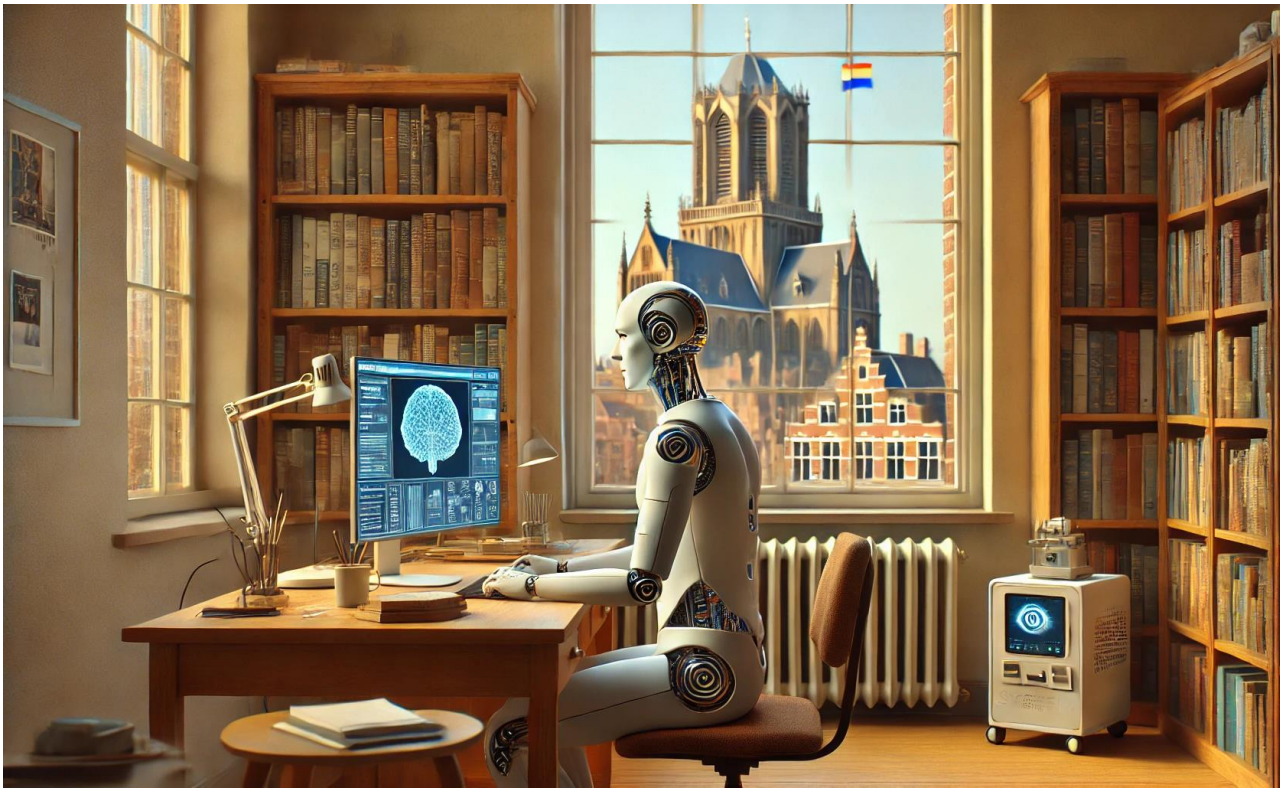
Research School of Behavioural and Cognitive Neurosciences

BCN Symposium

Brains on AI:

How AI changes the brain and brain research.



