# Progress Report University Research Priority Program (URPP)

## Adaptive Brain Circuits in Development and Learning (AdaBD)

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## Content

# Scientific Report of the URPP AdaBD

## 1. Management Summary

The URPP AdaBD wants to understand the fundamental neurobiological processes underlying formation and adaptation of brain circuits during development, multisensory processing, and learning. In addition to revealing physiological processes, we seek to establish causal links between impaired mechanisms of multisensory processing and brain circuit adaptation, and learning or developmental disorders. Finally, we aim to translate new insights from our research to the clinic and to develop new diagnostic tools and innovative treatment strategies.

In 2025, the URPP AdaBD made strong progress in building interdisciplinary synergies. The community, which has developed over the past few years, is now increasingly working together and building up a research and innovation hub that would not have been possible without the URPP. 12 new **interdisciplinary research projects** started during the last months. A particular focus hereby is placed on multisensory processing in both neurotypical conditions and developmental or learning disorders. Several of these new projects study different neurodevelopmental aspects of Autism Spectrum Disorders at different scales. Research based on induced pluripotent stem cells (**iPSC**) assesses circuit formation and interneural communication at the synapse level. Other research projects focus on **behavioral** aspects and on **neural circuits** responsible for integrating and sorting out information from multiple senses in human subjects and animal models. **Clinical studies** compare behavior and brain activity patterns before and after interventions.

Our PLATFORMS significantly expanded both their research and development activities and their service offerings. The **Microscopy Innovation PLATFORM** (MIP, formerly mesoSPIM PLATFORM) expanded R&D to additional technologies (Schmidt-Voigt two photon microscope), improved tissue clearing protocols and began offering tissue expansion as a service. The **HDDS PLATFORM** further improved the software DataDelv (formerly Dataspace), which is scheduled for release soon. The **Learning and Learning Disorders (LLD) PLATFORM** continued to focus on dyslexia and dyscalculia. This platform provides a space for collaboration in research, education, public outreach, and development of diagnostic and therapy tools. The overarching goal is to help improve educational outcomes and well-being for individuals with learning disorders. As an important milestone, in the reporting year the LLD established a diagnostic service for dyslexia.

The interdisciplinary exchange is highly valued and represents one of the main goals of the URPP. A particular highlight of the year was the **international conference *"The Adaptive Brain: Development, Learning, and Learning Disorders"***, held at **Monte Verità.** The conference focused on neurobiological mechanisms underlying brain development, circuit adaptation during learning, and the mechanisms driving learning disorders, and involved the active participation of most of our researchers and students. Furthermore, the MIP organized the international **"*10 Years of mesoSPIM*" symposium**, which highlighted a decade of technological innovation, provided opportunities for collaboration for researchers at all career stages, and outlined future collaboration opportunities in the field.

The URPP AdaBD continued its efforts to promote dialogue with the public. We are preparing an exhibition on the topic "Learning with all senses" at the **Science Pavilion UZH** of the Faculty of Science. A further highlight was a **teacher training workshop** co-organized with SUPSI (Scuola universitaria professionale della Svizzera italiana) and held at Monte Verità. This continuing education course introduced participants to biological mechanisms underlying brain development and learning, addressed research on learning disorders, and presented evidence-based support strategies. Local teachers responded very positively to the workshop, and we may offer it again in the future. We are also collaborating with the Developmental Science Network Zurich. In 2025, we co-organized the **panel discussion *"How do People on the Autism Spectrum Perceive the World?"***, bringing together perspectives from research, professional practice, and lived experience.

# 2. Objectives

## 2.1 Objectives and milestones of the reporting year

The reporting year was mainly focused on starting new projects and expanding existing structures. In addition, some projects from phase 1 have been completed. Below, we summarize the milestones planned for 2025 according to the target agreement. Achieved Milestones are marked with a ✓, while partially or not achieved milestones are marked with a **X**. Not achieved milestones and major changes are explained in Chapter 2.2.

### 2.1.1 Scientific Outputs

**Research projects:**

— 2 running projects completed ✓ (Chapter 3): 2 PhD Thesis Defences and at least 2 publications (Chapter 7) ✓
— 12 new projects set up (Chapter 3) ✓
— 10 projects from phase 1 continued ✓ (Chapter 3): 4 PhD Defences and at least 2 publications (Chapter 7) ✓

**Open Science:**

— The vast majority of research results published in Open Access **(96%)** ✓, several manuscripts uploaded as preprints in repositories ✓, if suited, data shared via repositories ✓
— mesoSPIM Software and Hardware open-source ✓

### 2.1.2 Interdisciplinary synergies and added value

**Further development of a microscopy innovation platform (Chapter 4):**

— Next generation mesoSPIM microscopes developed **X**
— A new research associate hired for development of next generation multiphoton microscopes ✓
— Next generation microscopes and complex technologies made accessible to non-specialists ✓

**Interdisciplinary research projects:**

— Publications with several AdaBD PIs as co-authors ✓ (16 publications 2025)
— Cooperative and translational projects set up ✓
— Three Postdocs hired to oversee development and implementation of translational methods ✓

**Expansion of the platform for learning and learning disorders:**

— Two new Research Associates (1.2 FTE in Job sharing) hired ✓
— Workshops for AdaBD researchers working on human data held **X**

**Interdisciplinary scientific exchange within the URPP community:**

— Regular online seminars ✓, lab visits events for AdaBD researchers ✓
— Educational workshops for students **X**

### 2.1.3 Governance of the URPP, gender equality, and support for Early Career Researchers

— An administrative assistant (0.5 FTE) and a fundraising manager (0.6 FTE) hired ✓
— New student representative, PhD / Postdoc event ✓
— New female PIs included, new female assistant professor hired ✓ (starting date January 1, 2026)
— High proportion of females maintained ✓
— New employees received information on the role of the gender equality representative ✓

### 2.1.4 Academic visibility and international standing

— International Conference on Monte Verità ✓, international mesoSPIM Symposium ✓
— External guest speakers within the Online Seminar Series (see Chapter 5.1) ✓
— AdaBD Newsletter twice a year **X**
— Research presented at international conferences and at symposia (at least one abstract per project) ✓

### 2.1.5 Outreach and knowledge transfer to society

— Event held for teachers at conference on Monte Verità ✓

— Social Media presence expanded✓, collaborations with communication office UZH and media established ✓
— Workshops and lecture at UZH's Children's University held ✓
— Panel discussion about autism in collaboration with the DSN-ZH ✓

#### 2.1.6 Sustainable structures

— Assistant professorship tenure track created and Lab set up ✓
— A fundraising strategy has been compiled **X**

### 2.2 Which milestones were not achieved and why?

— In the reporting year, we did not focus on developing a next generation mesoSPIM microscope. Instead, we focused on advancing tissue clearing and tissue expansion methods, as well as on the further development of the Schmidt-Voigt objective (see Chapter 4). The MIP leader has worked, however, on conceptualizing the next-generation mesoSPIM and preparing its realization.
— In the last year, we did not organize workshops for AdaBD researchers / students. Since most students either finished their PhD studies or started a few months ago, we plan to resume this kind of workshops in the next months. We organized a first workshop for poster presenters in March 2026
— We published only one issue of the AdaBD Newsletter instead of two as planned. This resulted from an increased workload due to the start of several new research projects and a temporary staff shortage (maternity leave in the Coordinating Office)
— The milestone to have compiled a fundraising strategy by the end of 2025 turned out to be unrealistic (see Chapter 4). We now plan first visions in 2026.

