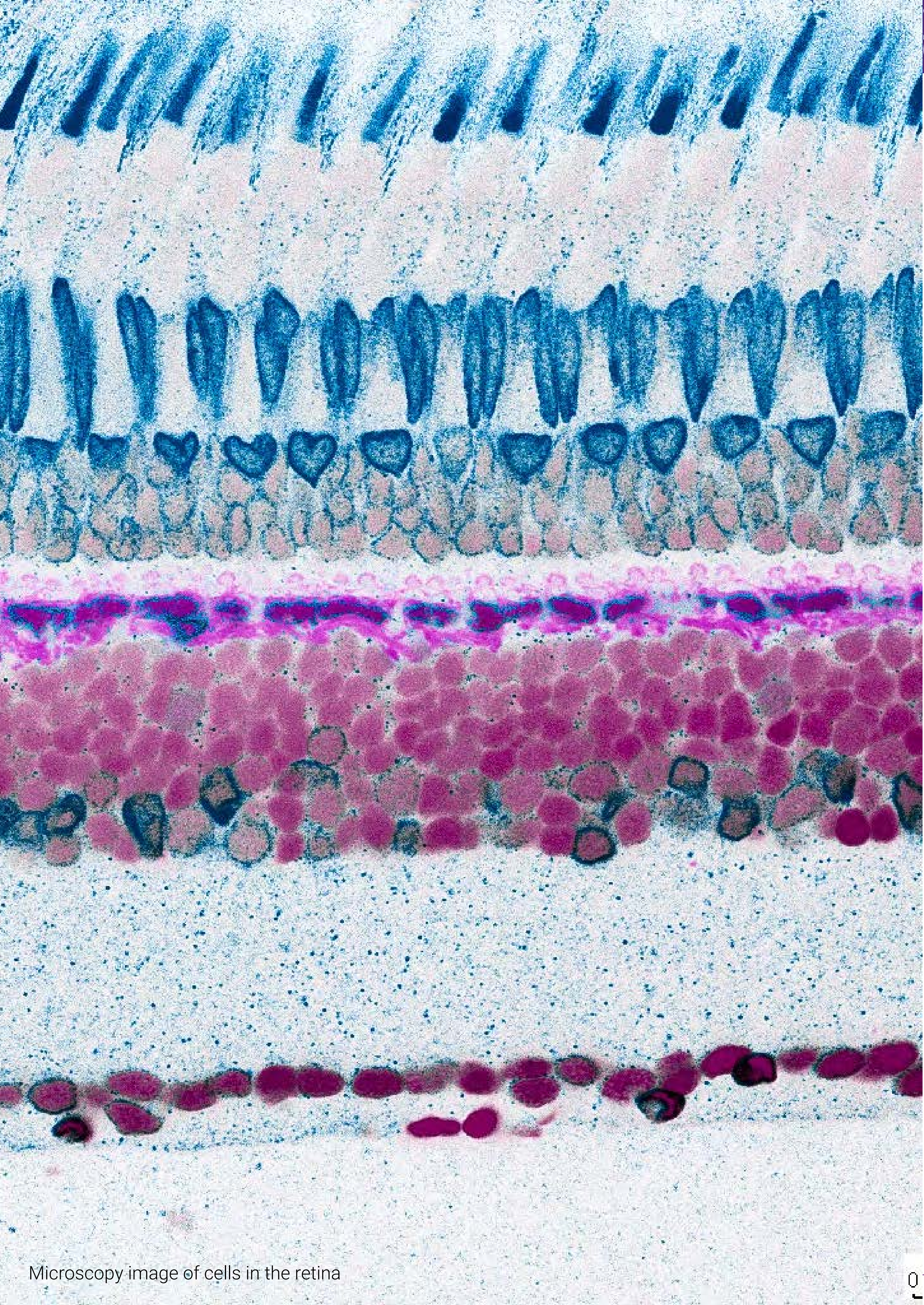
Appendix 7: Additional information about the NIN diversity & inclusion policy

Inclusion mission statement NIN

"At NIN, we recognize that prejudice, discrimination and racism can occur anywhere in both implicit and explicit ways. We therefore pursue an active diversity policy, to help reduce inequality, remove barriers and create equal opportunities for everyone. We strive for an environment with equal opportunities for all, regardless of age, sex, gender identity, sexual orientation, religion, culture, disability, race and ethnicity. NIN encourages excellence by resolutely pursuing an inclusive environment, where synergies across diverse individuals and groups are harnessed.
Acknowledging, respecting and integrating the diversity of our community, is our way to Master the Mind."

