
Stress in Action Annual Report 2024

Stress in Action is a multidisciplinary 10-year research project funded by the Dutch Research Council (NWO) Gravitation Programme.

Seven institutes collaborate in the Science of Stress in Daily life.



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Mission

The Stress in Action (SiA) consortium aims to undertake groundbreaking research to better measure, understand, and intervene on the detrimental effects of daily life stress on health. Our consortium is comprised of a multidisciplinary group of researchers from seven academic institutes: Amsterdam UMC, VU Amsterdam, UMC Groningen, University of Groningen, Utrecht University, University of Twente and Erasmus MC.

We develop and evaluate innovative ambulatory methods to measure affective, cognitive, biological, and behavioural responses to daily life stress. By conducting studies within large-scale cohorts, we aim to identify the contextual and personal factors that influence these stress responses and understand how daily life stress contributes to the development and course of mental and cardiometabolic diseases.

SiA's research will pave the way for the development of novel monitoring techniques and personalized intervention strategies to track and alleviate daily life stress, ultimately improving overall health and wellbeing.

Stress in Action is funded by a 10-year Gravitation grant from the Dutch Research Council and the Dutch Ministry of Education, Culture and Science.

Coordinating Researcher/PI
Prof. dr. Brenda Penninx



Executive summary

In 2024, the Stress in Action (SiA) consortium continued to grow, expanding to 91 members across a diverse range of expertise, including genetics, psychiatry, internal medicine, psychology, sociology, longitudinal data analytics, machine learning, engineering, and interaction design. This year, we welcomed one postdoctoral researcher, a hardware developer, and two research assistants. Additionally, through in-kind arrangements, we attracted two PhD students, two postdoctoral researchers, and one mid-career researcher, further enriching our multidisciplinary team. The consortium remains diverse, with 63% female members, 45% non-Dutch, and representatives from 19 different nationalities.

Our early career researchers—PhD students and postdoctoral researchers—continued their dedicated work on their research projects, and their initial study activities are outlined in the Appendix.

In 2024, we celebrated the publication of our first five Stress in Action articles, marking an important milestone in our research output. Our team also presented at 22 national and international conferences. These efforts reflect the continued commitment of our consortium to advancing the field of stress research and fostering collaboration within the scientific community.

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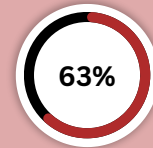
Years

91

Consortium members

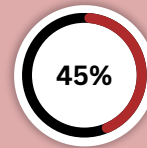
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Nationalities



Female

63% of consortium members is female.



Non-dutch

45% of consortium members has a non-Dutch nationality. 9% of the total consortium is non-European.

26

PhD students

Highlights

Publications

Kuckuck, S., Lengton, R., Boon, M.R., Boersma, E., Penninx, B.W.J.H., Kavousi, M., & van Rossum, E.F.C. **Long-term glucocorticoids in relation to the metabolic syndrome and cardiovascular disease: A systematic review and meta-analysis.** *Journal of Internal Medicine.* 2024 Jan;295(1):2-19.

Kavousi, M., & Snieder, H. **On the importance of birth weight in relation to disease risk in later life.** *European Heart Journal.* 2024 Feb 7;45(6):455-457

Bringmann, L. F., Ariens, S., Ernst, A. F., Snippe, E., & Ceulemans, E. **Changing networks: Moderated idiographic psychological networks.** 2024 *advances.in/psychology, 2, e658296.*

van Lotringen, C.M., ten Klooster, P.M., Austin, J., et al. **Development of the Compassionate Technology Scale for Professionals (CTS-P): value driven evaluation of digital mental health interventions.** *BMC Digital Health 2, 77 (2024).*

Gelner, H., Bagrowska, P., Jeronimus, B.F., Misiak, B., Samochowiec, J., & Gawęda, Ł. **Psychotic-like Experiences and Underlying Mechanisms: An Integrative Model of ADHD Symptoms, Rumination, Negative Affect, and Trauma Experience.** *Journal of Clinical Medicine.* 2024 Nov 8;13(22):6727.

Additionally, we have more than 5 papers accepted to be published in 2025.

Our consortium grew from 81 to 91 members, expanding our collaborative network. We also marked an academic achievement with two colleagues being appointed as professors, further strengthening our expertise.

We have developed the first version of the Stress Measurement Toolkit. The Toolkit is currently being validated at various institutions in validation and feasibility projects, in patient and population based samples.

25 PhD students successfully completed the highly regarded Interdisciplinary Education Course on Stress in Daily Life, held in November in Amsterdam, reflecting our ongoing commitment to research and education in the field.

We held two engaging and well-attended consortium meetings: a two-day event in June at Leusderheide and a one-day gathering in November in Amersfoort.

In addition to these accomplishments, we launched our very own podcast, Stress Navigation, which debuted successfully in November. With four episodes already published and many more planned for 2025, the podcast is an exciting new platform for sharing knowledge.



Over-arching goal

Stress in Action capitalizes on the fast advances in technology and big data analytics to move stress research from the lab to daily life. A theoretical framework of daily life stress will be developed using the novel insights from ambulatory assessments in large, long-running Dutch cohorts and from experimental validation studies.

This generates novel, mechanistic understanding of:

- How responses to daily life stress arise from the temporal, dynamic interplay between context and person-specific factors.
- How daily life stress can be reliably measured in a specific individual in real-time.
- How and when potential beneficial stress-response mechanisms turn into detrimental effects on mental and cardio metabolic health. This will enable the development of novel monitoring and intervention strategies to track and reduce daily life stress and its health impact.



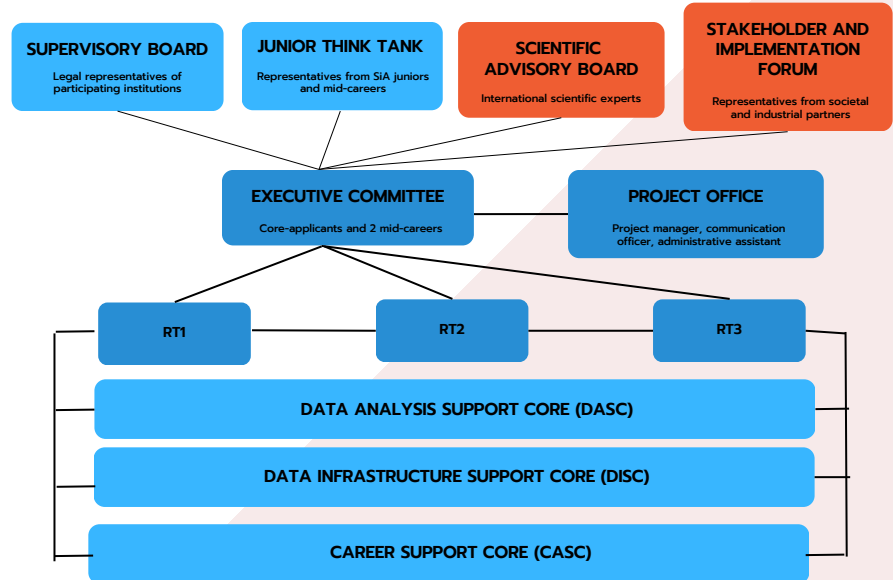
Organisation

In 2024, we continued to strengthen the organisational framework of the Stress in Action consortium. All research themes and support core groups sustained their activities, which are detailed throughout this annual report.