December 3, 2024

Groningen

Program

8:30 –9.00	Registration with coffee/tea
9:00 – 9:05	**Opening**
	Theme: Learning more about the brain using AI or vice versa
9:05 – 09:35	**Dr. Catherine Sibert** *Theories of Minds: Connecting Cognitive Architecture Models to Brain Imaging Data*
9:35– 10:05	**Dr. Leendert van Maanen** *Rethinking the Speed-Accuracy Trade-Off: A New Cognitive Operation in the Decision-Making Process*
10:05 - 10:35	**Dr. Umut Güçlü** *Deep Generative Models for Neural Decoding of Visual Perception*
10:35 – 11:05	**Dr. Micha Heilbron** *LLMs as a challenge and an opportunity for cognitive (neuro)science*
11:05 – 11:30	Coffee break
	Theme: UG applications of AI for BCN
11:30 – 12:00	**Drs. Koen Freerks** *From Posture to Behaviour: Applying AI to Behavioural Tracking*
12:00 – 12.30	**Dr. Sebastiaan Mathot** *Developing custom teaching tools that use large language models*
12:30 – 13:30	Lunch break
	Theme: AI for Education Cognitive AI
13:30 – 14:00	**Prof. dr. Niels Taatgen** *Skills: the building blocks of human intelligence*
14:00 – 14:30	**Prof. dr. Hedderik van Rijn** *How Cognitive AI Improves Passing Rates and Grades in Academic Courses*
	Theme: AI for Education LLM
14:30 – 15:00	**Dr. Burcu Arslan** *Personalizing Digital Learning and Assessment with Generative AI: Opportunities, Challenges, and Future Directions*
15:00 – 15:30	**Dr. Joost Kruis** *The Bayesian Brain strikes again?*
15:30 – 16:00	Tea break
	Theme: LLM reconsidered
16:00 – 16:30	**Dr. Yevgen Matusevych** *Beyond text-based models: A case study on mutual exclusivity*
16:30 – 17:00	**Prof. dr. Pim Haselager** *Societal debates about responsible use of AI & neurotechnology*
17:00 – 18:00	Drinks

Theme

Artificial Intelligence has a large impact on society, but also on science. It provides us with new tools for research in all fields, but also requires input from science to develop. Research on cognition and the brain has a special place in this, because AI research itself is heavily inspired by what we know of human intelligence.

In the BCN Symposium "Brains on AI", we will explore how AI can advance research of the brain and behavior by providing new tools to analyze the vast amounts of data we have regularly collect, irrespective of whether this is from animal studies, neuroscience studies, or complex behavioral experiments. Moreover, we will feature presentations that show how AI can support the learning brain. This can be either by using the knowledge of cognition augmented by AI techniques to provide learners with personalized materials, or by exploring how large-language models can take over some of the tasks of the teacher.

The BCN-symposium also is a great day to meet your colleagues, to get inspiration for new projects, and to meet prospective MSc students and PhD candidates or more senior academic staff.

We hope you enjoy this inspiring day, filled with numerous opportunities to be inspired by AI and to inspire AI in return.

university of groningen

bcn

umcg

BCN

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

Our main objectives are twofold:

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

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

BCN Cross-Disciplinary Symposia

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

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

Organization
Research School of Behavioural and Cognitive Neurosciences (**BCN**)
FA30
Hanzeplein 1
9713 GZ Groningen

Diana Koopmans ✆ +31 (0)50 361 6775
Cato Scheppink ✉ c.m.scheppink@umcg.nl
E-mail: bcn@umcg.nl
website: www.rug.nl/bcn

Catherine Sibert

Human Computer Collaboration, Bernoulli Institute, University of Groningen

Catherine Sibert is an assistant professor of Human Computer Collaboration at the Faculty of Science and Engineering of the University of Groningen. Her research focuses on the use of AI tools and frameworks in the analysis of human brain data, with an emphasis on how models of whole-brain cognition can provide insight into the underlying mechanisms of thought. She is also interested in how understanding the brain can inform and improve AI systems to collaborate more effectively with human users.

Theories of Minds: Connecting Cognitive Architecture Models to Brain Imaging Data

Cognitive architecture models can provide a high-level, whole-brain account of cognition, but have not seen wide use in the neuroscience research community due to a perceived lack of connection between the theoretical model elements and the biological reality of the brain. Recent work has tried to bridge this gap by using the structural configuration of architecture models, specifically the Common Model of Cognition (CMC), as a framework for Dynamic Causal Modeling (DCM) analyses of large scale fMRI data, both during tasks and at rest. The high-level framework proposed by the CMC produces higher quality predictions of human brain data than several plausible alternatives, suggesting both the presence of a consistent underlying structure of cognition in the brain as well as a sense of its shape and dynamics. These results demonstrate how the analysis of brain signaling data can benefit from the addition of cognitive modeling theories, as well as showing how brain data can be used to validate, refine, and improve cognitive architecture frameworks. Combining these tools and approaches provides many challenges and opportunities for gaining a deeper understanding of the structure and mechanisms of cognition.

