Corners

CAAT feed

MPS World Summit Abstract Submissions and Travel Awards Open

Abstract submissions are now open for the second MPS World Summit. The deadline to submit an abstract is Tuesday, January 31, 2023. To submit an abstract, please visit the Abstract Submission page: https://mpsworldsummit.com/2023-abstract-submission/

Travel award submissions are also open, and we are currently accepting submissions. For more information on deadlines and required documents, please visit the Awards page: https://mpsworldsummit.com/2023-awards-and-travel-grants/

CAAT Neurotoxicity Research Funded by the National Institute of Neurological Disorders and Stroke (NINDS)

Drs Sillé (lead PI), Biswal, Hartung, Nachman (MPIs), and Smirnova (co-I) were funded for their R01 titled "Neurotoxicity due to Environmental complex Metal Mixtures Exposure" (NEMEX) from the National Institute of Neurological Disorders and Stroke (NINDS). The study will investigate the neurotoxicological effects of developmental and adult exposures to the interaction profile of Pb, As, Cd, and Cr(VI) (PACC) and single metals along with gene-by-environment studies leveraging human brain organoids to discover the adverse outcome pathways (AOPs) which will help in cumulative risk assessment for Alzheimer's Disease.

CAAT's Next Generation Humane Science Award

CAAT's Next Generation Humane Science Award is available annually to young scientists to acknowledge and encourage researchers who focus on replacing the use of animals in experiments. The 2023 award will be a 1st prize of $5,000 to recognize the outstanding work of one young scientist. Depending on the number and quality of the applications, a 2nd place $4,000 award may be issued as well. Please email your completed application to caat@jhu.edu. Complete applications due by 11:59 PM EST on Sunday, January 31, 2023. Full application here: https://caat.jhsph.edu/programs/awards/2023%20Next%20Gen%20Humane%20Science%20award.pdf

Drug Discovery and Development Explained: Introductory Notes for the General Public

Abstract and manuscript submissions are now open for *Frontiers in Drug Discovery* article collection, Drug Discovery and Development Explained: Introductory Notes for the General Public. Katya Tsaioun, Director of EBTC, is an editor of the topic. The deadline to submit an abstract is Tuesday, January 31, 2023. The deadline to submit a manuscript is Sunday, April 30, 2023. For more information, or to submit your research, please visit the article collection's page here: https://www.frontiersin.org/research-topics/48853/drug-discovery-and-development-explained-introductory-notes-for-the-general-public

CAAT's Work to Replace, Reduce, and Refine Cited in *Baltimore Magazine*

In a September article in *Baltimore Magazine*, CAAT's work has been cited. The article concentrates on the experiments performed on owls with connection to ADHD. Thomas Hartung is quoted on the benefits of non-animal testing, specifically that these non-animal tests are more promising and more cost-effective.

Read the full article here: https://www.baltimoremagazine.com/section/sciencetechnology/johns-hopkins-university-deadly-owl-experiments-controversy-peta/

Paul Locke cited in *Nature* article "US agency seeks to phase out animal testing"

A recent article published in *Nature*, regarding the FDA's efforts to phase out animal testing, features Paul Locke, an environmental-health scientist and lawyer at Johns Hopkins University, who specializes in alternatives to animal testing. Locke speaks to how alternatives to animal testing are more relevant to humans, as well as the concerns around funding these methods. The article can be found at: https://www.nature.com/articles/d41586-022-03569-9

Thomas Hartung Interviewed on The Animal Turn Podcast

Thomas Hartung was recently interviewed for Claudia Hirtenfelder's podcast, The Animal Turn, on the topic of animal testing. The episode is available here: https://www.theanimalturnpodcast.com/s5-animals-and-biosecurity/s5e5%3A-animal-testing-and-its-alternatives-with-thomas-hartung

Thomas Hartung cited in recent *Vox* article

Vox' recently published article concerning the reported investigation of Elon Musk's brain chip implant company and its potential violations of the Animal Welfare Act cites Dr Hartung. Dr Hartung speaks to the higher European standards of accepting experiments within Institutional Animal Care and Use Committees (IACUCs). The article can be read here: https://www.vox.com/future-perfect/2022/12/11/23500157/neuralink-animal-testing-elon-musk-usda-probe

Recent Events

Video of CAAT Co-Sponsored "Introducing 3Rs To Young Minds" Event in Lausanne available

