



Master's specialisation in Neurophysics

Prof dr AJ van Opstal
April 2020

<https://www.ru.nl/opleidingen/master/neurophysics>

change perspective



Master's specialisation in Neurophysics

This specialisation is part of the Master's programme(s) in **Physics and Astronomy**

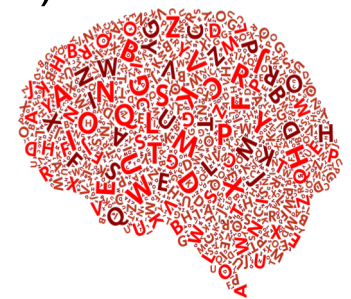
It offers a flexible and interdisciplinary programme, which challenges you to unravel the workings of the most complex system known to us, the human and animal brain, using experimental, theoretical, and computational methods from the natural sciences.

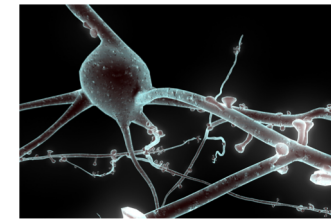
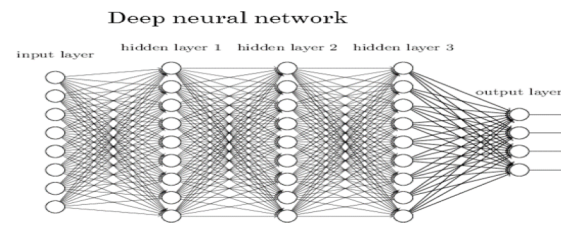
Focus:

This a **unique program** in the Netherlands. We cover the full spectrum from behavioural studies with human subjects (psychophysics), computational studies of advanced brain models (neuroinformatics, computational neuroscience), to theoretical studies on intelligent systems and behaviour (machine learning, robotics, artificial intelligence, data science), and electrophysiological studies (the 'hardware')

For whom:

Students with a bachelor diploma in
Physics, Science, but also
Biomedical Engineering, Mathematics, or similar





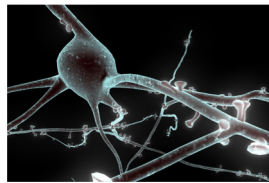
Master's specialisation in Neurophysics



*“To understand **ANY** information-processing system, it has to be studied at **three** complementary levels, all equally necessary” (David Marr, ‘82):*

- **L1:** What is the **function** of the system? Why does it do what it does? What benefit does it acquire? Which problem (usually, for survival) does it solve? How does it do it? In Neuroscience, this is the research topic of **Psychophysics (the goal)**
- **L2:** What is the optimal **algorithm**, computational principle, that underlies the observed behavior? Importantly, how can the system acquire such behavior through unsupervised learning? This is the field of **Computational neuroscience and Machine Learning (the software...)**
- **L3:** How are the algorithm(s) and behaviour(s) **implemented** in the system? In Neuroscience, this is the topic of **Neurophysiology (the hardware...)**

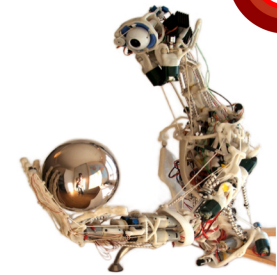
The Neurophysics specialisation at DCN studies **all three levels.**



Why study Neurophysics at Radboud University?

- A **multidisciplinary field**, merging neurobiology, physical chemistry, informatics, mathematics, and physics. You become an analytic, independent academic with relevant skills, prepared for near-future technologies (AI, data science, etc.)
- Large **flexibility** in designing your own study program, depending on your personal preferences (more experimental, theoretical, or more neurobiological, biochemical, etc.), through a wide variety of elective courses.
- Possibilities for **external internships**, e.g. at Philips (Brain, Body and Behavior division), several MSE companies, Maartens Kliniek (revalidation), RadboudUmc, but also at the Instituto Técnico Superior in Lisbon (robotics), Western Univ. at London, Ontario, etc. etc..
- Possibility to incorporate a **minor data science** into your master program
- Possibility to obtain a **double master diploma**: in Physics and Astronomy (your principal diploma) and Cognitive Neuroscience (60 ec courses at the CNS master; total 180 ec)