Leendert van Maanen

Cognitive Aspects of AI at Department of Psychology and Helmholtz Institute, Utrecht University

Leendert van Maanen is associate professor Cognitive Aspects of AI at Department of Psychology and Helmholtz Institute, Utrecht University. His research has focused on computational modeling of various aspects of cognition, including memory, language, and decision making. A major trend in his research is understanding how time pressure alters the cognitive mechanisms used to support optimal behavior in these contexts.

Rethinking the Speed-Accuracy Trade-Off: A New Cognitive Operation in the Decision-Making Process

Cognition is not static; it unfolds as sequences of events, marked by different cognitive operations. This seems clear for perceptual decision-making, which is typically believed to progress through three main stages: perceptual encoding, decision formation, and response execution. This structure is supported by computational models that characterize decision-making as an accumulation of evidence towards a threshold. A popular perspective is that the height of such a threshold is under an individual's control, and they can adjust it to accommodate speed-accuracy trade-offs.

However, recent findings from our lab challenge this simple three-stage scheme. Leveraging the idea that cognitive operations can be detected in neural (EEG) time series, we identified that the number of cognitive operations differed between perceptual choices that were under time pressure, and those that were not. This suggests that - contrary to the popular evidence accumulation models - a speed-accuracy trade-off requires skipping a cognitive operation to try to meet temporal demands.

In my talk I will highlight the methodology that we used to identify the number and onset of cognitive operations, and discuss our attempts to understand the nature of the additionally observed operation when time pressure was not important. We tentatively dubbed this operation a confirmation event to acknowledge that participants were more accurate – possibly confirming their choice - on trials where they engaged the additional operation.

Umut Güçlü

Donders Institute for Brain, Cognition, and Behaviour, Radboud University

Umut Güçlü is the Principal Investigator of the Neural Coding Lab, the Scientific Director of the Donders AI for Neurotech Lab and an ELLIS Scholar. His research group combines neural coding with deep learning to simulate and emulate *in vivo* neural computation with *in silico* connectionism for "brain-reading and -writing".

Deep Generative Models for Neural Decoding of Visual Perception

Understanding how the brain represents and processes visual information is a fundamental challenge in neuroscience. The field of neural decoding seeks to address this challenge by mapping brain activity back to the features of the perceived stimulus. In this talk, I will focus on recent advancements in neural decoding that utilize deep generative models, specifically Generative Adversarial Networks, to reconstruct visual experiences from brain activity.

Micha Heilbron

University of Amsterdam

Micha Heilbron is Assistant Professor of Cognitive AI at the University of Amsterdam, based at Amsterdam Brain and Cognition (ABC). He works at the intersection of cognitive (neuro)science and AI, studying how brains and artificial neural networks understand language and make sense of the world. Currently, his primary research focus is on language comprehension in both Large Language Models and the human mind and brain.

LLMs as a challenge and an opportunity for cognitive (neuro)science

Large Language Models (LLMs) are not only the best AI models on linguistic tasks, but also at predicting brain responses to language, despite not being designed with the brain in mind. As such, they present both a challenge and opportunity for cognitive neuroscience. The challenge lies in understanding what drives the alignment between LLM and neural representations. The opportunity lies in developing more cognitively plausible LLMs. In this talk, I will present new results on both frontiers. The results highlight that (1) abstract syntactic representations are important for explaining brain-LLM alignment; and (2) equipping transformer-based LLMs with human-like fleeting working memory makes LLMs learn more effectively, and learn more human-like syntactic knowledge. Together, these findings reveal how cognitive science can both explain and enhance LLM performance.