In a collaboration with Altertox, CAAT, EPFL, *Frontiers for Young Minds*, and Swiss 3R Competence Centre, the University of Lausanne hosted an event earlier in 2022, "Introducing 3Rs to Young Minds", which introduced children to the 3Rs and alternatives to animal testing through a series of presentations as well as an interactive workshop. Thomas Hartung presented at the event and authored a corresponding article, "Replacing Animal Testing: How and When?". Read the article here: doi:10.3389/frym.2022.959496

Watch highlights from the event at https://www.youtube.com/watch?v=j-w76Vy8s-LA, and see the full event announcement here: https://www.linkedin.com/posts/frontiers_introducing-the-3rs-to-young-minds-activity-6985514244003786752-QNKD/

India-Embo Lecture Course

Thomas Hartung spoke on the topic *Brain organoids to study neurological diseases* at the India-Embo Lecture Course in Hyderabad, India. The course was held on October 31-November 4, 2022 and gave an overview of the current research on how human model systems, such as MPS, are being used to understand human disease and development. You can watch the video here: https://www.youtube.com/watch?v=wgghk2K7Ucs

The 7th Asian Congress on Environmental Mutagens (ACEM) / The 19th Chinese Environmental Mutagen Society Meeting (CEMS)

ACEM/CEMS 2022, hosted by the Asian Association of Environmental Mutagen Societies (AAEMS) and the Chinese Environment Mutagen Society (CEMS), was held November 4-7 in Qingdao, China. The theme was "The Impact of Global Change on Asian Environment and Genomic Health". Thomas Hartung spoke on the topic of "How AI Can Beat Animal Testing at Finding Toxic Chemicals as Potential Carcinogen".

The Lush Prize 2022 Conference

Thomas Hartung participated in the Lush Prize 2022 Conference, held virtually. Dr Hartung presented on November 10 in the session "What do we need to do to 'bring down the curtain' on animal testing?". The video is available at: https://vimeo.com/777370835?embedded=true&source=video_title&owner=15513693

Latin American Congress for Alternative Methods

Thomas Hartung presented as a guest speaker at the Latin American Congress for Alternative Methods to the Use of Animals in Teaching, Research, and Industry held November 16-18. Dr Hartung's presentation was titled, "The global economic challenge of animal-free safety sciences".

ESTIV 2022

Thomas Hartung and Lena Smirnova participated at the ESTIV 2022 Congress in Barcelona held November 21-25.

Dr Smirnova presented on the topic "iPSC-derived brain organoids as versatile research tool for developmental neurotoxicity and neurological disorders". Dr Hartung presented on the topic "The key role of computational toxicology for Toxicology for the 21st Century 2.0". To view the scientific program and learn more about the congress, please visit their website here https://estiv.org/congress2022/scientific-program/

ASPIS Open Symposium 2022

Thomas Hartung presented at the ASPIS Open Symposium 2022 in Barcelona on November 25, 2022, in the training session focused on "Training course on applications for AI in risk assessment".

To view the scientific program and learn more about the symposium, please visit their website here: https://aspis-cluster.eu/calendar/event-details/

Kris Thayer Presented Keynote for CAAT Webinar

Kris Thayer, Chemical & Pollutant Assessment Division (CPAD) Director at US Environmental Protection Agency (EPA), gave a keynote speech on the topic "*Overview of US EPA's Health and Environmental Risk Assessment (HERA) National Research Program*" on behalf of the Center for Alternatives to Animal Testing, which took place in-person at the Bloomberg School of Public Health as well online on November 30, 2022.

5th Annual Conference of SAAE – India

Thomas Hartung and Lena Smirnova presented at the 5th Annual Conference of SAAE – India on December 8. To learn more about the event, please visit the conference website: https://meetsaaeindia.in/

Thomas Hartung's Talk from "Challenges in Public Health Protection in the 21st Century: New Methods, Omics and Novel Concepts in Toxicology" Published

Dr Hartung's talk from the 2021 symposium hosted by the *Bundesinstitut für Risikobewertung* is available on YouTube. The symposium aimed to provide an update on major developments in the field of new emerging methods and concepts in toxicology. As a platform for researchers and representatives from academia, industry, and regulatory authorities, the symposium highlighted methodological progress (e.g., *in vitro*, *in silico*, omics methods) as well as current and future applications for regulatory risk assessment. Watch the video here: https://www.youtube.com/watch?v=iqbspBgzHiA