### 2.3 Updated project planning

Here, we list the milestones planned for 2026 according to Chapter 2.2 and the target agreement

#### 2.3.1 Scientific Outputs

**Research projects:**

— 5 running projects completed with 7 PhD Thesis Defences
— 17 projects continued with 1 additional MD Position
— at least 8 papers published or in preparation by our students, additional publications connected to our projects

**Open Science:**

— The vast majority of research results uploaded as preprints in repositories and then published Open Access, data shared via repositories if suited
— mesoSPIM Software and Hardware open-source
— Workshop on Open Science

#### 2.3.2 Interdisciplinary synergies and added value

**Further development of a microscopy innovation platform:**

— Next generation mesoSPIM microscope fully conceptualized and setting up started
— Work towards development of next-generation Schmidt-Voigt objectives
— Pending patent application "multi-immersion objective" approved. Trademarking of 'mesoSPIM'.
— Next generation microscopes and complex technologies made accessible to non-specialists
— Expansion microscopy methods further developed

**Interdisciplinary research projects:**

— Papers with several AdaBD members as co-authors published
— Cooperative and translational projects continued
— Behavioral task design adapted to different needs

**Expansion of the platform for learning and learning disorders:**

— Workshops for AdaBD researchers working in the field of the platform

— Submission of a citizen science grant
— Ethical permission for joint interdisciplinary data analyses of both labs (Brem, KJPP & Kucian, KISPI)
— Harmonization of behavioral and brain imaging data acquisition protocols

**Further development of data analysis tools**

— Data analysis tool DataDelv (previously Dataspace) completed and published as anOpen-source Software
— An additional data scientist with a focus on support and outreach is hired

**Interdisciplinary scientific exchange within the URPP community:**

— Regular online seminars, lab visit events for AdaBD researchers continued
— Educational workshops for students
— Annual AdaBD Symposium in Spring 2026

**Knowledge transfer to students**

The Interdisciplinary seminar / lecture for BSc and MSc students on learning and learning disorders is delayed due to the retirement of E. Stoeckli, who was leading the organization. As soon as we find a new lead, we will resume planning

#### 2.3.3 Governance of the URPP, gender equality, and support for Early Career Researchers

— PhD / Postdoc events
— New female PIs included, new female APTT has started her lab, high proportion of females maintained
— New employees received information on the role of the gender equality representative

#### 2.3.4 Academic visibility and international standing

— External guest speakers within the Online Seminar Series
— AdaBD Newsletter twice a year
— Research presented at international conferences and at symposia (at least one abstract per project)

#### 2.3.5 Outreach and knowledge transfer to society

— Teaching material on multisensory learning made available for primary school teachers (originally planned for 2026, may be delayed to 2027 due to maternity leave)
— Exhibition in Science Pavilion prepared. The exhibition will open in January 2027
— Participation at Scientifica with 3 events, partially in collaboration with the Developmental Science Network Zurich
— Collaboration with communication office of the UZH and media continued
— Outreach materials, consulting service, and diagnostic service for dyslexia by the LLD Platform continued
— Launch of the first modules of a new CAS on learning with learning disorders (by the LLD Platform)

#### 2.3.6 Sustainable structures

— Assistant professorship tenure track hired three PhD Students
— A fundraising strategy has been compiled, including possible services and research visions
— Discussions with important potential stakeholders of the future structures have taken place and a development plan has been drawn up (development plan potentially delayed to 2027)

# 3. Research

## 3.1 Overview of the research activities

With the beginning of phase 2, our research program made substantial progress. Thanks in great part to the evaluation in 2024, the community grew together and intensified collaborations between research groups. We identified overarching research areas focusing on brain circuit formation and on multisensory integration in neurotypical conditions and neurodevelopmental and learning disorders, such as Autism Spectrum Disorders (ASD), developmental language disorders and dyscalculia.

Taking advantage of knowledge gained and methods developed in Phase 1, we started several new projects, which are highly cooperative and interdisciplinary, clearly making a big step towards **bridging the gap between basic and clinical science**. Several of these projects study **different neurodevelopmental aspects of ASD at different scales**: From inter-neuronal communication at the synapse level, to circuit formation, and to brain activity patterns. Some projects focus on multisensory integration and salience detection. An interdisciplinary consortium led by the PhD Student J. Nieweler and with members from the research groups Ruff, Walitza, Tobler, Karayannis, Helmchen, Kucian, and Brem, met regularly and worked towards design of **behavioral tasks** that can be used **to assess salience and multisensory integration** at different ages, across disorders, and across species (see Chapter 4). Another focus is on the use of **induced pluripotent stem cells (iPSC)** for studies of neurodevelopmental disorders and **patient-specific disease mechanisms** (see also Chapter 4). At the end of the year, we could also welcome our new **Assistant professor tenure track** Akanksha Jain, who will combine **stem-cell derived brain organoids, long-term light-sheet imaging, and mapping of gene expression** to uncover the developmental dynamics that shape the human brain, and how these processes are dysregulated in neurodevelopmental disorders.

One focus of the URPP AdaBD is on development and application of **imaging technologies** for investigations across scales and species. In the last year, we continued working on methods for tissue clearing and tissue expansion that allow us to image across scales from receptor clusters at synapses to entire neural networks in different model systems. We also further developed our microscopes and substantially enlarged our mesoSPIM platform towards a microscopy innovation platform (MIP) for different technologies (see Chapter 4).

Below, we summarize our research projects, list objectives, milestones, and deliverables with reference to the target agreement, and briefly describe the main findings. A more detailed discussion of the collaborative interdisciplinary efforts as well as a summary of achievements from our platforms can be found in Chapter 4.

### 3.1.1 Path 1: From genes to circuit formation and function

*Workpackage leaders: Martin Müller, Ruxandra Bachmann, Andras Jakab*

In Path 1, we investigate how neural circuits develop and how their functions are established in both neurotypical conditions and developmental disorders. We aim at three objectives:

**Objective A: Molecular mechanisms of circuit development in animal models are discovered**

| Expected milestones 2025 | Deliverables 2025 | Main Insights 2025 |
|---|---|---|
| 1. ***Running project continued:*** *Study of brain circuit rewiring and its consequences on learning and memory in adult mouse* | *PhD Thesis N Cruz-Ochoa completed (06.2025) We did not employ a new PhD Student as planned, but we prolong Natalia's contract as a Postdoc (financed by AdaBD until 04.2026.* | Over the past year, we focused on quantifying the anatomical consequences of circuit rewiring, using mesoSPIM imaging. Thanks to technological advances in light-sheet microscopy and tissue processing (e.g. tissue clearing and expansion in collaboration with the Stoeckli lab, project EXPAND), we generated proof-of-concept results demonstrating the **mesoSPIM system's ability to resolve single axonal structures throughout the brain** (see (2.) and Chapter 4). |

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| 2. ***New project set up:*** *Quantification of neural connectivity in wild-type and ASD mouse model by combining and refining developed technologies (tissue expansion, mesoSPIM microscopy, data analysis); probing functional rewiring in the ASD model.* | *1 new PhD position filled as expected (01.2025)* | Impairments in neuronal wiring are thought to underlie learning deficits and developmental delay but approaches that can provide a **detailed view of the projectomes of single neurons are missing.** Over the past year, this project has already made significant progress **towards developing a stable, robust, and scalable pipeline for mesoSPIM and 2-Photon imaging and axon-resolution image analysis**. First images have been analyzed in collaboration with Natalia Cruz-Ochoa (see (1.)) and AdaBD Postdoc Luca Godenzini (see Chapter 4). |

**Further insights reached by projects without planned milestones in 2025**

Our project **EXPAND established and refined live STED super-resolution imaging** of glutamate receptors at the Drosophila neuromuscular junction. STED super-resolution microscopy data **implicate the extracellular N-terminal glutamate receptor domain in homeostatic plasticity** in Drosophila. Further, it provided first evidence for distinct presynaptic forms of homeostatic plasticity in human iPSC-derived neurons co-cultured with human astrocytes. The induced human iPSC-derived neurons were used in a collaborative project within the URPP published in the reporting year (Hänseler et al., 2025). The EXPAND project also used live imaging to study the migration behavior of neural crest cells in vitro. The established infrastructure, expertise, and model systems are available to the AdaBD consortium.