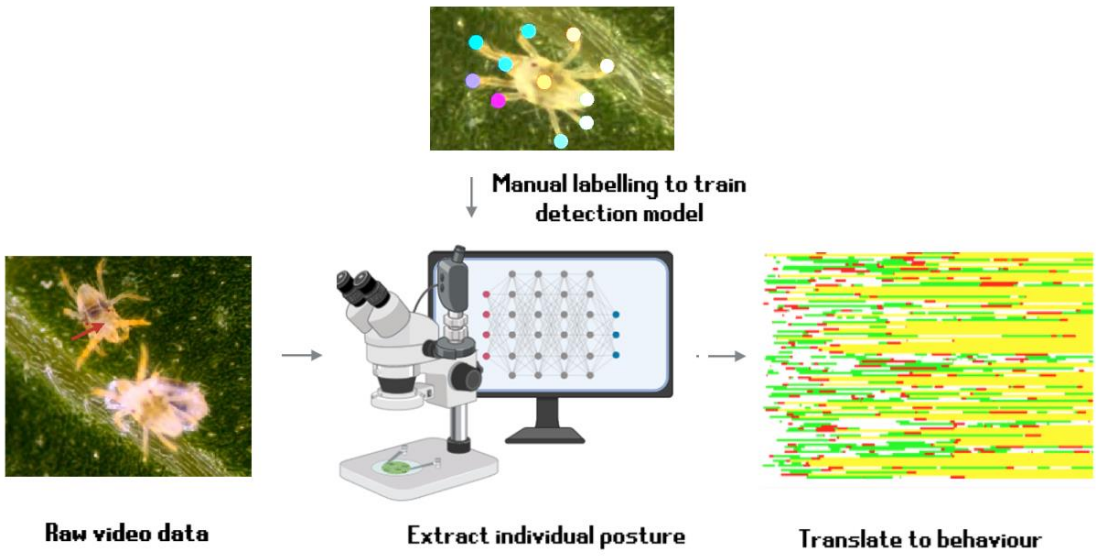
Koen Freerks

PhD Student at the Groningen Institute for Evolutionary Life Sciences

Koen Freerks is a PhD student specializing in the eco-evolutionary dynamics of fighting behaviour in the males of the two-spotted spider mite. His work combines computational methods with empirical approaches to investigate feedback between behavioural polymorphisms and environmental factors, exploring how these interactions may drive rapid evolutionary changes in behaviour. By applying AI-driven posture-tracking and custom imaging techniques, Koen's research overcomes limitations of traditional tracking, enabling high-resolution, automated analysis of behaviour in complex environments.

From Posture to Behaviour: Applying AI to Behavioural Tracking

Artificial intelligence allows tools for analysing complex behavioural data, reshaping research in ecology, neuroscience, and beyond. In this presentation, I will discuss how AI-driven techniques have been applied to animal behaviour studies, from analysing movement and social behaviour in fruit flies during my master's research to quantifying fighting behaviours in spider mites as part of my PhD. By linking individual posture dynamics to specific behaviours, this AI-driven approach enables automated behaviour classification, bypassing the limitations of manual tracking methods. This work is a practical example of the potential of AI in enhancing behavioural data analysis across diverse scientific domains.



Sebastiaan Mathôt

University of Groningen, Faculty of Behavioral and Social Sciences, Department of Psychology

Sebastiaan Mathôt is an assistant professor at the Faculty of Behavioral and Social Sciences. In addition to his scientific research, which focuses on visual perception and pupillometry, he is actively involved in the development of open-source scientific software, such as OpenSesame, a tool for building behavioral experiments. Currently, Sebastiaan is also working on Heymans, an open-source AI tool for higher education.

Developing custom teaching tools that use large language models

Large language models have taken the world by storm. As teachers, our focus has so far mainly been on dealing with students' use of ChatGPT for written assignments. We have taken few steps to integrate LLMs into our teaching in ways that do not use ChatGPT or similar web interfaces, in part because the underlying technology seems daunting and out of reach. In this talk, I will show how we can integrate LLMs into our teaching, using as an example Heymans, an AI tutor that we are developing in Groningen, and that we have already piloted in a number of courses. Heymans mainly provides automated grading of open-ended exams, and interactive formative quizzes based on textbook material. This makes it possible to use these valuable teaching methods with large numbers of students. I will argue that we should not let ourselves become dependent on commercial providers (OpenAI, Google, Microsoft, etc.), but rather that we can and should leverage the considerable resources and knowledge that we, as educational organizations, have at our disposal to take ownership of this new technology so that we can use it on our terms.

Niels Taatgen

Cognitive Modeling, and director of the Bernoulli Institute in the Faculty of Science and Engineering

Niels Taatgen is Professor of Cognitive Modeling, and director of the Bernoulli Institute in the Faculty of Science and Engineering. He has degrees in both Computer Science and Psychology, and was one of the founders of the AI program in Groningen. His research includes human learning, multittasking, neuromorphic computing and time peception. He was teacher of the year of the RUG in 2015.

Skills: the building blocks of human intelligence

Humans have the amazing ability to carry out novel tasks they have never seen before. We can explain this by assuming we have a "mental toolbox" of skills that we reconfigure to fit the situation. The challenge is to discover what the tools are, and how we learn them. The skill approach can be used to offer new explanations for psychological phenomena. However, in this talk I want to focus on how we discover skills in an educational setting, and how we can develop the optimal environment for students to develop their mental toolbox.