Curriculum Master's specialisation in Neurophysics



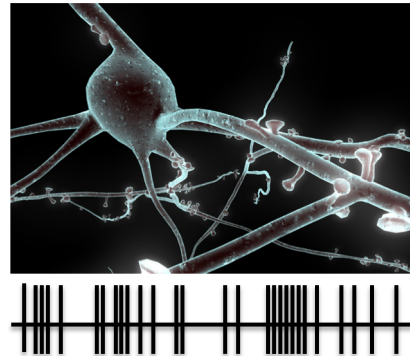
Compulsory courses Physics and Astronomy (7 EC)

Compulsory courses Neurophysics (15 EC)

Specialisation electives* (21 EC)

Free electives** (18 EC)

Internship (60 EC)



Considerable
Freedom

*e.g. Advanced Computational neuroscience (6 EC), Adv. Machine Learning (6 EC), Quantitative Brain Networks (3 EC), Psychophysics 2 (6 EC)

**e.g. Track in Data Science (18 EC), courses from the CognNeurosci master, other Physics courses (e.g. statistical physics), some catch-up bachelor courses



Compulsory courses Master's specialisation in Neurophysics



Compulsory Physics courses (7 ec):

Electrodynamics (3 ec), Philosophy (3 ec), Professional Preparation (1 ec)

Compulsory Neurophysics courses (15 ec):

Course 1

Neurobiophysics (3 ec) / Optimal sensory encoding; Optimal motor control;

Course 2

Computational Neuroscience (3 ec) / nonlinear dynamics; information theory

Course 3

Machine Learning (3 ec) / data modeling; inference

Course 4

Neuroscience Review (6 ec) / Literature study; your own topic; report writing



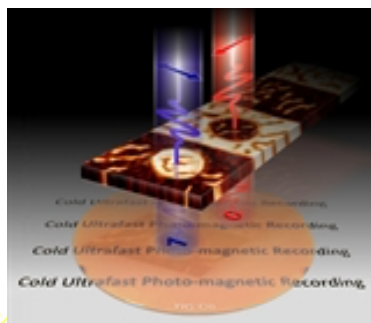
Track in Computational Data Science (CDS)

Mandatory Courses:

Numerical methods (3ec), Advanced programming (3ec), Machine learning (3ec)

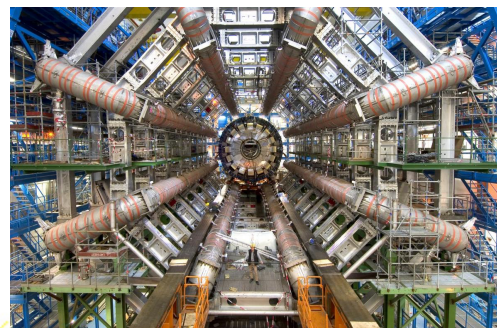
Electives IMM

Quantum chemistry (3ec)
Quantum dynamics (3ec)
Molecular modeling (3ec)
Pattern recognition
for Natural science (3ec)



Electives IMAPP

Monte Carlo Techniques (6ec)
Data analysis (3ec)
Machine learning in particle
physics and astronomy (3ec)
Astronomical Data analysis
and instrumentation (3ec)



Electives DCN

Advanced machine
learning (6ec)
Computational
neuroscience (6ec)
Machine Learning in
practice (6ec)



Research Master's specialisation in Neurophysics



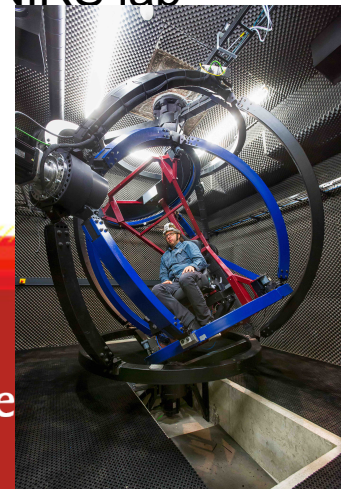
This specialisation is embedded in the Donders Centre for Neuroscience (DCN@FNWI).