The Executive Committee and the Junior Think Tank was integral to the project's direction, consistently meeting to organise and steer the research initiatives. Meanwhile, the Scientific Advisory Board was kept informed of our progress and has been invited to formally join the consortium in 2025, offering continued expert consultation as the project moves forward.

Looking ahead, we are eager to hold our first Stakeholder Meeting in 2025, in collaboration with our sister consortium, DE-STRESS. This meeting will be a key opportunity to engage with external partners and start the process of creating the Stakeholder Implementation Forum.

An organisational structure chart is included to provide a clear overview of the consortium's framework.



Research Theme 1. Stress in context

Research Theme 1 (RT1) focuses on the Theory of Stress. The primary objectives of RT1 are to 1) develop a comprehensive evidence-based theory of daily-life stress responses, 2) determine the key contextual factors in the aetiology of daily-life stress responses, and 3) test how these stress responses are moderated by evoking/buffering environmental factors and person-specific vulnerability and resilience characteristics. Further, RT1 will develop a nomenclature of stress and will build the foundation for a common language and understanding of the stress concepts in the consortium.

During the past year, we worked on four reviews. The reviews concern: 1) an umbrella review on theories, hypotheses, and models describing the relationship between stress exposures, stress responses and psychopathology, 2 and 3) systematic reviews of original longitudinal studies on stress and psychopathology / cardiovascular diseases, and 4) a systematic review of the conceptualization, classification and contextualization of modern daily-life stressors. We continued with the development of an (online) Stress wiki and Stress database, both envisioned to grow into (public) platforms for collaboration and knowledge sharing. Moreover, we started a representative population-based survey to explore the 'meaning of stress' in society.

A key milestone was our interactive SiA RT1 symposium in October 2024 with four distinguished invited speakers; dr. Markus Eronen, prof. dr. Matijn van Zomeren, prof. dr. Laura Batstra and prof. dr. Jan-Willem Romeijn. We shared the insights from this symposium with the entire SiA consortium during the consortium meeting in November 2024.

RT1 collaborates continuously and intensively with the DASC, e.g. joint participation in the EMA Toolkit taskforce. We are engaged in projects and exchange with RT2 and RT3 on context sensing and moderation of stress effects on health.



Next year

In 2025, we will recruit two new postdoctoral researchers, and four new PhD students. We will focus on the completion of the reviews, the SiA manifesto, the symposium synthesis, the initiated empirical research activities, and the dissemination of results in national and international conferences.

Research Theme 2.

Stress assessment & intervention

Research Theme 2 (RT2) focuses on developing an advanced ambulatory assessment toolkit to quantify stress in daily-life using wearable technology. Six PhD students and two postdoctoral researchers contribute to: (1) responsible design standards for wearables, (2) a curated wearables database for researchers, (3) lab-based validation pipelines, (4) methods to correct physiological stress signals for confounders, (5) machine learning models for affect recognition from sensors, and (6) cognitive tasks to assess attention, memory, and processing speed in daily-life.

Progress in 2024

Responsible Design of Wearables: Key achievements include a narrative review on user perspectives, a position paper addressing challenges with consumer wearables, and speculative design efforts aligned with embedded values.

Wearables Database: The SiA wearables database (SiA-WD), cataloging 30+ research-relevant aspects of consumer and research-grade wearables, is complete and ready for public release in 2025, supported by a publication.

Validation Pipelines: Two validation pipelines for wearable stress sensors are nearing completion, incorporating VR-based tools, hardware, and protocols, with Institutional Review Board approvals in place.

Physiological Stress Signals: Methods have been developed to detect stress-induced heart rate changes correcting for posture and physical activity and speech.

Digital Phenotyping: Machine learning analyses recognize depression/anxiety from smartphone and wearable data. A submitted paper highlights the role of self-perceived cognitive functioning in depression severity.

Cognitive Stress Response: Two scoping reviews address cognitive tools' usability and validity, while a pilot study explores passive sensing and ambulatory cognitive tasks in 20 participants. We submitted 6 papers and published 2 papers relevant to the themes above.

Technical progress includes completing the Trier Social Stress Test (TSST) VR simulation, ongoing development of a high-altitude VR fear of heights scenario, Bluetooth integration for the VU-AMS device, and IMU-based posture and gait determination.

Cross-RT collaborations include the 'Christmas tree project', optimizing HPA-axis measurements using gold-standard cortisol metrics.

Planned in 2025

1. Develop responsible toolkit guidelines and speculative designs.
2. Launch the SiA-WD (version 1.0) as an open-source platform.
3. Validate low-burden wearables for large cohort studies.
4. Provide proof of concept for new ambulatory monitoring technologies.
5. Advance cognitive stress response research and toolkit development.
6. Recruit a PhD student for contextual stress assessment validation.



Research Theme 3. Stress impact on health

Research Theme 3 (RT3) explores how daily-life stress responses affect mental and cardiometabolic health. In 2024, we continued our analyses of existing data. We investigated how 1) daily-life affect and behavioural responses (VU Amsterdam and Erasmus MC) and 2) physiological stress measures and genetics (Amsterdam UMC, UMC Groningen and Erasmus MC) are linked to mental and cardiometabolic health.

Notably, this has resulted in one published meta-analysis (Kuckuck et al. 2024, *Journal of Internal Medicine*) and three accepted publications in 2024. Two of the ePub articles include original data confirming the association of long-term biological stress (measured as scalp hair cortisol and cortisone) and long-term psychological stress (measured using questionnaires) with levels of appetite-regulating hormones and eating behaviour in persons with obesity (PMID: 39509754, PMID: 39433032). The other paper is a review exploring the link between stress and obesity, highlighting how prolonged stress can lead to unhealthy behaviours, such as overeating, reduced physical activity, and poor sleep, which together increase the risk of obesity and related health issues (PMID: 39623561).

In 2024 there were two RT3 meetings, each attended by over 20 researchers. Moreover, SiA members across RT2 and RT3 are pursuing a collaborative effort to validate new stress measurements, including ambulatory monitoring solutions, microdialysis, and ecological-momentary assessments. For this, members of RT3 visited Bristol (UK) to test the microdialysis device which can measure cortisol exposure continuously over >24 hours. The devices worked smoothly, and the RT3 members came back with new laboratory skills. We also engaged with the public, including science communication at two festivals in summer 2024.