New publications

Blum, J., Masjosthusmann, S., Bartmann, K. et al. (2022). Establishment of a human cell-based in vitro battery to assess developmental neurotoxicity hazard of chemicals. *Chemosphere 311*, 137035. doi:10.1016/j.chemosphere.2022.137035

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Spreng, A. S., Brüll, M., Leisner, H. et al. (2022). Distinct and dynamic transcriptome adaptations of iPSC-generated astrocytes after cytokine stimulation. *Cells 11*, 2644. doi:10.3390/cells11172644

Cruelty Free INTERNATIONAL
Ending animal experiments worldwide

European Commission commits to a roadmap to replace animal testing for chemicals

At the European Partnership for Alternatives to Animal Testing (EPAA) Annual Conference 2022, which was held on November 15 in Brussels, the European Commission (EC) committed to the development of an EU roadmap towards the full replacement of animals in chemical safety testing.

Since the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation was first introduced in 2007, Cruelty Free International has estimated that over 2.6 million animals have been used in chemical safety tests across the EU.

Working with the European Chemicals Agency (ECHA), the EC plans to create a roadmap that will identify the needs for transitioning to an animal-free system for regulating industrial chemicals. Considerations will include opportunities to apply the non-animal methods and approaches already available today and how the regulatory system may need to change to accommodate the use of non-animal methods in the future. The EC anticipates that the chemicals roadmap could set an example for other policy areas that still rely heavily on animal tests.

UK's Animals in Science Committee finds lack of justification for using animals to produce antibodies

According to the report of an investigation conducted by the UK's Animals in Science Committee (ASC) – an indepen-

dent body providing advice to the government on the use of animals in research and testing – animals are being used to produce antibodies without adequate scientific justification and despite the availability of animal-free production methods.

The report outlines recommendations for animal antibody production license holders, including the need to provide evidence that they have exhausted all other possibilities before using animals and explaining the efforts they are making to replace the use of animals in future work.

The ASC was prompted to conduct its investigation by a 2020 report from the EU Reference Laboratory for alternatives to animal testing (EURL ECVAM), which urged researchers to recognize the scientific and economic benefits of animal-free antibodies and to cease the use of animals in antibody production without robust, legitimate scientific justification.

Report reveals increase in cases of non-compliance with UK law protecting animals in laboratories

On October 26, the Animals in Science Regulation Unit (ASRU) – the regulator overseeing the use of animals in research and testing in Great Britain – released its annual reports for 2019 to 2021, which detail cases where animal users have failed to comply with the Animals (Scientific Procedures) Act (ASPA) on the protection of animals used for scientific purposes in the UK.

The reports showed a 107% increase in breaches of the law between 2018 and 2019, many of which resulted in animal suffering. Cases described in the reports included 112 rats crushed to death in a trash compactor, a primate dying after becoming trapped behind a restraint device, and two rats dying due to excessive head restraint during blood sampling. As was the case in previous years, the reports also detailed multiple cases of animals dying as a result of being left without food and/or water.

Most cases of non-compliance are reported by the individuals or establishments themselves, with just a handful each year identified by the ASRU. It is therefore likely that there are cases that remain unreported and unidentified.

While the ASRU does have the authority to refer cases of non-compliance for prosecution, it chose not to take this course of action for any of the cases reported, instead issuing letters of reprimand.

Northern Ireland publishes 2021 animal testing statistics

Official statistics recently released by the Northern Ireland Department of Health show a 29% increase in tests on animals in 2021 compared to the previous year.

A total of 29,221 experiments were conducted on animals in 2021, rising from 22,707 in 2020. The figures also show that 62% of experiments caused moderate or severe suffering to the animals involved, compared to 55% in 2020.

Animal testing numbers in Northern Ireland have steadily increased over the last ten years and reached an all-time high in 2021, with an increase of 58% since 2012. The report did not acknowledge or provide an explanation for this trend.

Animal-free methods likely to be accepted for classifying endocrine disruptors in EU

Following months of campaigning by Cruelty Free Europe scientists, the European Commission amended the classification criteria under the new endocrine disruptor hazard class planned for the Classification, Labelling and Packaging (CLP) Regulation. The criteria now explicitly include the use of data from non-animal methods for classifying substances as endocrine disruptors.

Cruelty Free Europe has previously estimated that new tests conducted for the purpose of identifying and characterizing endocrine disruptors could use over 3 million animals, so a clear signal that data from non-animal methods could be accepted may prevent unnecessary animal use.