**Objective B: More knowledge on neural circuit development is created using human in vitro systems**

| Expected milestones 2025 | Deliverables 2025 | Main Insights 2025 |
|---|---|---|
| 3. ***New project set up:*** *Creation of 2D and 3D (organoid) in vitro systems **using iPSC-derived neurons from ASD patients.** These in vitro systems will be used for investigation of synaptic connectivity, transmission, and plasticity, and for comparisons between different patient groups (responding or poorly responding to therapy)* | *2 new PhD positions filled as expected (07.2025 and 09.2025)*<br><br>*1 clinician position for selection of patients filled as expected, currently covered by matching funds* | In the last months, we have initiated long-term culturing of human neurons and worked on synaptic tracing approaches in 2D systems. Moreover, one student has been trained in patch-clamp electrophysiology-based analysis of cultured human 2D neurons. Finally, we have refined confocal microscopy and STED super-resolution microscopy-based analysis of synaptic structure in cultured human 2D neurons. |

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| **4.** ***Running projects continued****: Investigating the role of* ***primary cilia****, sensory organelles that serve as antennae of cells, in building and regulating neural circuits, whose dysfunction underlies neurodevelopmental disorders.* | *PhD Thesis A. Noble completed as expected (06.2025)*<br><br>*1 new PhD Position filled as expected (02.2025)*<br><br>*1 Publication by E. Yusifov (E-print Dec. 2024)* | In the first phase of this project we used chick and zebrafish embryos to study the role of primary cilia in development of the CNS: In chick embryos, we showed that primary cilia are required for development of the peripheral nervous system. In zebrafish mutants for cilia-genes we showed that **primary cilia and neuronal function are altered** despite largely normal brain morphology. In the second part, we used human iPSC-derived cortical neurons and identified not only primary cilia on the cell body, but also **previously undescribed, dynamically moving primary cilia on immature neurites.** These cilia **suggest additional, previously underappreciated ways in which ciliary signaling could influence how human neurons differentiate and connect.**<br>For a follow-up project, a new student will disrupt ciliopathy- and autism-associated genes with CRISPR. Afterwards, he will investigate ciliary dynamics and neural circuit formation and function. He is currently quantifying cilia behavior in different cell lines and planning perturbations. |
| **5.** ***New project set up****: Comparing in vitro human* ***iPSC-based neuronal models for different ASD genes*** *with respect to synapse formation, composition, structure and function* | *1 Postdoc position filled as expected (12.2025)* | J. Crowe will **establish iPSC lines with mutations in ASD genes**. Analysis will be performed in collaboration with T. Lobriglio (see (4.)) and the Müller lab (see (3.)).<br>See also Chapter 4. |

**Further insights reached by projects without planned milestones in 2025**

A systematic characterization of primary cilia in iPSC-derived neurons across multiple protocols was published (Haenseler et al, 2025). Further, we are currently validating hippocampus-like, human embryonic stem cell-derived organoids.

**Objective C: Mouse and human neural circuit development is linked**

| Expected milestones 2025 | Deliverables 2025 | Main Insights 2025 |
|---|---|---|
| **6.** ***New project set up:*** *Study* ***of associations between prenatal human connectome and autistic traits****, and on the comparison with connectome in ASD mouse models.* | *1 new PhD position filled as expected (04.2025)* | We will study fetal brain connectivity during pregnancy and examine its links to social and communication traits in a general population dataset consisting of MRI data acquired from fetuses and newborns. Towards this end, the student established a processing pipeline with specialized, tailored software tools. First analyses revealed **preliminary differences in network organization in fetuses with later higher scores for autistic traits.** |

### 3.1.2 Path 2: From behavior to underlying circuit computations

*Workpackage leaders: Fritjof Helmchen, Reto Huber, Theofanis Karayannis, Valerio Mante*

Path 2 takes the reverse approach of Path 1 – starting with studies of circuit dynamics in behaving animals, particularly during multisensory learning, and tracing these findings back to specific circuit elements and genetic factors associated with developmental disorders and learning deficits. We aim at three objectives:

**Objective A: Neural circuit adaptations underlying learning are discovered**

| | Expected milestones 2025 | Deliverables 2025 | Main Insights 2025 |
|---|---|---|---|
| **7.** | ***Running project continued:*** *Investigating* ***integration of salience information in dendrites of neocortical pyramidal neurons*** *in the primary somatosensory cortex during multisensory learning. Development of behavioral tasks for quantification of multisensory learning in mice and for comparison with measurements in humans.* | Schoenfeld et al. manuscript reviewed at Science, but rejected. It will be submitted to another high-impact journal soon. | Work in the past year focused on establishing the behavioral paradigm, building the behavioral setup, and testing it. To be able to measure task-related activity in dendrites, we **optimized the setup** for longitudinal two-photon calcium imaging and investigated mouse lines with specific expression of calcium indicators in the neurons of interest. In parallel, we have traced **long-range connections in whole-brain 3D histological preparations** to map brain-wide inputs onto the neurons of the somatosensory cortex. |
| **8.** | ***Running project continued:*** *On the development of the prefrontal cortex in mice and the effect of perturbing environmental factors on its maturation and on multisensory learning* | *PhD Thesis S. Wicki completed as expected (03.2025)*<br><br>*In addition, S. Wicki published one paper.* | The Pryce lab demonstrated that adolescence is a dynamic period in terms of multi-sensory learning in the visual and somatosensory domains, that ends with the onset of adult levels of behavior. They **revealed that reduced socialization during adolescence inhibits adolescent-to-adulthood development of multi-sensory learning.** In collaboration with the Karayannis lab, a method for accurate quantification of immunohistochemical images of synaptic puncta in specific populations of neurons in the prefrontal cortex has been established and applied, **showing an alteration in PFC glutamatergic synapses across the adolescent periods** where the behavioral changes take place. Further, the Karayannis lab is refining a whisker and visual stimulation paradigm and using in-vivo widefield calcium imaging and silicon probe recordings to tackle how the visual and whisker-driven somatosensory stimuli are processed across the cortex and how they interact over development.<br>The Grewe lab worked on developing and implementing new experimental approaches that allow to directly measure how multisensory signals are integrated within cortical dendrites. The lab contributed e.g. to the |

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| | | | development of advanced two-photon imaging methodologies (see (7.)) |
| **9.** | ***New project set up:*** *Investigation of how* ***models of the world*** *are learned through active exploration* | 2 new PhD Positions filled as expected (10.2025) | This project started at the end of the reporting year. We will use a novel object manipulation task to study learning through active exploration. |
| **10.** | ***New project set up:*** *Investigation of* ***multisensory salience processing in brain circuits of healthy mice and ASD mouse models*** | One PhD position filled as of 01.2026. | This project started in January 2026 as a close collaboration with other running AdaBD projects on multisensory integration and salience assessment in mice and humans (see (7.), (15.), (16.), (17.)). We will apply wide-field calcium imaging to compare cortex-wide salience representation in control vs. ASD mouse model. |

**Objective B: More knowledge on memory consolidation in multisensory learning in hippocampal-cortical circuits is created**

| | Expected milestones 2025 | Deliverables 2025 | Main Insights 2025 |
|---|---|---|---|
| **11.** | ***New project set up:*** *Study on how the brain integrates* ***multisensory experiences into long-term memories*** *(memory consolidation) in hippocampal-cortical circuits in mice and human.* | *3 PhD positions filled as expected (01.2025, 05.2025, 06.2025)* | The Han lab focuses on cortical mechanisms in mice. Since the start of the projects, the student has established a **multisensory virtual reality platform** for head-fixed mice, generated preliminary datasets in two cohorts, and developed dedicated data processing pipelines. The Zhang lab focuses on **hippocampal encoding and consolidation** in mice. They investigated awake ripples (brief, high-frequency brain activity patterns mediating episodic memory consolidation) in the hippocampus to understand how CA1 pyramidal cells are recruited to fire. The Huber lab focuses on **cortical-hippocampal interactions in humans during sleep.** They developed the study protocol, set up the experimental environment, and submitted the ethics application. |

**Objective C: Learning-related brain dynamics across scales are linked with artificial neural networks**

| | Expected milestones 2025 | Deliverables 2025 | Main Insights 2025 |
|---|---|---|---|
| **12.** | ***Running project completed:*** *On* ***computational models of brain development****, which may help simplifying comparison between species* | PhD Thesis L. Pompe completed as expected (11.2025, not published, yet).<br><br>Several manuscripts are in preparation, but they are not submitted, yet. | The goal of this project was to **identify components of brain-wide activity that are internally driven** (as opposed to driven by external inputs) and to determine if and how these components are shaped by learning. In a first phase, we developed a novel approach based on artificial neural networks, which do not receive any external inputs. We validated the model on simulated activity. Then, we applied it to imaging data from the neocortex of mice performing a behavioral task. The model could capture a large fraction of the trial-by-trial variability in neural activity, suggesting that a **large component of the variability is internally generated**. We found that learning modulates only the temporal properties of internal dynamics, but not the underlying |