Next year

For 2025, we expect more journal articles that examine the most important daily-life stress response measurements that determine mental and cardio-metabolic health outcomes. In addition, we will start two validation and feasibility studies among persons with obesity (Erasmus MC) and depression (Amsterdam UMC) for which Institutional Review Board (IRB) applications have been submitted. All these RT3 results will contribute to improve decision making regarding data enrichment in a later stage of Stress in Action.



Data Analysis Support Core

The Data Analysis Support Core (DASC) aims to help Stress in Action's researchers make the most of their research. This requires an alignment between one's research question, data, and analytical technique. Hence, the DASC is concerned with:

1. raising awareness about how to best align these components of empirical research and how to make methodological decisions,
2. identifying data analytical challenges and developing new techniques to tackle these, by innovating the individual techniques and by combining dynamic modelling and machine learning techniques.

In 2024, the DASC held monthly online meetings to discuss progress, challenges, and opportunities for cross-fertilization between projects. We also reviewed updates on the 14 consultancy requests from the consortium, covering topics such as the application of statistical and AI techniques and evaluations of methodological approaches.



Within the DASC, four PhD candidates and one postdoctoral researcher worked on a variety of advanced research topics, submitting five papers for publication. Their projects included ensemble learning for dynamic prediction, using Deep Latent Variable Models for longitudinal data analysis, addressing time-series analysis challenges, expanding joint models for intensive longitudinal data, and exploring dynamic prediction in digital phenotyping. Additional research included the development of a mask initialization algorithm for deep learning model explanations, as well as the establishment of power analyses for g-methods and causal effects in panel data.

As each senior DASC member is also part of one of the three RTs, short lines of communication are guaranteed. Several of the research projects the DASC members are involved in include collaborations with researchers from specific RTs, allowing them to study their data or collaborating to answer their research questions.

In addition, during the SiA educational programme in November two sessions were held to explain both longitudinal and AI techniques, along with the associated methodological challenges, in order to better equip the junior researchers to apply such techniques.

Looking ahead, we plan to actively seek out use cases within the RTs to apply our methodological innovations.

Data Infrastructure Support Core

The Data Infrastructure Support Core (DISC) aims to provide a central coordinating hub for data collection, data management, and data delivery processes within Stress in Action. In phase 1, the DISC will catalogue the existing datasets and provide meta-data annotation. In phase 2, it will create the Data Governance Framework and the Standard Operational Procedures for the new data collection.

Progress

In 2024, we released the SiA Cohorts Data Access Protocol, containing information about access procedures for the cohort studies within Stress in Action. We identified vendors of EMA smartphone platforms and negotiated package deals with them for pilot studies in Stress in Action. The vendor mPath was selected, and the DISC provided SiA members with the application forms and protocols to request mPath access for their phase 1 experimental studies. A manual was created on using (elements of) the EMA part of the Stress in Action toolkit. We also provided NWO with the 2024 update of the Data Management Plan, adding the ongoing experimental phase I studies. Finally we worked on an exposure inventory in the SiA cohorts.

Since March 2024, our team has been strengthened with postdoctoral researcher Hugo Klarenberg.

Ongoing

DISC members played a key role in setting up the Toolkit Task Force that works in small sub-teams towards a first version of the Stress in Action toolkit for ambulatory data collection of emotional, cognitive, behavioural and physiological stress responses. In conjunction, the DISC is piloting the feasibility of using Sports Data Valley to extract data of fitness trackers of our cohort participants during the phase 2 cohort enrichment.

Next year

We are building a Shiny app for the SiA wearables database, which we will make available as an open source for stress researchers (in- and outside Stress in Action) to aid optimal wearable selection for their research. The exposure inventory will be completed and we'll continue with the outcomes inventory. Using the data listed in the EMA inventory sheet we will perform a confirmatory factor analysis on the EMA data in the SiA cohorts to establish the resemblance of the between and within factor structure across the items.

15	studies
1075	EMA items
7662	subjects

EMA data inventory

DISC has done an inventory on EMA studies. Currently, we have 15 studies catalogued. They have collected 1075 EMA items in 5593 subjects.



Career Support Core

The Career Support Core (CASC) aims to stimulate the careers of the early-career scientists (PhD students and postdoctoral researchers) in order to let them excel and grow into well-trained stress scientists. In 2024, the CASC has provided the following activities:

- New early-career scientists that started in 2024 (n=5) received a personal onboarding by the project manager in order to teach them about the project's structure, management and (internal) communication.
- An inventory of the standard support and mentoring activities provided by the academic institutes has been created. In addition, a living document with relevant (postdoctoral) courses is shared with all consortium members and constantly updated with new information.
- The CASC organized a very successful and well-evaluated interdisciplinary Education Course on Stress in Daily-Life on the 26th to 28th of November 2024 in Amsterdam. 95% of all early-career scientists connected to SiA participated in this course. Teachers included 11 senior researchers from the SiA consortium, and education topics covered included stress theories, causality in stress research, transdisciplinarity and ethics, ambulatory stress assessments, and advanced data analytics. The CASC is currently discussing with the Junior Think Tank where and how to organise a 3-day Education Course in 2025.
- The CASC engages with the SiA postdoctoral researchers on a regular basis to discuss competencies, skills and career planning.
- The CASC stimulates and oversees the SiA exchange programme. Early-career scientists are stimulated to spend time abroad at another academic institute during their career. There is some financial support for this, when needed.



Cohort enrichment

Starting in our second phase, from 2026 onwards, the Stress in Action project will start enriching existing cohort studies with novel ambulatory stress measurements.

As there are currently no large cohort studies available that have done a prolonged and extensive assessment of stress context and affective, cognitive, biological and behavioral stress responses in daily life, we have set ourselves to this challenging but exciting task. The Netherlands has a wealth of large-scale longitudinal ongoing cohort studies (such as Lifelines, Netherlands Twin Registry, Netherlands Study of Depression and Anxiety, Generation R, Rotterdam Study, MARIO project) with which we plan to collaborate on cohort enrichment of stress measures across a six month period. This enrichment will focus on 2000-3000 respondents, aged 18-60 years, who earlier participated in one of these cohorts studies, and on whom we therefore already have a wealth of data.

Cohort enrichment will increase our opportunities to examine the bidirectional interactions between stress context and stress responses, to examine individual vulnerability and resilience factors in these interactions, and to examine the (longitudinal) impact that stress context and responses have on mental and cardiometabolic health outcomes. To guide this cohort enrichment, we have set up a 'Toolkit taskforce' to shape the stress toolkit that will be implemented in cohorts. In this taskforce, we currently evaluate (pilot) results of e.g. EMA assessments, different wearables and passive sensing tools, and we discuss the stable characteristics (e.g. personality, work contents, social context) and biological and psychological outcomes that we find crucial to assess. In the fall of 2025 we expect to have a concrete and complete cohort enrichment plan that can be submitted to the Scientific Advisory Board followed by the Institutional Review Boards.