Hedderik van Rijn

Faculty of Behavioral and Social Sciences, Department of Psychology, University of Groningen

Prof. dr. Hedderik van Rijn is a professor of Cognitive Science and Neuroscience at the Faculty of Behavioral and Social Sciences at the University of Groningen. After obtaining his Master's at the Radboud University, and a PhD at the University of Amsterdam, he spend two years at Carnegie Mellon University before first joining the AI department, and later Experimental Psychology department in Groningen. He is interested in the formal modeling of cognition, improving our understanding of cognitive psychological theories. In additional to fundamental research, he has proven successful in applying computational cognitive modeling to the real-world, founding two companies in which computational cognitive models drive educational and medical innovations.

How Cognitive AI Improves Passing Rates and Grades in Academic Courses

Using computational models of the human memory system, we can trace the learning process at very high temporal resolution. Using these cognitive AI methods, we can optimize the learning process by adapting to the specific prior-knowledge levels and memorisation aptitudes of individual learners. At the same time, by inspecting the computational model, we can determine when someone has mastered the materials sufficiently to warrant stopping with studying for that day. These mastery levels also provide an alternative to examination, as sufficient mastery would reduce the need for summative testing. Here I will present the results of a classroom study in which the passing rate and grades were impressively improved.

Burcu Arslan

Research Scientist, Educational Testing Service (ETS), Princeton, NJ, USA

Burcu Arslan is a Research Scientist at the ETS Research Institute. She holds a Ph.D. in Artificial Intelligence from the University of Groningen (accompanied by a certificate from BCN), an M.S. in Cognitive Science, and a B.S. in Statistics. Her work bridges AI, cognitive science, and statistics to advance educational assessment practices. She focuses on personalizing assessments and modeling construct-relevant behaviors through process data gathered from digital educational tools, aiming to gain deeper insights into learners' knowledge, skills, and strategies.

Personalizing Digital Learning and Assessment with Generative AI: Opportunities, Challenges, and Future Directions

Recent advancements in AI enable *scalable, personalized* content creation for digital educational tools. For example, generative AI (genAI), powered by large language models (LLMs), can customize educational content *in real time*. However, using genAI introduces significant challenges, including ensuring fairness and maintaining validity and reliability. In this talk, I will introduce Context-AI, a digital research prototype that leverages genAI to personalize the context of the mathematics story problems in real time based on learners' input about their interests. This AI-powered tool is designed to support teachers in personalizing math problems, better assess learners' knowledge, skills, and strategies, and foster interest in mathematics. I will also outline a research agenda to address some of the challenges and investigate the hypothesized positive effects of Context-AI on learners' motivation, engagement, and performance.

Joost Kruis

Cito AI, CitoLab – Cito, Arnhem

Joost Kruis received his Ph.D. with a dissertation titled "Item Response Mechanics" from the Department of Psychological Methods at the University of Amsterdam. At Cito, the central institute of test development in the Netherlands, he works as a psychometric researcher and heads the AI research program at Cito AI. His current research focuses on the applications of machine learning (ML) and artificial intelligence (AI) in educational measurement. Additionally, he is involved in the norming and equating of the annual Dutch national secondary school exams.

The Bayesian Brain strikes again?

The integration of artificial intelligence (AI) in educational assessment, particularly in high-stakes settings, presents a unique paradox. On one hand, there is a pressing demand for AI systems to be flawless in grading student responses, to uphold the fairness and accuracy expected in crucial examinations. On the other hand, human raters, who have historically managed these assessments, are inherently imperfect in their judgments. Through examples of our research on the applications of AI at Cito, this talk will explore the dichotomy between the necessity for AI to achieve near-perfect performance in the grading of high-stakes tests and the reality of human error in grading those same tests.

Yevgen Matusevych

CLCG, University of Groningen

Yevgen Matusevych is an assistant professor at the Center for Language and Cognition Groningen (CLCG), University of Groningen. He is interested in identifying similarities and differences between language learning processes in human speakers vs. computational models. He has worked on computational cognitive models of language learning, in particular bilingual and non-native learning, across multiple linguistic domains, from speech perception and lexical-semantic organization to morphology and grammar.