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| Computational models for internally generated variability in neural activity | spatial patterns. Further, the internal dynamics evolves with activity that is modulated by task-related events, but not with spontaneous movements of the mouse. | |

### 3.1.3 Path 3: Integrating HUMAN, ANIMAL, and CLINICAL Perspectives

*Workpackage leaders: Christian Ruff and Bea Latal*

In Path 3, we focus on research in humans with the goal to integrate findings with those from basic research in animals, and with the goal to have prospective translational impact. We want to eventually improve diagnosis and treatment strategies for developmental and learning disorders. We aim at three objectives:

**Objective A: Neural circuit mechanisms underlying multisensory learning and processing are understood**

| | Expected milestones 2025 | Deliverables 2025 | Main Insights 2025 |
|---|---|---|---|
| **13.** | ***Running project completed:*** *On structural basis* ***of mild developmental delay*** *in the developing human brain* ***connectome*** | *PhD Thesis A. Speckert completed as expected (04.2025)*<br>*In addition, two articles published* | During the last year, this project focused on the **development of advanced neuroimaging graph-based machine-learning approaches** and demonstrated their utility for connectome analysis in newborns. In future projects, the developed methods will be also used to analyze animal data (see (6.)) as well as clinical data. |
| **14.** | ***Continuation and expansion of the project***<br>*ChildBrainCircuits (****CBC****) – Studies on* ***how brain structure, activation, and connectivity adapt during multisensory learning and processing*** *in* ***typically developing*** *children and those with* ***developmental language disorders*** *or* ***ASD****. Periodical tests will allow* ***longitudinal follow-ups*** *to characterize individual developmental trajectories.* | *PhD Thesis N. Raduner completed as expected: (09.2025)*<br>*Two articles published (one 2026)*<br>*2 new PhD positions filled as expected (07.2025; 10.2025)* | In 2025, the recruitment of the core sample was successfully completed, with annual follow-ups ongoing. Two original articles on multisensory learning were published (see highlights, Chapter 3.2). |
| **15.** | ***New project set up*** *(****NUMIS****) examining the* ***multisensory integration of numerical information*** *and the* ***influence of stress*** *on numerical performance in children and adults with* ***Developmental Dyscalculia*** *and* ***ASD****. Comparison with experiments in mice.* | *1 new PhD position filled as expected (09.2025)* | In the last months, we worked closely with several AdaBD groups and **defined tasks and experimental paradigms** to be performed both in human healthy participants, children with different developmental disorders, and mice. Participants / mice will have to judge whether they were presented with more auditory stimuli or more visual stimuli. Furthermore, the ethical approval for the examination of the specific effects of stress on numerical cognition in children with developmental dyscalculia is currently in progress. |

**Further important insights reached by projects without planned milestones in 2025**

Our **3D Atlas project** successfully implemented a new tissue clearing protocol and identified markers for effective labeling of different structures in thick tissue samples. Also, it established robust MRI processing pipelines for imaging of the same brain tissues.

Our project on **Functional mechanisms** underlying multisensory learning completed the main fMRI study and finalized analysis. The findings (see Chapter 3.2) are currently posted as a preprint.

**Objective B: Neural computations underlying disrupted learning and decision making are discovered**

| | Expected milestones 2025 | Deliverables 2025 | Main Insights 2025 |
|---|---|---|---|
| **16.** | ***New project set up*** *on neural circuit mechanisms underlying multisensory salience processing (**NeCiMuS**). This project investigates how **different sensory information is combined to predict future events.** This is important for recognition of relevant events, focusing attention on important features.* | *One new PhD position filled as expected (05.2025)* | In the last months, **a task requiring integration of sensory information** across visual and auditory modalities to predict future events was developed and coded. This included extensive collaboration with other AdaBD projects to make the task more suitable for adolescents with ASD (see (17.)) and for a mouse model (see (7.), (10.). |

**Further important insights reached by projects without planned milestones in 2025**

Our project on neural origins of disrupted magnitude processing and risk taking in dyscalculia (**NumRisk**) had developed a novel task battery and analysis pipeline that now allowed to disentangle perceptual, memory-related, and integrative components of numerical decision-making (see Chapter 3.2).

**Objective C: Research is translated into interventions and patient care**

| | Expected milestones 2025 | Deliverables 2025 | Main Insights 2025 |
|---|---|---|---|
| **17.** | ***New project set up****: Study of **multisensory and neurocognitive circuit mechanisms underlying different symptom profiles** in adolescents with **ASD**, prediction of therapy success, and evaluation of a **therapeutic intervention** addressing **sensory oversensitivity** (**BIMA**).* | *Two new PhD positions filled as expected (04.2025; 08.2025)* | In the last months, **a virtual reality exposure therapy (VRET)** has been developed. In addition, **tasks** for the study of circuit mechanisms and for evaluation of the intervention have been selected and adjusted in close collaboration with other URPP projects (see (7.), (10.), (14.), (15.), (16.)). A strong focus was also on ethics application. |
| **18.** | ***New project set up:*** *Exploring how **sensory processing difficulties** in children with **Global Developmental Delay** (GDD) impact **cognitive and emotional development** (**CONNECT**)* | *Two new PhD positions filled as expected (07.2025; 11.2025)* | Assessment tools are finalized and ethics application is close to completion. Further, medical records from children with GDD are being systematically screened to evaluate eligibility. |
| **19.** | ***New project set up:*** *Study of the **impact of sleep** on sensory integration, cognitive function and* | *One new PhD position filled as expected (07.2025)* | A central achievement was the preparation of the technical adaptation of the core assessment tools (eye tracker, home EEG, actimetry) for young children with ASD. Also, an existing |

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| *emotion regulation in children with **ASD**.* | *Ethics application completed* | learning paradigm was adapted forpreschool children with ASD. |

**Further important insights reached by projects without planned milestones in 2025**
Preliminary data analysis in the project **SMILE** suggest that the **intervention improved mathematical skills** in adolescents and adults with dyscalculia. Data collection and analysis of MRI data are still ongoing.

### 3.2 Highlights of research activities in the reporting year

Scientific highlights in the reporting year have been achieved in particular by research groups working with human data. Major progress has been made in the development of learning tasks during functional MRI (fMRI) measurements, which have the goal to better understand brain network mechanisms underlying multisensory perception, integration, and learning in neurotypical individuals and in individuals with developmental and learning disorders.

The project **"Functional Mechanisms"** developed a multisensory experimental paradigm that allows to study and **differentiate** three different learning processes in adults**: multisensory statistical learning** (learning from the statistical co-occurrence of inputs from different sensory modalities), **reinforcement learning** (learning from errors in the prediction of rewards & punishments), and **outcome-related surprise** (learning from unexpected, surprising events). This work demonstrated that the different learning processes **rely on distinct although partially overlapping neural networks**, but that these networks were **modality-general**, i.e. they worked similarly across different sensory inputs (Bedi et al, 2025). This work establishes a principled framework for studying multisensory learning beyond traditional unisensory approaches and provides a strong foundation for future translational and clinical studies within the URPP AdaBD.

The **ChildBrainCircuits consortium** successfully adapted and implemented the multisensory learning task described above in two variants to study both reward-based and statistical multisensory learning in children. By combining computational modelling with neuroimaging (fMRI), the results show that adults use more advanced learning strategies and make more deterministic choices, while children rely on simpler decision strategies. In addition, reward prediction error signals were found to be remarkably stable across age groups (children and adults) and task variants, indicating that core neural reinforcement-learning computations are already robust in childhood. In contrast, neural surprise processing was strongly task-dependent: It only emerged in one of the two task variants (the match recognition task), and it also revealed developmental differences. This highlights that **apparent learning differences between children and adults can depend critically on task design**, when probing sensitivity to statistical regularities. Our findings therefore provide an important methodological contribution to developmental cognitive neuroscience and offer a powerful approach for studying reinforcement and statistical learning side-by-side across different age groups (Raduner et al., 2025; Raduner et al., 2026).

The **NumRisk** project studies the neurocomputational mechanisms of dyscalculia and fundamentally revised the currently prevailing hypothesis that dyscalculia reflects a primary deficit in number representations. Its novel behavioral, computational modelling, and neuroimaging dataset revealed that adolescents with dyscalculia show preserved neural precision of numerical representations in the parietal cortex but exhibit pronounced alterations in number-memory-related processes and the associated large-scale functional connectivity. This suggests that **dyscalculia reflects difficulties in integrating numerical information over time** (manuscript in preparation, will be submitted soon). This shift in understanding has direct implications for the development of diagnostic tools and interventions. In future studies, the URPP AdaBD will emphasize working memory, attentional control, and network-level brain organization, which may become key targets for therapeutic approaches.