Governance



Executive Committee

The Executive Committee (EC) is made up of the senior researchers, who are the principal investigators on behalf of their institutes, and two mid-career researchers. The Executive Committee plays a pivotal role steering the Stress in Action project by; discussing the progress within Research Themes and Support Cores, ensuring adequate interaction between institutes, overseeing consortium composition and organization of consortium meetings, and discussing all matters regarding communication.

In 2024, we had ten EC meetings, with two live meetings on location, one in Amsterdam (VU Amsterdam and Amsterdam UMC) and one in Rotterdam (Erasmus MC). At the live EC meeting, presentations were given by other researchers of participating departments offering insights on parallel projects that strengthen the SiA project. At the EC meeting in March, we invited another gravitation research project, NSMD (New Science of Mental Disorders), to join the EC, to discuss our progress and explore potential synergies between our projects. This live meeting, led to a second online meeting to discuss the progress each consortium had made in regards to EMA.



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Associate
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Scientific Advisory Board

In 2024, the Scientific Advisory Board (SAB) remained actively engaged with the Stress in Action consortium, staying informed about our ongoing activities and progress. The SAB has been invited to join our next meeting in October 2025, where they will continue to provide valuable insights and guidance.

We would also like to express our sincere gratitude to Marcella Rietschel for her contributions to the SAB. As she retires in 2024, we thank her for her invaluable expertise and support. Looking ahead, we will be inviting a new member to join the SAB in 2025, further strengthening the board's diverse expert input.



PROF. JOSHUA SMYTH

Ohio State University, USA; Psychology and president of the Society for Ambulatory Assessment



PROF. VIOLA VACCARINO

Director at Rollins School of Public Health, Atlanta, USA; Behavioural medicine in cardiology



PROF. PETER KUPPENS

University of Leuven, Belgium; Psychology statistical methodology for ambulatory assessment



PROF. MATTHIAS MEHL

University of Arizona, USA; Ambulatory research methods



PROF. MARCELLA RIETSCHEL

Central Institute of Mental Health, Germany; Psychiatric Genetics



DR. VAIBHAV NARAYAN

Davos Alzheimer's Collaborative executive vice president and head of strategy and innovation, and Chief Industry Officer of the UK Mental Health Mission at Oxford University



PROF. JOHANNES SIEGRIST

University of Düsseldorf, Germany; Sociology, Work stress models

GOVERNANCE

Supervisory Board

In April 2024, we held the first meeting of the Supervisory Board (SB), which includes seven deans from the participating institutes. The SB will meet annually to guide and support the Executive Committee (EC) in ensuring the effective integration of Stress in Action within the participating institutions and faculties.

During this inaugural meeting, the SB assessed the quality and scientific progress of the SiA project, offering valuable feedback and recommendations. They also reviewed and approved the consortium's structure, scientific direction, and the 2023 financial report, as well as the 2024 budget plan proposed by the EC.

The SB will play a key role in addressing any unresolved issues, making final decisions through majority voting. Additionally, the board is committed to supporting the embedding of SiA's activities within the institutions to ensure the project's long-term success and impact.

- Chair of the Supervisory Board: Prof. dr. Saskia Peerdeman, Dean of Amsterdam UMC.
- Prof. dr. Maurits van Tulder, Dean of the Faculty of Behavioural and Movement Sciences VU Amsterdam.
- Prof. dr. Wiro Niessen, Dean of UMCg.
- Prof. dr. Casper Albers, Dean of the Faculty of Behavioural and Social Sciences, RUG.
- Prof. dr. Gerjo J.V.M. van Osch, Vice Dean Erasmus MC.
- Prof. dr. Tanya Bondarouk, Dean of the BMS faculty at the University of Twente.
- Prof. dr. Sander Thomaes, Vice Dean of Research at the University of Utrecht.

Project Office

The Project Office supports Stress in Action. The Project Office consists of the project manager, communications officer, and project assistant. These individuals play a crucial role in coordinating our activities, managing communications channels, and providing administrative support.

The Project Office organises and manages the weekly meetings with the management team where all operational SiA tasks are discussed. These range from organising all consortium and executive committee meetings to onboarding our newest researchers to creating and managing all the communications channels such as the website.



Marianne Knudsen, Project assistant
Anna Silvestrin, Project manager
Anouk Weverling, Communications officer

Junior Think Tank

The Junior Think Tank (JTT) was established in June 2023 to represent and support the PhD candidates and postdoctoral researchers of SiA. It provides advice to the Executive Committee (EC) and the Career Support Core (CASC) on matters that impact the work and wellbeing of junior researchers. The JTT consists of seven members, representing all universities and Research Themes involved in SiA: Merel van den Berg (PhD, RT2, University of Twente), Robin Lengton (PhD, RT3, Erasmus MC), Jeroen Mulder (postdoctoral researcher, DASC, Utrecht University), Fridtjof Petersen (PhD, RT1, DASC, University of Groningen), Felix Reichelt (PhD, RT3, UMC Groningen), Marcos Ross (PhD, RT2 and RT3, Amsterdam UMC), and Melisa Saygin (PhD, RT2, VU Amsterdam).



The JTT holds monthly meetings in which developments and plans for PhD students and postdoctoral researchers within SiA are discussed. The year's biggest success was the SiA Interdisciplinary Education Course in November, which the JTT helped organise alongside the CASC and the Project Office. By gathering information on what the junior researchers wanted to learn and planning social activities, the JTT contributed to fostering a sense of unity within SiA.

Another important task in 2024 concerned gathering information on the wellbeing of junior researchers. Making use of the time we had together during the SiA Consortium meeting in June 2024, the JTT provided space for the junior researchers to share how they are doing within the organisation and whether there is something they need. By doing so, the JTT supported SiA's junior researchers and found points that have been relayed to the CASC and EC to improve the overall health of SiA.

For the year 2025, the JTT will continue working for the PhD students and postdoctoral researchers. Particular focus areas include fostering collaborations among junior researchers, organising career development workshops with the CASC, and creating plans for disseminating work by PhD students and postdoctoral researchers.



Finance

In the second year of the project, Stress in Action budgeted a total of € 3.081.012. Of this total, € 2.864.227 was designated for Personnel costs and € 216.785 for Material costs.

The second year of the project saw a 30% underspend (figure 1), primarily due to several positions being postponed. These positions are in the process of being filled, and the underspent funds are being reserved to cover the costs of these hires. Notably, University of Groningen deviated from this approach by advancing the timeline for a PhD position, which was initiated earlier than originally planned in the project proposal.

This year's (2024) underspend is lower compared to the first year (2023), where we experienced a more significant underspend of 50%, which was mainly driven by delays in recruitment. Although overall expenditure in 2024 was slightly lower than anticipated, the spending pattern remained consistent with the forecasted distribution in the 10-year budget plan. As a result, no adjustments or reallocations between cost categories are necessary for the 2025 budget.