The planned revision of the CLP regulation is proceeding via a delegated act, which will now be considered by the European Parliament and Council. If approved, it will likely enter into force in the first half of 2023.

Target Zero online workshop October 27

On October 27, Cruelty Free Europe hosted an online workshop called "Target Zero – Routes to a toxic-free Europe without animal testing" to discuss how the EU Chemicals Strategy for Sustainability's goal for a "toxic-free EU" could be achieved without the use of animal tests.

The workshop brought together experts from the European Commission, the European Chemicals Agency, the European Partnership for Alternatives to Animal Testing, the US National Institute of Environmental Health Sciences, environmental NGOs, academia, and industry.

Discussions focused around three main topics: whether no animal testing would result in less protection from dangerous chemicals, whether non-animal approaches are required for dealing with endocrine disruptors, and how chemicals regulations could be revised to become animal-free.

Participants agreed that the transition to an animal-free system for ensuring the safety of chemicals would be beneficial for animals, human and environmental health, and innovation, and that achieving this goal would require cooperation and collaboration between all stakeholders to build scientific confidence in the use of new approach methodologies (NAMs). Supportive legislation and policy were also identified as essential components to drive this transition.

The 2022 Doerenkamp-Zbinden (DZ) Prize was awarded to Andrea Terron on occasion of the ASPIS meeting in Sitges, Spain (November 24-25, 2022). The award speech was given by M. Leist (University of Konstanz) and recognized in particular the achievements of the winner concerning "implementation of NAM for food safety assessment".

Andrea Terron is a pathologist with 20 years of experience in industry. His more than 10 years of work at EFSA showed him the limitations of animal-based data in regulatory toxicology. Two highlights of his work on the implementation of NAM are the neurotoxicity assessment of compounds based on a newly generated AOP, and the work with OECD to establish procedures for developmental neurotoxicity (DNT) assessment on the basis of NAM. Andrea chaired a working group to establish AOP:3 "Parkinsonian motor deficits as consequence of mitochondrial complex I inhibition". He brought this AOP not only to the highest validation level but also continued with practical applications and towards creating a publication format that may be exemplary for transparent communication of AOP (Terron et al., 2018). To provide material, data, and experience for a draft guidance on the use of *in vitro* data for DNT assessment, he organized EFSA projects, working groups, and the communication with OECD. Some of the initial work has been published (Blum et al., 2022), and a draft OECD guidance is at an advanced stage. Altogether, the work of Andrea Terron has shown that difficult toxicological domains can be assessed by NAM and that applied case studies can pave the way towards regulatory implementation.

With this achievement, Andrea Terron joins a long row of DZ prize winners from academia, industry, and regulatory authorities (https://www.doerenkamp.ch). The DZ foundation looks forward to more prize suggestions in the future. The award is one of the foundation's main instruments to create awareness for the importance of the replacement of experimental animals and to highlight the great achievements in this field.

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Terron, A., Bal-Price, A., Paini, A. et al. (2018). An adverse outcome pathway for parkinsonian motor deficits associated with mitochondrial complex I inhibition. *Arch Toxicol 92*, 41-82. doi:10.1007/s00204-017-2133-4

EUSAAT

European Society for Alternatives to Animal Testing

Summary of the EUSAAT Annual General Assembly (AGA) 2022

The EUSAAT Society concluded a very successful year with the 2022 AGA on December 6, 2022. The President's Report included the facts and numbers from the EUSAAT Congress and news from the European 3Rs Network EU3Rnet and the COST Action IMPROVE.

During the EUSAAT 2022 Congress at the Med Campus of the Johannes Kepler University in Linz (Austria) on September 26-28, we offered 25 sessions (including the Prof. Horst Spielmann Session) with 131 oral talks including 3 keynote lectures and one round table. Moreover, two poster sessions with 79 posters were organized, and we welcomed > 260 participants from 29 countries. We are very grateful to the 37 sponsors including 16 exhibitors with a booth, who supported the congress. In addition, we are very proud that we were able to grant 28 Young Scientist Travel Awards sponsored by five organizations in addition to EUSAAT. Further highlights were the YOU – Young Scientist in Action events and the gala dinner. The summary and further details of the congress, including the congress program and abstracts, scientific committee, sponsors, and co-organizers can be found on the EUSAAT website https://eusaat.eu/eusaat-congress/23rd-edition/congress-2022/.