Research departments and topics at our Centre

- **Biophysics:** Psychophysics (Van Opstal, Van Wezel, Van Wanrooij, vacancy)
Machine Learning, Optimal Control, Data science (Kappen) L1+2
- **Neuroinformatics:** Computational modelling (Tiesinga), Electrophysiological
and modelling studies of the memory system (Battaglia). L2+3
- **Neurophysiology:** Neural implementation of sensorimotor behaviors (Celikel,
Englitz, Zeldenrust). L2+3
- **Applications:** Sensory and motoric patients (hearing, vision, balance, motoric)
Forensic analysis through machine learning (Bonaparte)
Bits and Brains (with Solid-State Physics); Human Brain Project. L1+2

Facilities

- Six fully equipped psychophysical labs (visual, auditory, vestibular), EEG/fNIRS lab
- Animal facilities with high data throughput recording systems
- Computer facilities for large-scale computational modelling studies
- The Donders Neuroimaging facilities (MEG, fMRI)



Internships Master's specialisation in Neurophysics

Relevant departments at Radboud University



Science faculty

- Dept. of Biophysics (PI's: Van Opstal, Kappen, Van Wezel, Van Ee, Noppene, Coolen)
- Dept. of Neuroinformatics (PI's: Tiesinga, Battaglia, vacancy)
- Dept. of Neurophysiology (PI's: Celikel, Englitz, Zeldenrust)
- Donders Center for Cognitive Neuroimaging (PI: Norris)

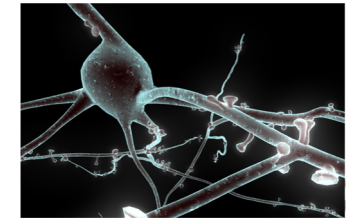
Medical faculty

- Dept. of Cognitive Neuroscience (Goossens)
- Depts. of Otolaryngology (Snik) and Neurology/Clinical Neurophysiology (Bloem)



Social sciences

- Sensorimotor Lab (Medendorp)



Universities abroad (examples)

- Western Univ. in London, Ontario, Brain and Mind Institute (Corneil; systems neuroscience)
- Instituto Técnico Superior de Lisboa (Bernardino; robotics)
- Max Planck Institute in Frankfurt (Fries; primate neurophysiology)



Companies (examples)

- Philips Eindhoven (Van Ee)
- Other companies (Artinis (fNIRS), TMSi (EEG), hearing aid/cochlear implant companies)

Admission requirements Master's specialisation in Neurophysics



You'll need a Bachelor's diploma in

- Physics, with at least Neurophysics 1 and Introduction Machine Learning from Bachelor
- Science, with 9 ec from *
- Mathematics, with Neurophysics 1 and Introduction Machine Learning
- or a related discipline (e.g. (Bio)medical or Electrical Engineering)

And a fluency in both written and spoken English

- *A TOEFL score of >575 (paper based) or >232 (computer based) or >90 (internet based)*
- *An IELTS score of >6.5*
- *Cambridge Certificate of Advanced English (CAE) or Certificate of Proficiency in English (CPE) with a mark of C or higher*

Native speakers of English and students with a Dutch VWO or Bachelor's diploma don't need to perform an English test.

*Neurophysics 1 and Neurophysics 2, Psychophysics 1, Introduction Machine Learning (each 3 ec)

(two of these courses may be included in the free electives of the master; at the start of the master; Neurophysics 1 and 2 and Intro ML may be done in the first semester)

Career prospects Master's specialisation in Neurophysics



Positions of our alumni:

- PhD student in Neuroscience topics, anywhere in the world
- PhD student in other disciplines, e.g. electrical engineering, computational modelling
- Teaching (physics)
- Some stay in academia (postdoc, assistant/associate/full professor)
- Start-up companies (e.g. Orikami, SMART)
- Politics
- Banks (data science)
- Philips (BBB, lighting, ...)
- Shell (data science, modelling)
- ASML (control problems)
- TMSi, Artinis, XSense, HOCOMA, Cochlear (applied bio-measurement systems/prosthetics)
- Clinical physicist
- Maartenskliniek (revalidation technology)
-





Questions, more information?

Coordinator of the Neurophysics specialisation:

Prof. dr. John van Opstal
j.vanopstal@science.ru.nl

Tel: 024-36 14251

Room: HG00.831

Or contact the student advisor/study coordinator:

Drs. Vincent van Heijden

Vincent.vanHeijden@science.ru.nl or vincentvanheijden.youcanbook.me

Drs Emily van Mierlo

e.vanmierlo@science.ru.nl