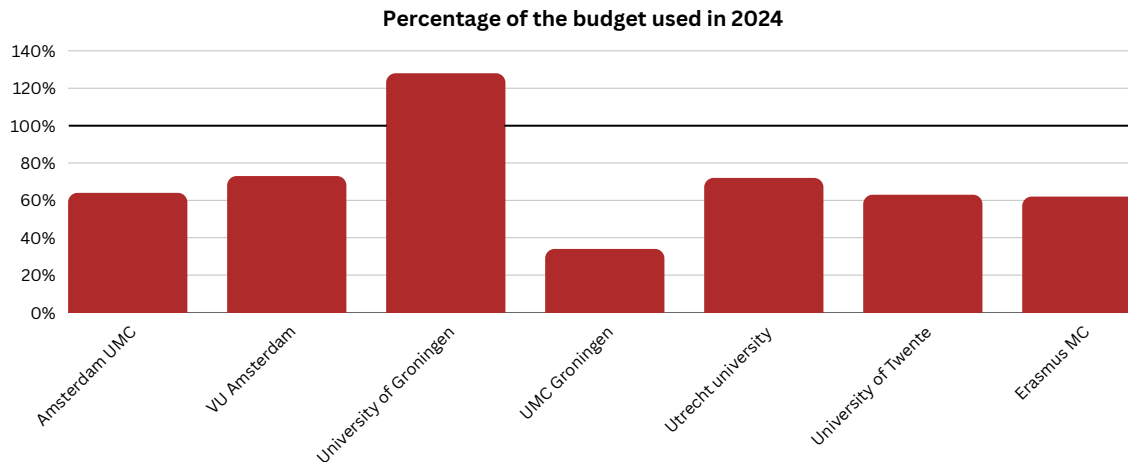


Figure 1. The graph depicts the percentage of the budget allocated for the year 2024 that has been utilized by each institute

Communication & Dissemination

After laying a solid base of internal communication, community and knowledge transfer in 2023, this year we invested more in external dissemination.

The Stress in Action website and social media (LinkedIn) are serving either the internal and external audience, whereas the newsletter, lab meetings and consortium meetings serve an internal audience.

Internal communication

In internal meetings we aim to share updates on projects, progress, results, events, new colleagues and encourage community building. The lab meetings are hosted monthly in an online setting. In addition, physical consortium meetings, are hosted on location twice a year (two days in June and one day in November) to foster and encourage connection within the consortium, improve collaboration and allow the opportunity for socialisation. We share the latest news and updates in a monthly newsletter. Additionally we updated the website with researcher profiles and their areas of expertise. This improves collaboration within the consortium by helping members easily identify who is doing what and what expertise we have in-house.



External communication

Stress in Action aims for all consortium members to become engaged in (inter)national dissemination of research results. On the website and social media, we aim to actively spread information about the objectives, approach, and results of our research to the broader scientific community and to the general public thereby raising interest in, understanding of, and support for our science goals and results in general. In 2024, we added a webpage to the website in Dutch, to inform and engage the Dutch population in our study.

In addition to a listing of our open access scientific publications, in 2024 we started to focus more on science communication to the general public. We achieved this by writing blogs (to be published in 2025) and by starting our own podcast: Stress Navigation.



Stress Navigation podcast

Our Stress Navigation podcast delves into stress and health from a multidisciplinary perspective, offering insights into the latest stress research and exploring its broader implications on topics like human-technology interaction and societal impacts. The main goal of the podcast is to contribute to the ongoing conversation about stress in daily life, providing valuable content to help Stress in Action grow, while deepening understanding for both listeners and the consortium. The podcast also aims to bridge connections within Stress in Action.

Listeners can expect to learn about stress, health, and technology, and they will also meet the researchers behind these studies. The podcast alternates between Dutch and English episodes, with the Dutch episodes hosted by Myrte Schoenmakers, a PhD student at VU Amsterdam, and the English episodes hosted by Marcos Ross, a PhD student at Amsterdam UMC. The podcast is produced by Anouk Weverling, our communications officer.

They receive editorial support from Artemis Stefani and Noa van Zwieten. They recorded the first episodes in the summer of 2024 with experts such as Brenda Penninx, Christiaan Vinkers, and Meike Bartels, followed by more episodes featuring Mariëtte Boon, Liesbeth van Rossum, Geke Ludden, and Matthijs Noordzij.

After a successful launch in November 2024, four episodes were published, with many more scheduled for release and recording in 2025.



Media

In 2024, many consortium members featured in newspapers, radio, websites and other media, indicating the relevance and impact of our research into stress.

Mariëtte Boon – ‘Gezondheidscheck op festival: ‘Ik wil nog lang leven’’, Omroep West, 4 August 2024

During the Milan Summer Festival in The Hague, dr. Mariëtte Boon, prof. dr. Liesbeth Van Rossum, Robin Lengton, Susanne Kuckuck and dr. Joëlle Oosterman collected hair samples and measurements from more than 200 people. Mariëtte Boon was interviewed by Omroep West to talk about her research into the relationship of stress and health outcomes in people with Hindustani backgrounds.

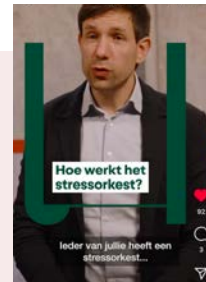


Matthijs Noordzij – ‘Het Technologische Lichaam – zo helpt je smartwatch bij stress’, NTR Focus podcast, 21 February 2024

In the Focus Podcast, by NTR Wetenschap, prof. dr. Matthijs Noordzij discusses smartwatches and stress measurements. We wear technological devices closer and closer to our bodies, often with the aim of monitoring our health. We measure steps, heart rate and sleep, and nowadays even our stress levels. But can wearable technology prevent us from experiencing stress? Or does all that technology create more stress?

Christiaan Vinkers – ‘Wat gebeurt er in ons lichaam bij een burn-out?’, Universiteit van Nederland, 13 March 2024

Everyone experiences stress every once in a while! It can even be good for you. In a 5-minute video by the Universiteit van Nederland prof. dr. Christiaan Vinkers explains how your body reacts to stress with your ‘stress orchestra’. The stress orchestra helps you deal with stress and alerts you when ‘a little’ stress becomes ‘too much’ stress. This video teaches the viewer how to recognize stress signals and what to do when you experience burn out.



Els Maeckelberghe and Femke Lamers – ‘De nacht van NTR Wetenschap’, NPO Radio 1, 2 May 2024

In the early morning dr. Els Maeckelberghe was a guest of the NPO Radio 1 show ‘De nacht van NTR Wetenschap’. During this 1-hour interview Maeckelberghe delves into her research in medical ethics. Using a few examples she shows the ethical dilemmas medical doctors face. Not only in care, but also in research medical ethical advice is very important. Maeckelberghe’s study in Stress in Action explores the connection of technology and humans. How will we measure stress and what’s the impact of those measurements on the participants?