Actions taken to achieve a better representation of all groups within society

- Improvement of gender balance across all (and particularly the top) recruitment levels, e.g., hiring two additional female group leaders.
- Ensure diversity in gender and ethnicity across all recruitment committees, managerial committees, and workgroups.



Microscopy image of cells in the retina

Actions taken to standardize the monitoring of D&I metrics

- Inclusion of D&I-related questions in annual staff surveys.

Actions taken to increase awareness on D&I-related topics

- Publication of the D&I Action Plan on intranet (2024)
- Establishment of the NIN D&I workgroup (NINclusion) (2022-present)
- Publication of the NIN Inclusion mission statement (2022-present)
- Annual celebration of diverse inclusion and cultural events through physical gatherings or email communication, including Chinese/Lunar New Year, Ramadan, Diwali, Pride, Women in Science, Keti Koti, and Easter (recurrent – yearly)

Actions taken to improve social safety

- Promotion of the KNAW/NIN code of conduct within the institute via onboarding, posters, intranet, internship agreements, etc. (2024-present).
- Introduction of internal confidential advisors and external confidential advisors for all employees (recurrent, monthly onboarding sessions).
- Implementation of undesirable behavior training: nearly 200 employees attended the 90-minute 'social safety' training sessions in 2024, with a summary provided during monthly onboarding trainings (recurring, monthly onboarding sessions).
- Adaptation of Annual Feedback Meeting Report by adding specific questions about equal opportunities and undesirable treatment (ongoing).
- Organization of a Social Safety Theater event: Scenes on Social Safety (Het Acteursgenootschap) (September 2024).
- Provision of Bystander training for all employees (recurrent, biyearly).
- Contracting Open Up to provide unlimited psychological support to all staff (Mentaal welzijn met OpenUp - De laagdrempelige 360-oplossing) (2022-present).
- Hosting a mental health awareness event during the PhD ONWAR retreat (September 2022).
- Workshop on Burnout awareness and prevention (October 2024).

Actions taken to create an inclusive workplace

- Establishment of a fully equipped nursery room for breastfeeding mothers, which also serves as a prayer room and meditation room (2022-present).
- Provision of neuroscience training for underrepresented youth groups (e.g., IMC weekend school, Life skills) (recurrent, yearly).
- Facilitation of flexible working hours and working from home – by improving remote access to work documents through tools such as Microsoft cloud (email & OneDrive), virtual NIN desktop infrastructure (VMware Horizon, transitioning to a Windows solution), access to NIN computers from home (VMware Horizon), and secure access to NIN servers (Zero Trust VPN: Twingate).
- Creation of more opportunities for social interaction and vision-sharing between scientific and support staff through social and work-related events such as the Summer teambuilding event (yearly); Support-each-other seminars (monthly); Lifelong learning seminars (monthly), Joint group & team leader meetings (biyearly); Town hall meetings (three times a year).

Samples from the Netherlands Brain Bank

- Organization of LGBTQ+ STEM Day, featuring a short film followed by a roundtable discussion: Ben Barres (Stanford) 2: Women in Science - YouTube (November 2023).
- Introduction of "Walk-in" hour for addressing LGBTQ+-related issues within the institute (November 2023).
- Hosting a workshop on neurodiversity in the workplace (ITvitae.nl) (May 2024).
- Organization of a Women in science seminar (Agnes Uhereczky | VIB Conferences) (June 2024).

Actions taken to improve the accessibility of the working environment

- Website accessibility.
- Gender-neutral toilets (in R-Noord & new building).

Appendix 8: Appreciative leadership training opportunities for NIN staff

Recent actions taken to support the NIN staff and enhance its competence

- Intercultural communication training by Mundi Training (October 2023).
- Intercultural communication follow-up Workshop by Mundi Training (February 2024).
- Inclusive leadership training for group leaders by hfp-consulting (January 2024).
- Life-long research training seminars for support staff (recurrent, monthly).
- Intervision meetings for group leaders (recurrent, monthly).
- Leadership/management courses and personal development coaching trajectories for team leaders, lab responsible people, all staff (recurrent, on demand).
- Availability of 'NIN education budget' (€65K/year, €80K for 2025) for training and education.