Beyond text-based models: A case study on mutual exclusivity

Many modern AI models are text-based, while others incorporate multimodal capabilities through integration with image and speech processing modules. Text-based and multimodal models not only differ in their functionality, but may also show different behaviors in simple tasks. In this case study, we focus on the mutual exclusivity (ME) bias in early word learning – a tendency in children to associate a novel word with an unfamiliar object rather than with an object whose name they already know. This bias has been studied computationally, but only in models trained with text-based word representations. Such models fail to capture the high variability of spoken language and lack mechanisms for meaningfully encoding truly novel words. Here, we investigate the ME bias in visually grounded speech models, which learn from natural images and continuous speech audio. We observe a consistent presence of the ME bias in these models, suggesting that grounding in multimodal data is important for simulating human-like word learning.

Pim Haselager

Societal Implications of AI and Cognitive Neuroscience (SIAC), Radboud University, Nijmegen

Pim Haselager focuses on philosophy, psychology and artificial intelligence (AI). He has been teaching many very promising students (such as a certain Hedderik van Rijn) since decades. He investigates the societal implications of using AI and neuroscience. How can we stimulate that new technology is used responsibly?

Societal debates about responsible use of AI & neurotechnology

Brains *and* AI: Societal debates about responsible use of AI & neurotechnology Obviously there is a lot of progress in AI and Cognitive neuroscience (CNS). The impact on society is large, and, amidst a lot of hype, many questions are raised about the potentially good and bad consequences. Attempts at regulation are in full swing, see e.g. the AI act and the discussion about neurorights. It will be increasingly important for scientists to actively participate in societal debates about the implications of AI & CNS. I will present various cases and discuss some pros and cons of active societal engagement.

All Speakers

Dr. Catherine Sibert
Human Computer Collaboration
Bernoulli Institute
University of Groningen
c.l.sibert@rug.nl

Dr. Leendert van Maanen
Cognitive Aspects of AI
Department of Psychology and Helmholtz Institute
Utrecht University
l.vanmaanen@uu.nl

Dr. Umut Güçlü
Neural Coding Lab
Scientific Director of the Donders AI for Neurotech Lab and an ELLIS Scholar
Donders Institute
Radboud University Nijmegen
u.guclu@donders.ru.nl

Dr. Micha Heilbron
Cognitive AI
Amsterdam Brain and Cognition
University of Amsterdam
m.heilbron@uva.nl

Drs. Koen Freerks
Institute for Evolutionary Life Sciences
PhD Student at the Groningen
k.freerks@rug.nl

Dr. Sebastiaan Mathôt
Faculty of Behavioral and Social Sciences
Department of Psychology
University of Groningen
s.mathot@rug.nl

Prof. dr. Niels Taatgen
Cognitive Modeling
Director of the Bernoulli Institute Faculty of Science and Engineering
University of Groningen
n.a.taatgen@rug.nl

Prof. dr. Hedderik van Rijn
Cognitive Science and Neuroscience
Faculty of Behavioral and Social Sciences
University of Groningen

Dr. Burcu Arslan
Research Scientist
Educational Testing Service (ETS)
Princeton, NJ, USA
barslan@ets.org

Dr. Joost Kruis
Cito AI
CitoLab – Central institute of test development
Arnhem, the Netherlands
Joost.Kruis@cito.nl

Dr. Yevgen Matusevych
Center for Language and Cognition Groningen (CLCG)
University of Groningen
Yevgen.matusevych@rug.nl

Prof. dr. Pim Haselager
Societal Implications of AI and Cognitive Neuroscience (SIAC)
Radboud University, Nijmegen
w.haselager@donders.ru.nl

Organizing Committee

Prof. dr. Niels Taatgen
Cognitive Modeling
Director of the Bernoulli Institute Faculty of Science and Engineering
University of Groningen
n.a.taatgen@rug.nl

Prof. dr. Hedderik van Rijn
Cognitive Science and Neuroscience
Faculty of Behavioral and Social Sciences
University of Groningen

Prof. dr. Marie-José van Tol
Director Research School Behavioural and Cognitive Neurosciences (BCN)
University Medical Center Groningen
m.j.van.tol@umcg.nl

Drs. Diana Koopmans
Research School Behavioural and Cognitive Neurosciences (BCN)
University Medical Center Groningen
d.h.koopmans@umcg.nl

Cato Scheppink
Research School Behavioural and Cognitive Neurosciences (BCN)
University Medical Center Groningen
c.m.scheppink@umcg.nl