The programme concluded with a 20 minute interview with dr. ir. Femke Lamers. She elaborated on data collection, data infrastructure, and wearables in Stress in Action. Additionally Lamers spoke about her research projects on immunometabolic depression and treatment.

Liesbeth van Rossum – Cover editorial MEZZA Magazine, Algemeen Dagblad, 3 March 2024

Prof. Dr. Liesbeth van Rossum expresses concern over supermarkets that primarily promote unhealthy products, politicians who fail to take action, and widespread misunderstandings about obesity. In the cover editorial of the weekend magazine MEZZA, van Rossum discusses prevention of obesity and other stress-related disorders, challenges surrounding misconceptions about individuals struggling with obesity, and the influence of politics on public health.



Awards, Grants & Promotions

Prof. dr. ir. Monique Tabak was appointed professor in Personalised e-health technology for complex chronic conditions at University of Twente after successfully completing her inaugural lecture on the 28th of November 2024.



Prof. dr. Matthijs Noordzij is part of the DE-ESCALATING consortium which received NWA-ORC funding. In this project Noordzij will contribute to research on aggression de-escalation. In the (VR) validation lab, he will validate wearables to support this research.



Prof. dr. Maryam Kavousi was appointed Professor Population Cardiovascular Health (Erasmus MC). Her inaugural lecture will take place in 2025.



Prof. dr. ir. Geke Ludden was appointed professor in Interaction Design at University of Twente after successfully completing her inaugural lecture on the 20th of June 2024.

Prof. dr. Brenda Penninx was appointed editor of the special issue of the journal Depression and Anxiety, on 'Wearable Technology in Mood Disorders Management'.

Prof. dr. Susanne Scheibe was appointed chair of the General Board of the Kurt Lewin Institute, national graduate school of social psychology and its applications.

Dr. Lianne de Vries was promoted to assistant professor at VU Amsterdam, focusing on the long-term and daily dynamics between stress, resilience factors, and wellbeing and mental health. She received the VCAS/VU Talentfonds grant to start this new position.



Dr. Martin Gevonden founded VU – Ambulatory Monitoring Solutions B.V.



Prof. dr. Christiaan Vinkers is Principal Investigator of the NWA funded DESTRESS project. DESTRESS is a multidisciplinary consortium of experts who join forces, focusing on reducing stress and increasing resilience in both individuals and organisations.

SWOT Analysis

Strengths

S

- Funding for long-term research without distraction,
- Top tier researchers who are strongly committed,
- Rapid growth of a diverse consortium in first years with strong governance structure,
- Many new cross-institute connections due to (1) mixed PhD supervisory teams, (2) exchange of datasets, (3) shared terminology and (4) harmonisation of cross-lab experimental approaches to stress measurement,
- The rapid international growth of digital phenotyping and ambulatory assessment.

W

Weaknesses

- Risk of disconnect between individual projects and overall project aims,
- Geographic & organisational distribution of the team,
- Stakeholder interactions not well developed in this early stage.

Opportunities

O

- Importance of theme of stress further increased with societal insecurity about the maintenance of standards of living due to geopolitical developments, erosion of democratic traditions, climate change, reduced social cohesion and challenges related to migration,
- Increased interest of the public in self-monitoring,
- Much common ground with relevant other gravitation programmes (e.g. [NSMD](#)), NWA (Dutch Science Agenda) programmes [DESTRESS](#) and [DE-ESCALATING](#) and international stress networks (DFG, Proposed Collaborative Research Centre CRC 393, the [Global Stress and Resilience Network](#) and the US' [Stress Measurement Network](#)),
- Advances in applications of 'AI for health' in academia and beyond.

T

Threats

- Current budget cuts in academia lead to greater pressure on researchers to do teaching instead of research,
- Local rules and research climate sometimes oppose cross-institute collaboration,
- Financial risks as salary raises and overheads are higher than expected,
- Medical-ethical and privacy regulations make ambulatory monitoring for research more complicated,
- Talented junior staff moving away due to limited tenured positions in academia,
- Governmental pressure to reduce international students and staff,
- Reliance on the willingness and ability of complexly governed cohort studies.



Appendix

George Aalbers Postdoctoral researcher, Amsterdam UMC



I submitted my first first-author paper as a postdoctoral researcher. This paper, currently under review, associated passive sensing data collected with a smartphone over 6 weeks to depression and anxiety status. I am supervising two PhD-students whom also submitted their first first-author papers on ambulatory EMA and cognitive data, respectively, in persons with depression. I am a second author on these papers. Furthermore I am a coauthor on a paper for a PhD-student I supported with machine learning analyses. Finally, I presented a poster on my own paper at the Annual Meeting of Amsterdam Public Health.

Merel van den Berg, PhD student, University of Twente



I have written two papers that are under review: 1) a narrative literature review of user perspectives on wearable stress management technology; and 2) a short paper critiquing wearable stress tracking technology on the consumer market (e.g., Fitbit). I completed a course on the ethics of technology, for which I wrote a philosophical essay on the potential implications of employing commercial health trackers in large-scale research. I participated in the MindTech Summit on innovating digital behavioural health, which included a training programme for junior researchers. As a member of the Toolkit Taskforce, I have drafted guidelines for responsibly selecting from the SiA toolkit and evaluating participants' experiences with it.

Caroline Broeder, PhD student, Amsterdam UMC



In 2024, I completed data collection for an (f)MRI study on stress reactivity in individuals with depression and childhood trauma, with results expected next year. I have prepared a new project starting in January 2025, exploring 72-hour fine-grained cortisol signaling using ambulatory microdialysis in depression, PTSD, and healthy individuals. Additionally, I started a Delphi study on best practices for stress research in people with psychiatric and neurological disorders, collaborating with lived experience experts; data collection is ongoing. Finally, I submitted a review about the (neuro)biological, psychological and behavioural mechanisms linking childhood trauma to mental and physical health outcomes.

Nina van Gerwen, PhD student, Erasmus MC



I finished my first project concerning Super Learner for the joint analysis of longitudinal and time-to-event outcomes. I plan to submit this for publication in the Biometrical Journal soon. I also made progress on my second project: a new Deep Learning neural network architecture for analysing (intensive) longitudinal data.

Haixia Gu,
PhD student, UMC Groningen



In the second half of 2024, I arrived as a visiting PhD student in genetics, in the Psychiatry Department at the University Medical Center Groningen (UMCG). My research is passionately dedicated to precisely defining and measuring psychological stress, while exploring its critical role in disease development and treatment. Leveraging my unique interdisciplinary background in psychology and genetics, my current work focuses on uncovering the genetic foundations of psychological stress and its relationships with neuropsychiatric disorders.