Another highlight of the URPP AdaBD is the expansion of the mesoSPIM Platform into a **Microscopy Innovation Platform**, which is pushing the boundaries of brain imaging through cutting-edge innovation across a wider range of light microscopy technologies (see Chapter 4).

# 4. Interdisciplinary synergies

In the reporting period, the URPP AdaBD made substantial progress in building interdisciplinary synergies. The community, which began forming a couple of years ago, now increasingly works together and is developing into a research and innovation hub that would not exist in this form without the URPP.

The **microscopy innovation platform** (MIP, formerly mesoSPIM platform) continues to drive cutting-edge innovation across a wider range of light microscopy technologies and increasingly collaborates with researchers across disciplines, also beyond the AdaBD community. Last year, we hired an additional research associate (A. Vavladeli) to **advance the Schmidt-Voigt objective**, which is implemented in a two-photon microscope and enables large field-of-view imaging with submicron resolution, bridging the gap between mesoscopic and cellular scales. We have already begun active development of a second-generation instrument of this system. In parallel, we started **imaging expanded brain tissues** using both mesoSPIM and Schmidt-Voigt microscopes, and we initiated **tissue expansion as a service**. We further improved our tissue clearing protocols and **successfully cleared and stained an entire mouse**, enabling whole-body studies of tumor growth and metastasis. The MIP Platform actively contributed to two publications (Garbelli and Chen, 2025; Naert et al., 2025) and two preprints (Araujo et al, 2025; Reuss et al, 2025).
The **High-Dimensional-Data-Science Platform** further developed its analysis software DataDelv (formerly DataSpace) and contributed to two publications in 2025 (Speckert et al, 2025; Calangiu et al, 2025). Additional manuscripts, including the software release, are in preparation and close to submission.

Several research groups are engaged in interdisciplinary collaborations (see Chapter 3.1). A key highlight is the **development of behavioral tasks to investigate multisensory integration**. These tasks, as well as associated analysis pipelines for fMRI and microscopy data, are designed to be transferable across settings, enabling cross-species and cross-disorder comparisons at different ages (see Chapter 3.1, page 7). Towards this goal, we hired two Postdocs (L. Godenzini and J. Algermissen), who oversee development and implementation of translational methods and support research groups with their experience in these methods.
Another effort focuses on **iPSC-based models for ASD** (See Chapter 3.1). We hired a Postdoc, J. Crowe, to investigate synapse structure and function in human iPSC-derived neuronal models carrying different ASD-associated genes, using CRISPR-based gene editing. A complementary project uses iPSC derived from ASD individuals to study circuit formation and cell-to-cell communication in neurons with the genetic background of single ASD individuals. The goal is to combine neuronal phenotyping with clinical data to better understand disease mechanisms and support patient stratification. The project builds a strong new bridge between basic neuroscience (Müller, Jessberger) and clinical research (Walitza) and is a best-practice example of bridging the gap between basic science and clinics . These projects have recently started and have the potential in the years to come to shape at the University of Zurich translational research in neurodevelopmental and psychiatric disorders, by connecting patient-specific neuronal models with clinical data.

**The Learning and Learning Disorders (LLD) Platform** hired two Research Associates in Job sharing, who increased efforts for interdisciplinary research across disorders. A particular highlight was the development and initiation of pilot testing of two **new assessment instruments for dyscalculia**. The platform also established a **shared data infrastructure** across collaborating research groups. Further, the LLD expanded its outreach activities including **teaching and support services** (see Chapter 5), which also provide valuable insights into informational needs. A key milestone was the establishment of a **diagnostic center for dyslexia** which

combines the direct support for families with valuable insights into real-life challenges, relevant for our work in research and communication.

At the level of the entire URPP, the coordinating office engaged in **public outreach activities** involving researchers from different fields. For example, we organized a continuing education afternoon for primary school teachers in Ascona TI, with contributions from the LLD Platform and AdaBD Postdoc L. Godenzini from the Brain Research Institute (see Chapter 5). In addition, the planned exhibition at the Science Pavilion UZH is a joint effort of an interdisciplinary organizing committee.

The Monte Verità Conference and the mesoSPIM Symposium were great opportunities for **interdisciplinary scientific exchange** and contributed to bridging basic and clinical science (see Chapter 5). Both events strengthened the collaborative culture within our community.

Early career researchers engaged in cooperative projects and benefit from the **interdisciplinary environment**.

To ensure the acquisition of third-party funding beyond 2028 (see also Chapter 10), we appointed **a fundraising manager**, N. Greter, who plays a substantial role in strengthening collaborations and further developing the community. The original goal to have a fundraising strategy plan by the end of 2025 proved unrealistic. However, we are working on a development plan with a first version expected within the coming months. This includes strategies for sustainability of the platforms and vision papers outlining future research directions and follow-up research projects. Based on this, we will approach stakeholders and the UZH foundation.

# 5. Scientific activities and outreach

## 5.1 Scientific activities

In 2025, the established **bi-weekly online seminar series** continued successfully, with the aim of presenting the AdaBD research groups and fostering discussion on ongoing projects. As a new feature, external guest speakers were invited (T. Bourgeron, D. Colameo, M. Manfredi, L. Traunmüller, K. Wilmes), enhancing the visibility of the series and bringing in additional academic perspectives.

A particular highlight of the year was the **international conference *"The Adaptive Brain: Development, Learning, and Learning Disorders"***, held at **Monte Verità** and organized by AdaBD (Organizing Committee: F. Helmchen, E. Stoeckli, S. Brem, M. Müller, S. Huber-Reggi, C. Nussbaumer, L. Zanetti). From May 25 to May 28, 2025, researchers from Switzerland and abroad gathered to exchange ideas and discuss current developments and future directions in the field. The conference **focused on neurobiological mechanisms underlying brain development, circuit adaptation during learning, and the mechanisms driving learning disorders**. The scientific program was structured into a series of thematic sessions, each addressing a key aspect of brain development and learning. These included an Overview Session to set the stage, followed by sessions on Genetics and Circuit Development, Models and Tools Across Species, Memory Consolidation, Multisensory Learning, Computational Modelling, and Learning Disorders. Together, these sessions provided a comprehensive perspective, ranging from molecular and genetic foundations to systems-level and computational approaches. Alongside invited international experts, following AdaBD members presented their research work: R. Bachmann-Gagescu, S. Brem, S. Han, A. Jakab, C. Ruff, X. Zhang. In addition to the main sessions, poster sessions provided an important platform for early-career researchers – including most of our students – to present their work and engage in scientific exchange. To recognize outstanding contributions, awards were presented for the best posters and best short talks. The conference also fostered informal exchange and networking opportunities, most notably through a joint excursion to the Brissago Islands, which included a social dinner and further strengthened interdisciplinary connections among participants. Overall, the conference was very

positively received by participants, who highlighted both the high scientific quality and the collaborative atmosphere.

Furthermore, the Microscopy Innovation Platform (MIP), in collaboration with ZMB, organized the **"*10 Years of mesoSPIM*" symposium** (Organizing Committee: N. Vladimirov, F. Helmchen, U. Ziegler, P. Bethge, M. Garbelli, N. Greter, S. Huber-Reggi, C. Nussbaumer, A. Vavladeli, S. Weiss, L. Zanetti). Held from October 13 to October 15, 2025, the symposium offered a retrospective on a decade of technological innovation, while also highlighting future developments and opportunities for collaboration. International researchers at all career stages—from early-career scientists to established experts—presented their work in light-sheet microscopy, tissue clearing, and image analysis, and engaged with an international community of peers.