Susanne Kuckuck,
PhD student, Erasmus MC



In 2024, my first paper was published in the Journal of Internal Medicine (ePub 2023) and two first-author papers were published online. The online papers describe the association of long-term biological stress (measured as hair cortisol and cortisone) and long-term psychological stress (measured using questionnaires) with levels of appetite-regulating hormones and eating behaviour in patients with obesity. The results suggest that higher long-term biological stress (especially scalp hair cortisone) and psychological stress are linked to more hedonic eating tendencies. This might be mediated by links with appetite-regulating hormones; however, we need more data to investigate this possibility. Findings were presented at different conferences, emphasizing stress and cardiometabolic health links.

Hugo Klarenberg,
Postdoctoral researcher, VU Amsterdam



I have made progress with primarily deliverables to build an infrastructure for the data management in the pilot studies and the enrichment phase of SiA. Various policies have been described for data access to existing cohort data and access to our collective mPath account. I also have been involved in an RT2 project to build an online (Shiny) app for the wearable pipeline for external researchers. Moreover I have started to gather EMA data from multiple cohorts to start a factor analysis on the invariance of the between-person and within-person factor structure of the most commonly used items in our EMA inventory, with the goal to publish it in 2025.

Robin Lengton,
PhD student, Erasmus MC



My current project focuses on the validation of novel biological stress measures in different populations. This year, I published an article in the journal Clinical Obesity, exploring the link between stress and obesity. Additionally, we are drafting a manuscript on NESDA cohort data to unravel how daily life stress and glucocorticoid regulation influence cardiometabolic health. Meanwhile, the extensive multi-systems measurement "Christmas Tree" project has taken shape, with a METC proposal underway to compare, at higher temporal resolution than before, stress measurement methods. Findings were presented at different conferences, emphasizing stress and cardiometabolic health links. Through these initiatives, we aim to improve the understanding and practical application of stress markers in health assessments.

Julius März,
PhD student, Erasmus MC

A major achievement this year was the submission of my first article to a scientific journal. The paper, currently under review, describes the compliance patterns to EMA assessments in youth, and relevant determinants of compliance. When presenting the paper at the Sophia Research Day in Rotterdam, I won the "Best Poster Award" of the event. Furthermore, I gave a flash talk about the paper at the ESM Expert meeting conference in Heerlen. I successfully supervised a Bachelor Thesis, as well as two students who wrote a systematic review. At the moment, I am preparing the preregistrations for my next two articles.



Malin Meyer,
PhD student, UMC Groningen

In 2024, I made progress with our large-scale systematic review on daily life stressors. This included screening large amounts of multidisciplinary literature with the help of an artificial intelligence program. Furthermore, we started to develop the protocol for the next research project, which will further advance our understanding of daily life stressors. Next to this, I took part in the organization of a theoretically focused invited symposium on daily life stress in Groningen. In this symposium, different invited speakers presented their ideas on various conceptual complexities in daily life stress research.



Jeroen Mulder,
Postdoctoral researcher, Utrecht University

I have published (ePub) one didactical paper explaining how joint effects estimated via G-estimation of structural nested mean models compare to the cross-lagged panel modelling approach using SEM that is common in Psychology and related disciplines. Furthermore, I have started two new collaborations. First, together with prof. dr. Manuel Voelkle and prof. dr. Ellen Hamaker we study the impact of time-aggregation and low process coverage on study of causal effects with panel data. From March 2024 to December 2024, I have also been a visiting scholar at the Psychologische Methodenlehre department of prof. dr. Manuel Voelkle at Humboldt-Universität in Berlin, Germany. Second, together with dr. Julien Irmer we investigate how g-methods can be fitted in an M-estimation framework, which can subsequently be used for efficient power analyses.



Solomiia Myroniuk,
PhD Student, University of Groningen

I am conducting a scoping review of studies on daily stress (ESM, EMA, daily diaries) in the context of mental health. From 12,846 unique articles selected for abstract and title screening, 1,619 studies underwent full-text screening. Of these, 732 were selected for further processing, with 95% of studies already coded. The data analysis phase will commence in early 2025. I have presented my work at a systematic review seminar and during a research colloquium at the University of Hamburg.



Noluthando Ntlapo,
PhD student, Erasmus MC



I have successfully completed the analysis and discussion for the research paper I've been working on, which focuses on the relationship between depression, anxiety, and the risk of atrial fibrillation. In addition, I am actively engaged in data analysis for an approved proposal titled "Exploring the role of biomarkers in the relationship between depression trajectories and risk of coronary heart disease (CHD)." Another project in progress is a systematic review, which will examine gender-specific psychosocial factors and their impact on cardio-metabolic health. These projects align with my broader research interests in mental and cardiovascular health.

Joëlle Oosterman,
Postdoctoral researcher, Erasmus MC



In 2024, I joined the SiA consortium as an in-kind postdoctoral researcher. During SiA RT meetings, I got to know the team and got insight into the different projects, and learnt how the different RTs work together. I started working on the ethical approval for the so-called "Christmas Tree" project in RT3. Together with Robin Lengton and Mariëtte Boon, I visited a lab at the University of Bristol to get familiar with the microdialysis device for pulsatile cortisol release measurement, which we will be using in our project.

Jasmin Pasteuning,
PhD student, Amsterdam UMC



I have completed a paper on using dynamic time warping to model daily life stress reactivity with ecological momentary assessment (EMA) data using data from the NESDA study, which is set to be submitted soon. Additionally, I have spending a lot of time to recruit and assess persons for the REACT study, investigates mechanisms of stress reactivity and recovery in both laboratory and real-life settings using EMA and wearable devices. We have reached 50% participant inclusion.

Fridtjof Petersen
PhD student, University of Groningen



I wrote and submitted two papers to special issues of two journals. One paper was about the selection of optimal training windows in passive sensing, and the other was about extending joint models for autocorrelated data found in ESM studies. Additionally, I gave a presentation about the first paper at the International Society for Research on Internet Interventions (ISRII) and the International Meeting of Psychometric Society (IMPS) conferences. I also gave an invited talk at the University of Trier and attended a workshop organised by Measurement Is The New Black (MITNB).

**Emma Pruin,
PhD student, Amsterdam UMC**



In 2024, my main focus was on conducting analyses for my first projects. The comorbidity of depression and atherosclerotic disease was the topic of our investigation into gene expression in the atherosclerotic plaque, a tiny piece of the puzzle of how stable person characteristics such as genetics link to mental and cardiovascular health. Additionally, it has been very exciting to examine the value of family history data in predicting psychiatric disorders, with an eye on potential enrichment of the SiA cohorts. I expect to publish both projects in 2025.

**Felix Reichelt,
PhD Student, UMC Groningen**



In 2024, I advanced my research on stress heritability using the LifeLines cohort, focusing on personality traits, stress exposures, and childhood trauma. I examined both genetic and environmental influences, applying a liability threshold model for heritability estimation and conducting sensitivity analysis. I also collaborated on two ongoing studies with the CHARGE Consortium: a GWAS on blood pressure and educational attainment, and a polygenic risk score (PRS) project on stress and hypertension. Additionally, I was nominated for the Student Award at WEON (the Netherlands Epidemiology congress in Utrecht), where I presented my work on stress heritability.

**Marcos Ross,
PhD student, Amsterdam UMC**



In 2024 I have submitted my first paper to Depression & Anxiety for which I am currently working on the revisions. For this paper I looked at across- and within-person associations between cognitive function (using phone-based assessments) and depressive symptoms. We confirmed both across- and within-person associations, but the first being much stronger than the latter. I have also set up 3 projects for the remaining papers of my thesis, on which I am currently working. With fellow SiA colleagues, I have launched the Stress Navigation podcast and started a journal club.

**Melisa Saygin,
PhD student, VU Amsterdam**



I submitted my first paper on speech detection utilizing wearable respiration and accelerometry signals and subsequently revised it based on the reviewers' comments. I collected data for a second project aimed at identifying the optimal way to control for the effects of respiration while assessing cardiac vagal control in daily life and have worked on the data processing for that. I am also a co-first-author of the submitted wearables database paper. I have given two oral presentations at the Society of Ambulatory Assessment conference in Michigan and a poster presentation at the Society for Psychophysiological Research annual meeting in Prague.

**Myrte Schoenmakers,
PhD student, VU Amsterdam**

Various learning opportunities and achievements for me in 2024 were among others: organising a symposium regarding bio-impedance for the Society for Ambulator Assessment annual meeting; together with Magdalena Sikora (UT) and Melisa Saygin (VU), submitting the SiA wearables database paper to Behaviour Research Methods. This database also served for the preliminary SiA toolkit wearables advice. In addition, I collaborated with Robin Lengton (Erasmus MC), resulting in the online published review about stress and obesity, and shaping the “Christmas tree” project assessing the many axis of stress (e.g., biological, psychophysiological, and subjective experiences); and dissemination of SiA knowledge via the Stress Navigation podcast.



**Milou Sep,
Postdoctoral researcher, Amsterdam UMC**

My role in Stress in Action is mainly through the supervising of two PhD students in the department of Psychiatry at Amsterdam UMC. They have both progressed in their paper writing as well in the conduct of their practical tasks for their research projects. You can find their progress reports in this chapter; Caroline Broeder and Jasmin Pasteuning.



**Magdalena Sikora,
PhD student, University of Twente**

I contributed to the finalization of the first version of the SiA Wearables Database. Our paper on its development and intended use is currently under review at a scientific journal. We are also close to finalizing the VR validation pipeline, for which the design was informed by a scoping review. We plan to run its first version in January 2025. Concurrently, we are starting the design of the ambulatory validation pipeline and hope to be able to combine these two in the future.



**Artemis Stefani,
Postdoctoral researcher, VU Amsterdam**

I established a multiphase validation pipeline to assess commercial and research-grade wearable devices. The pipeline integrates the work of the wearables database and involves lab-based and ambulatory testing. On the cognitive front, I worked on two reviews (one that I lead, one that I co-supervise) on measuring objective and subjective cognition outside the lab, focusing on psychometric properties and applications in healthy and neuropsychiatric populations. I have also been an active member of the SiA Toolkit Taskforce, co-supervising PhD work, advising on several projects, presenting at SiA events, and supporting the work and vision of the Podcast and Blog teams.



**Anaïs Thijssen,
PhD student, Amsterdam UMC**



I developed a tool to visualise genetic heterogeneity in disorders based on a new construct of genetic distance. Applying the tool to depression has revealed new insights into its subtypes. For instance, the genetic signals associated with single-episode depression and recurrent episodes appear to be similar in direction but larger in magnitude in the latter. In contrast, the genetic signals of depression differ both in direction and magnitude when comparing individuals with or without childhood trauma. I have presented my work at the International Statistical Genetics Workshop in Boulder, USA.. The tool and its application to depression, are expected to be published in 2025.

**Bülent Ündes,
PhD student, VU Amsterdam**



In 2024, I submitted my first paper to a premier machine learning conference, presenting a novel mask initialization algorithm designed to enhance mask-based explanation methods for deep learning models. This approach accelerates the optimization process and achieves target metrics faster. Furthermore, I am at the end stage of my second project in which I use machine learning techniques to detect periods of mental stress using ECG data, in collaboration with researchers from RT3.

**Sjors van de Ven,
PhD student, VU Amsterdam**



This year, my first paper entitled “Accelerometer-based heart rate adjustment for ambulatory stress research” was accepted for publication in *Psychophysiology* (2025). The study aimed to differentiate functional cardiovascular responses (due to physical exercise or postural changes) from cardiovascular responses to psychosocial factors in laboratory setting. I am now implementing this methodology in existing ambulatory data (n≈800) to explore how additional heart rate relates to context and affective states in daily life. Additionally, I was involved as a presenter in a symposium during the ‘Al and Health’ Winter School at the VU Amsterdam, co-organised by Stress in Action.

**Yong Zhang,
PhD student, University of Groningen**



In 2024, I submitted two manuscripts for publication that tackle the methodological challenges of overfitting and non-stationarity in time-series analysis. I organized a symposium "Voyage of Time: Reflections and Advances in Intensive Longitudinal Research Methodology" at the Association for Psychological Science (2024) convention and presented a project on overfitting of dynamic network models.

Nan Zhao,
PhD student, University of Groningen

Over the past year, I have been conducting an umbrella review on stress and cardiometabolic diseases. The initial search identified 9,511 records. Following duplicate removal, title, and abstract screening, full-text screening, and overlap assessment, 119 records advanced to the data extraction and quality assessment stage. Currently, I am actively working on data extraction and quality assessments.



Xiaochang Zhao,
PhD student, University of Twente

I have created a preliminary version of the database that provides an overview of platforms featuring ambulatory cognitive tasks and/or passive sensing capabilities. In addition, I started a scoping review on the evidence of the validity, reliability and usability of active and passive sensing of cognition for use in ambulatory studies. I am now at the data extraction phase. I submitted this for a poster presentation at ARPH conference 2025. Finally, I have been collecting data for my pilot study "The dynamics of stress and cognition with mobile sensing: A usability and validation study" to explore how stress and cognition are related in daily life and to investigate the validity and usability of passive sensing.



Noa van Zwieten,
PhD student, Amsterdam UMC

In 2024, I submitted my first PhD paper, which examines the connections between affect – measured with Ecological Momentary Assessment - and physical activity – measured with actigraphy - in individuals with and without depressive and anxiety disorders. I also began my second project, which uses the same data on affect and physical activity but shifts focus toward physical health outcomes (obesity, metabolic syndrome). Additionally, I joined the SiA podcast and blogpost team, where I gained valuable experience in science communication and explored a range of topics.



Colofon

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