Following **symposia and workshops** have been co-organized by AdaBD members or AdaBD members acted as chairs:

| | **Title of the event** | **Date(s), Location** | **Webpage** (if available) | **Role of the URPP** |
|---|---|---|---|---|
| **1.** | Symposium *From Neurobiology to Mental Health in Children with Specific Learning Disorders* | June 29, 2025, European Society for Child and Adolescent Psychiatry (ESCAP) Conference, Strasbourg | https://www.escap.eu/events/escap-2025-congress-in-strasbourg | K. Kucian and S. Brem chairs |
| **2.** | Workshop *"Development of neural circuits across model systems: Insights from mice, zebrafish, and human neurons"* | Sept 11, 2025, ZNZ Annual Symposium, Zurich | https://www.neuroscience.uzh.ch/en/symposium/previous.html | Organized by R. Bachmann and T. Karayannis |
| **3.** | SfN Minisymposium *"Excitatory and inhibitory circuit rewiring in development and adulthood"* | Nov 16, 2025, Neuroscience 2025, SfN, San Diego, CA, USA | https://www.sfn.org/meetings/neuroscience-2025 | C. Foeldy chair |

## 5.2 Outreach activities

### 5.2.1 Outreach in the science community

Several AdaBD PIs and PhD students **presented research projects** of the URPP AdaBD at international congresses and seminars. PIs and students have been asked to acknowledge funding by the URPP AdaBD as well as their affiliation to the network. This enables us to increase our visibility in the scientific community. Due to space limitations, we refrain from listing all oral and poster presentations. On our website, we list invited talks and keynote lectures by AdaBD members on AdaBD related topics: Outreach in the science community | URPP Adaptive Brain Circuits in Development and Learning (AdaBD) | UZH.

### 5.2.2 Public Outreach

Public outreach activities in 2025 focused on strengthening the dialogue between research, education, and the broader community. A key highlight was a **teacher training workshop** co-organized with SUPSI (Scuola universitaria professionale della Svizzera italiana) and held at Monte Verità on May 28, 2025. This continuing education course introduced participants to the biological mechanisms underlying brain development and learning, with a particular focus on the interplay of genetic and environmental factors, including educational practices. The second part of the workshop addressed current research on dyslexia and dyscalculia and presented evidence-based strategies to support affected children and adolescents. An interactive session with small-group workshops allowed participants to reflect on how to translate scientific insights into classroom

practice, while also engaging in dialogue with researchers on how science can contribute to improving the management of learning disorders in schools and everyday life.
Another important outreach event was the **panel discussion *"How do People on the Autism Spectrum Perceive the World?"***, organized in collaboration with the Developmental Science Network Zürich on June 10, 2025. Bringing together perspectives from research, professional practice, and lived experience, the discussion explored how individuals on the autism spectrum perceive and interact with their environment, highlighting both challenges and strengths. The event provided a valuable platform for exchange with the public and fostered a deeper understanding of the diversity of autistic experiences. The recording and answers to additional questions from the audience are available here (in German): Öffentliche Podiumsdiskussion | URPP Adaptive Brain Circuits in Development and Learning (AdaBD) | UZH
In addition, AdaBD further expanded its digital outreach by strengthening its presence on **LinkedIn**, increasing its audience by more than 500 followers over the course of the year. This growth reflects a rising interest in the network's activities and supports the dissemination of research findings to a broader audience. The AdaBD Newsletter was published in August 2025 and contained exciting news on our platforms and interviews with new employees.

In the reporting year, the **UZH Magazin 02/25** published an article on imaging technologies developed in our URPP (Das Gehirn beim Lernen beobachten). In addition, we started a collaboration with SRF for a **SRF-Einstein** documentary about learning and attention. An organizing committee composed of the members of the Coordinating Office and of young AdaBD researchers (L. Zanetti, M. Antonios, M. Garbelli, N. Greter, N. Hehl, L. Holste, C. Nussbaumer, S. Huber-Reggi, M. Schneebeli, G. Schoenfeld, Science Lab UZH Team) is working on an exhibition at the **Science Pavilion UZH** on the theme "Learning with all the senses." The content has been finalized, and the team is currently working on the exact wording and the interactive elements. The opening is scheduled for January 2027.

**The LLD Platform (**www.lld.uzh.ch**)** has a strong focus on translation of research insights in the field of learning disorders to society. In the reporting year, the platform established a **diagnostic center for dyslexia** (see Chapter 4) as well as a **telephone counseling service** for families and, in the future, for professionals. In addition, the platform carried out following **outreach activities**:

| | Activity | Title | Date(s) | Location or Media, webpage |
|---|---|---|---|---|
| **1.** | Course for teachers by S. Brem | Lesenlernen, Einblick ins Gehirn | March 6, 2025 | ZAL – Online |
| **2.** | Talk by S. Brem | Lesespass oder Buchstabensalat: Wie das Gehirn Lesen lernt und was bei Kindern mit Dyslexie anders läuft | March 10, 2025 | Brainfair Zürich |
| **3.** | Course for teachers by K. Kucian | Dyskalkulie | March 2025 | ZAL – Online |
| **4.** | K. Kucian organized a two-day workshop on dyscalculia | Dyskalkulie: Grundlagen, Diagnostik und Therapie | March 2025 | Masterstudiengang Primarlehrer*innen, Kirchliche Pädagogische Hochschule Stams, Tirol, Austria |
| **5.** | Fokusreferat und Podiumsdiskussion von S. Brem | Buchstabensuppe im Kopf: Einblick ins Gehirn | May 17, 2025 | Tagung Schulische Heilpädagogik- Vom Papier zum Pixel, Bern |
| **6.** | Teacher training workshop in collaboration with the Coordinating | „Il cervello che cambia e si adatta: Sviluppo, apprendimento e disturbi dell'apprendimento" | May 28, 2025 | Monte Verità, Ascona https://www.supsi.ch/il-cervello-che-cambia-e-si-adatta-sviluppo- |

| | | | | |
|---|---|---|---|---|
| | Office of AdaBD and the SUPSI (held in Italian and Englisch) | | | apprendimento-e-disturbi-dell-apprendimento |
| **7.** | Keynote Lecture by S. Brem | Legasthenie oder Leserechtschreibstörung (LRS) im Kindesalter: Was ist das und wie gehe ich damit um? | Nov 28, 2025 | Kinder Augenheilkunde, Basler Fortbildungstage, Basel |
| **8.** | Interview with K. Kucian | Viele Dyskalkulie-Patienten erzählen mir von ihren Selbstzweifeln | May 5, 2025 | Zürcher Oberländer online and print |
| **9.** | Webinar by K. Kucian | Mathematikangst | Sept 2025 | FIL Fachverband für integrative Lerntherapie, Deutschland |
| **10.** | Webinar by K. Kucian | Lernstörungen und Dyskalkulie | Sept 2025 | PBS Privatebildung Schweiz |
| **11.** | Workshop by the LLD platform | Magische Bilder: Eine Reise ins Innere mit dem MRI | Nov 2025 | Kinderuni UZH |
| **12.** | K. Kucian gave twice a one-day course | Dyskalkulie – wenn Mathematik zu viel Kopfzerbrechen bereitet | Sept and Nov 2025 | Institut für Lerntherapie ILT Schweiz |

Following AdaBD members contributed to **further outreach activities**

| | **Activity** | **Title** | **Date(s)** | **Location or Media, webpage** |
|---|---|---|---|---|
| **1.** | Workshop by MIP Platform and L. Zanetti | Tiefe Einblicke ins Gehirn – entdecke die Lichtscheibenmikroskopie | Apr 16, 2025 | Kinderuni, UZH |
| **2.** | Panel Discussion of the DSN-ZH with following participants (AdaBD members marked with *): R. Bachmann-Gagescu*, R. Huber*, S. Neuhauss, E. Stoeckli*, S. Brem* (Moderation) | Brauchen wir noch Tierversuche in der neurobiologischen Forschung? | Nov 4, 2025 | Online, DSN-ZH<br>With recordings |
| **3.** | Lunchsymposium by R. Liamlahi | Schlafstörungen bei Kindern im Autismus-Spektrum | Nov 7-8, 2025 | 3. Nationaler Autismuskongress *Autismus: verstehen und gemeinsam wachsen in allen Lebensphasen*, Interlaken |
| **4.** | Lecture by M. Müller | Wie wir lernen – die Superkräfte des Gehirns | Nov 26, 2025 | Kinderuni, UZH |
| **5.** | Interview with F.Helmchen | Lernen findet auf ganz verschiedenen Ebenen statt | Dec 2025 | Naturforschende Gesellschaft Zürich, Vierteljahrsschrift 2025/4 |

# 6. Academic Career Development

## 6.1 Academic career development

In the last year, AdaBD invested financial resources for a total of **29 PhD and four Postdoc positions**. Of these positions, 23 are new and have been filled between January and December 2025. Additional students and postdocs are working on URPP research projects while being financed with UZH or third-party funds.

Young academics in our research groups can profit from an **interdisciplinary environment, symposia, online seminars and support from the platform managers.** This year, they had the opportunity to actively participate in the AdaBD 2025 conference on Monte Verità (see Chapter 5). Some young academics have the opportunity to participate in the **organizing committee** of the exhibition in the Science Pavilion UZH (see Chapter 5.2.2).

In 2025, we introduced the position of **AdaBD Postdoc** (see Chapter 4), which gives the opportunity to the position holders to work with different research groups and use their expertise to support younger researchers. They are acquiring skills in interdisciplinary thinking, mentoring, and project management, which will be very valuable for their next career steps within or outside academia.

Last year, we also successfully filled the open position of an **Assistant Professor Tenure Track** in stem cells technology. Akanksha Jain started in September 2025 as a Research Associate and was officially appointed as assistant professor starting January 2026. We continued our **support of the professorships** of R. Bachmann (70% of salary) and of A. Jakab (10% of salary).

Following career development **events** have been organized in the reporting year:

| | Title of the event | Date(s), Location | Description |
|---|---|---|---|
| **1.** | Informal networking event for PhD Students and Postdocs | Apr 15, 2025, Zurich | Topics:<br>— Networking<br>— Candidates as PhD student representative<br>— Wish to establish clear backup and fallback research plans early on, in collaboration with the PIs, at the start of the PhD |
| **2.** | Blockcourse “Modern microscopy in Life Science research” | Sept 16 – Oct 8, 2025 | Course for bachelor and master students organized by URPP member M. Müller and with the participation, among others, of AdaBD researchers R. Bachmann, F. Helmchen, N. Vladimirov. |
| **3.** | Lab Visits | — Nov 25, 2025, Stoeckli lab<br>— Dec 2, 2025, KISPI<br>— Dec 9, 2025, KJPP | In fall 2025, we resumed our series of lab visits to promote networking within the AdaBD community: During a two-hour tour, the host institutes presented their workspaces, working techniques and research projects. Each lab visit was followed by a get-together with Apéro. |

## 6.2 Gender equality development

The URPP AdaBD commits to a favorable gender balance and has the goal to provide family-friendly working conditions. Also in this reporting year, the AdaBD general manager *S. Huber-Reggi* acted as **representative for gender equality** in the steering committee. New employees are informed about her role and about support and rules in the context of gender equality.

When planning seminars and symposia, we always ensure **gender balance**. In 2025, we increased our already high standards regarding equal gender representation at all levels. The percentage of women in different employee categories and in different teams are summarized below (page 21).

Last year, we included two **new young female PIs** (S. Han and X. Zhang) with an Ambizione and a PRIMA fellowship, respectively. The **new APTT position** has been filled with a female researcher (A. Jain).

Our URPP offers several **family-friendly part-time and flexible positions**. The following employees work part-time due to family commitments: S. Huber and L. Zanetti in the coordinating office, L. Holste as coordinator of platform of the learning and learning disorders, M. Schneebeli as Project leader of BIMA. Also, two PIs are working part-time due to family commitments.

| | Employees Categories or Team | Percentage of women as of 12.2025 |
|---|---|---|
| **1.** | PhD Students | 67% |
| **2.** | Postdocs | 25% |
| **3.** | Platforms employees | 57% |
| **4.** | Coordinating Office | 100% |
| **5.** | Principal Investigators | 45% |
| **6.** | Steering Committee | 75% |
| **7.** | Advisory Board | 40% |

# 7. Publications

## 7.1 List of publications

**All publications except one and all dissertations except one are open access.** The closed publications are marked with **#**. **AdaBD members are marked in bold**.

***26 Peer-reviewed publications***

**Bachmann-Gagescu R**, Sayer JA. Tackling ciliary specialization to understand phenotypic variability in human primary ciliopathies. Journal of Cell Science. 2025; 138(20): jcs264177. doi:10.1242/jcs.264177

Calangiu I, **Kollmorgen S**, Reppas J, **Mante V**. Prospective and retrospective representations of saccadic movements in primate prefrontal cortex. Cell Rep. 2025; 44 (2): 115289. doi:10.1016/j.celrep.2025.115289

Disselhoff V, **Jakab A, Latal B**, Schnider B, Wehrle MF, Hagman C, EpoKidsResearch Group. Inhibition abilities and functional brain connectivity in school-aged term-born and preterm-born children. Pediatric Res. 2025; 97(1): 315-324. doi:10.1038/s41390-024-03241-0

**Ehrler M**, O'Gorman R, Wehrle FM, **Speckert A, Jakab A**, Kretschmar O, **Latal B**. Learning from those who thrive: protective factors and neuroimaging markers in adolescents with complex congenital heart disease and with a favorable neurodevelopmental profile. Child Neuropsychology. 2025; 31(4): 613–634. doi:10.1080/09297049.2024.2419048
*Was mentioned as 'in press' in the last report*

Eschment M, Mercey O, ..., **Rauch A**, Guichard P, Hamel V, **Bachmann-Gagescu R**. CEP290 deficiency disrupts ciliary axonemal architecture in human iPSC-derived brain organoids. Journal of Cell Science. 2025; 138(20): jcs264092. doi:10.1242/jcs.264092

Figueiro-Silva J, Eschment M, …, **Rauch A, Bachmann-Gagescu R**. CRISPR/Cas9-mediated generation of two isogenic CEP290-mutated iPSC lines. Stem Cell Research. 2025; 87: 103781. doi:10.1016/j.scr.2025.103781

Fraga-González G, Haller P, Willinger D, Gehring V, Frei N, **Brem S**. Functional brain activations correlated with association strength and prediction error during novel symbol-speech sound learning. Imaging Neuroscience. 2025; 3: imag_a_0039. doi:10.1162/imag_a_00439

**Garbelli M**, Chen Z. Food dye for optical clearing and invivo imaging. Kidney International. 2025; 107(5): 776–778. doi:10.1016/j.kint.2025.01.013

**#** Groos D, Reuss AM, Rupprecht P, Stachniak T, Lewis C, **Han S**, ..., **Karayannis T**, Aguzzi A, **Helmchen F**. A distinct hypothalamus–habenula circuit governs risk preference. Nature Neuroscience. 2025; 28(2): 361–373. doi:10.1038/s41593-024-01856-4
*OA via ZORA repository pending*

**Haenseler W**, Eschment M, Evans B, **Brasili M**, Figueiro-Silva J, Roethlisberger F, ..., **Müller M**, Cowley SA, **Bachmann-Gagescu R**. Differences in neuronal ciliation rate and ciliary content revealed by systematic imaging-based analysis of hiPSC-derived models across protocols. Frontiers Cell and Development Biol. 2025; 13: 1516596. doi:10.3389/fcell.2025.1516596

**Han S, Helmchen F.** Coordinated multi-level adaptations across neocortical areas during task learning. Nature Communications. 2025; 16: 7719. doi:10.1038/s41467-025-62949-7

Haugg A, Frei N, Lutz C, **Di Pietro SV, Karipidis II, Brem S.** The structural covariance of reading-related brain regions in adults and children with typical or poor reading skills. Developmental Cognitive Neuroscience. 2025; 72: 101522. doi:10.1016/j.dcn.2025.101522

Kapetaniou GE, Moisa M, **Ruff CC, Tobler PN**, Soutschek A. Frontopolar Cortex Interacts With Dorsolateral Prefrontal Cortex to Causally Guide Metacognition. Human Brain Mapping. 2025; 46(2): e70146. doi:10.1002/hbm.70146

Lugrin C, Hu J, **Ruff CC**. A computational account of multiple motives guiding context-dependent prosocial behavior. PLoS Computational Biology. 2025; 21(4): e1013032. doi:10.1371/journal.pcbi.1013032

Lugrin C, Konovalov A, **Ruff CC**. Manipulating attention facilitates cooperation. Commun Psychol. 2025; 3(1): 39. doi:10.1038/s44271-025-00206-9

Naert T, Yamamoto T, **Han S**, Röck R, Horn M, Bethge P, **Vladimirov N**, Voigt FF, Figueiro-Silva J, **Bachmann-Gagescu R**, Vleminckx K, **Helmchen F**, Lienkamp SS. Precise, predictable genome integrations by deep-learning-assisted design of microhomology-based templates. Nat Biotechnol. 2025; doi:10.1038/s41587-025-02771-0

Payette K, Steger C, ..., Bach Cuadra M, **Jakab A**. Multi-Center Fetal Brain Tissue Annotation (FeTA) Challenge 2022 Results. ArXiv. 2025; 44 (3): 1257-1272. doi:10.1109/TMI.2024.3485554

**Raduner N, Providoli C, Di Pietro SV, Schneebeli M, Karipidis II, Casimiro E, Bedi S, von Rhein M, Raschle NM, Ruff C, Brem S**. Growing minds, integrating senses: Neural and computational insights into age-related changes in audio-visual and tactile-visual learning in children. Developmental Cognitive Neurosci. 2025; 76: 101622. doi:10.1016/j.dcn.2025.101622

**Raduner N, Providoli C, Di Pietro SV, Schneebeli M,** Steuer MA, Gubler S, **Casimiro E, Bedi S**, **Karipidis II**, **von Rhein M, Raschle NM, Ruff CC**. Neural and behavioural differences in multisensory statistical and reinforcement learning across development and task variants. Imaging Neuroscience. 2026; 4: IMAG.a.1117. doi:10.1162/IMAG.a.1117

**Raschle NM**, Borbás R, ...., Konrad K, Stadler C . Losing Control: Prefrontal Emotion Regulation Is Related to Symptom Severity and Predicts Treatment-Related Symptom Change in Adolescent Girls With Conduct Disorder. Biological Psychiatry: Cognitive Neuroscience and Neuroimaging. 2025; 10(1): 80–93. doi:10.1016/j.bpsc.2024.08.005

**Speckert A**, Gianinazzi L, **Kollmorgen S**, Hagmann C, Grehten P, Kottke R, Natalucci G, **Latal B**, …, Hoefler T, **Jabkab A**. Atlas-independent brain connectome analysis at voxel-level granularity: graph convolutional networks for etiology classification in newborns. NeuroImage. 2025; 322: 121568. doi:10.1016/j.neuroimage.2025.121568

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### *5 Dissertations*

Author (underlined) and referees are listed. AdaBD members are marked in bold.

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## 7.2 Activities to promote open science

The URPP AdaBD supports promotion of Open Science and follows Open Science principles whenever applicable. Despite this, data protection constrains with clinical data and challenges due to the generation of raw images in the size of petabyte do not allow us to store or distribute all our data with current technologies.

**Open Access publishing**

All publications except one peer-reviewed paper and one dissertation (both marked with #) have been published open access (see Chapter 7.1).

**Open research data**

Data handling complies with the FAIR principle. Whenever possible, we make data, codes and methods openly available. In particular, following measures are currently being taken:

- The **structural connectome pipeline** is openly available on github: https://github.com/annspe/connetome_pipeline
- Repository of the **ChildBrainCircuits** project: https://osf.io/cmzne/overview
- Repository of Wu et al., 2025: https://zenodo.org/records/13893852
- The analysis code of all ongoing research projects led by Christian Ruff is openly available on github, e.g. https://github.com/Gilles86/risk_experiment. All collected data are immediately converted to the standard BILDS format for fMRI datasets and are or will be shared on the openneuro platform after publication (e.g. https://openneuro.org/datasets/ds004259). Extensive care is also taken to make the computer code for running the behavioral task modular, well documented, and easy to recombine and use in other projects.
- The **CONNECT** project and the project on Sleep in ASD are currently pre-registering the main research questions and analysis plans.

**Further Open Science aspects**

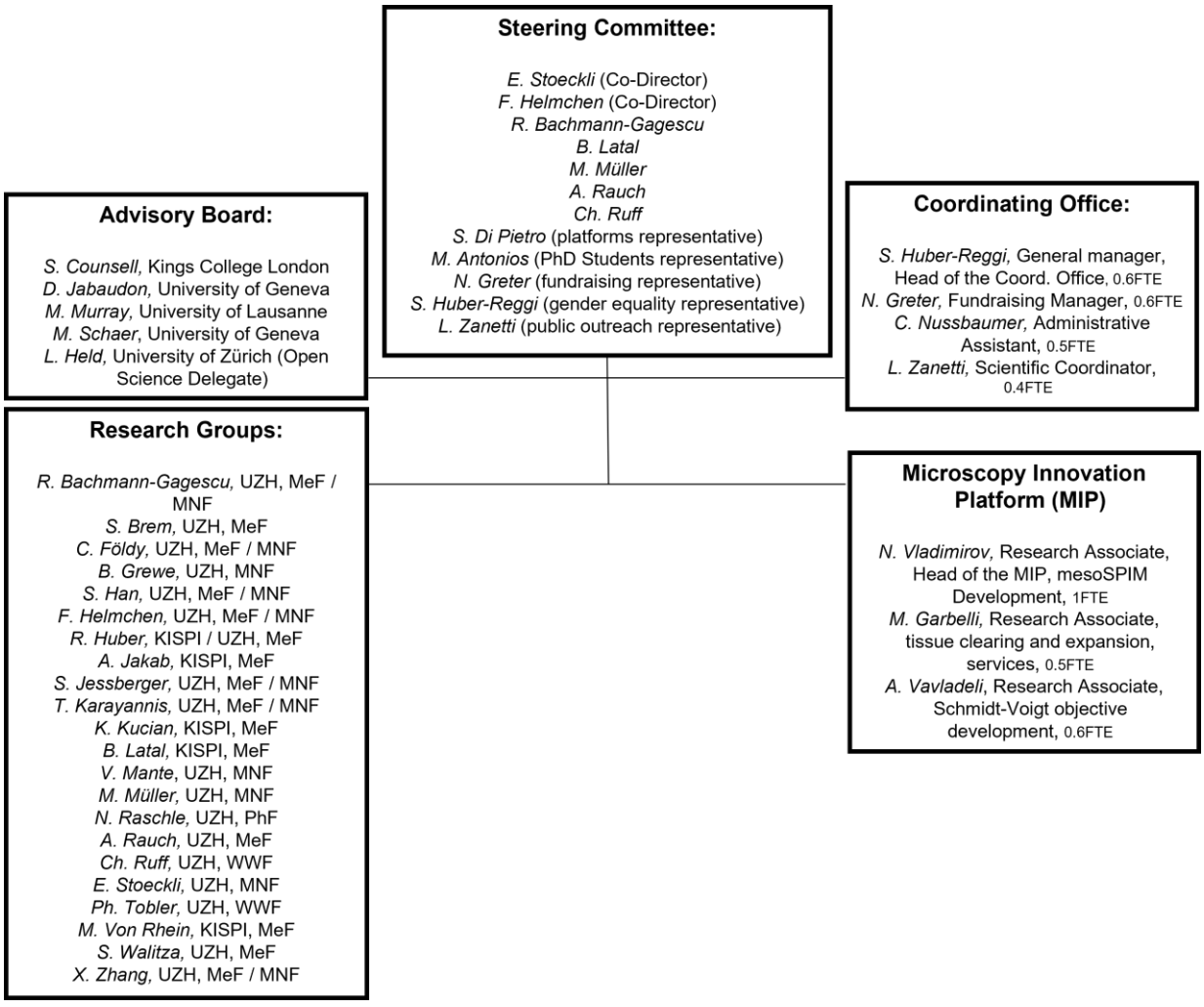
The **mesoSPIM initiative** further flourished this year. In 2025 alone, there were 35 (last year 28) publications (globally) that used mesoSPIM, 11 of them used the URPP mesoSPIM platform microscopes, including 2 PhD dissertations. Nikita Vladimirov gave workshops and students trainings for technology dissemination (see Chapter 5 and 6).

The research project on **connectome and autistic traits** (Chapter 3.1, (6)) relies on openly available datasets, in particular the dHCP cohort.

The research project "**3D atlas**" aims to make the 3D dataset of human thalamus, as well as the associated methodologies, freely available to the broader scientific community.

The research project **SMILE** will make the digital learning units to train numerical understanding freely available.

# 8. Structures




*31.12.2025*