The EU3Rnet community was very active in 2022, including the publication of two manuscripts in the 50th edition of the journal *ATLA* about the "Rise of Three 3Rs Centers and Platforms in Europe" and the "Current status and work of Three 3Rs Centers and Platforms in Europe" with 70 co-authors.

Related to EU3Rnet activities, progress on the EU-COST Action "CA21139 3Rs concepts to improve the quality of biomedical science (IMPROVE)" was presented. After the kick-off-meeting on October 21, in Brussels, the work and budget plans and the contract with the Grant Holder Institution were finalized and signed. Currently, representatives of 33 countries are on the management committee, over 130 persons have been accepted for the four working groups Quality and Translatability of Science, Implementation, Dissemination, and Education. The Memorandum of Understanding (MoU) and information on application to participate in the working groups can be found on https://www.cost.eu/actions/CA21139/.

Next to the financial report by the Secretary General and the discharge of the Board for the financial year 2021, we were very pleased about the large number of young colleagues who applied and were approved for EUSAAT membership by the AGA. In addition, it was agreed to reduce the membership fee for pensioners to the level of the student membership fee. Finally, future activities were discussed, for example plans for the next EUSAAT congress 2024, a possible 3Rs webinar series for 2023, and joint activities with ESTIV and other 3Rs related communities.

EUSAAT Congress 2024

The next EUSAAT Congress 2024 is planned for September 23-25, 2024. We look forward to a grand support like this year and hope that many stakeholders and researchers from all different areas of the 3Rs community will actively participate. EUSAAT will again make a special effort to enable as many young scientists as possible to participate – through low participation fees and a variety of Young Scientist Travel Awards. We are already very excited about the topics and key areas of the EUSAAT Congress 2024 and are of course happy to receive suggestions for additional topics.

Lush Prize conference celebrates its first ten years

In this tenth-year anniversary of Lush Prize, the 2022 Conference was held online in November and explored what progress has been made during the past decade to end the use of animals in research and testing. Over two days, ideas were exchanged on the roadmap of progress towards a future without animal testing. Sessions included expert speakers and panel discussions across several important themes:

- The regulatory environment 2012-2022 and future projections
- A decade of impact: public awareness and investigations
- Scientific advances over the last decade
- What do we need to do to "bring down the curtain" on animal testing?

Speakers included: Borami Seo (HSI/Korea), Tara Jackson (New Zealand Anti-Vivisection Society), Dr Kamel Mansouri (US National Institute of Environmental Health Sciences), Professor Merel Ritskes-Hoitinga (Utrecht University's Faculty of Veterinary Medicine) and Professor Thomas Hartung (Center for Alternatives to Animal Testing).

Fireside chat interviews were also held on "Culturally-relevant campaigning"; "Campaigning during the war in Ukraine" and "Young researchers and animal-free science".

All sessions and related video content (as well as a recording of the Awards Ceremony) can be viewed on the Lush Prize website at https://lushprize.org/2022-prize/2022-conference/

RISK HUNT3R

ASPIS

The first term of the ASPIS project cluster, chaired by RISK-HUNT*3R*, ended with a highlight event: the 2nd ASPIS cluster symposium (November 24-25, 2022) in Sitges, Spain. The meeting hosted more than 150 participants. It featured talks by 20 international speakers, panel discussions, award celebrations, and poster sessions.

The event's objectives were to introduce the cluster to its stakeholders and showcase the joint efforts of the three projects. On the first day, the main focus was the collaborative framework developed by the initiative to implement non-animal-based technologies in risk assessment. For further discussion and elaboration, this was named the "ASPIS Safety Profiling Algorithm" (ASPA). While various concepts for next-generation risk assessment (NGRA) have been published, description of their operationalization aspect is limited. Hence, there is a strong need for a well-guided workflow for the safety assessment of chemicals that guides data generation and interpretation. A primary goal of ASPA is to make decisions transparent and consistent. The ASPIS cluster has started to define case studies that should help to refine the workflow further. ASPA will also help to determine the cluster working group activities, e.g., evaluating ASPA's applicability, and to strengthen collaborations within and outside ASPIS.

The cluster partners and a group of international regulatory and industry stakeholders presented and discussed the concept to get broad feedback on the approach and to identify the most relevant applicability domains.

On the second day, the activities run by the cluster working groups (WG) were presented. ASPIS includes seven WGs focusing on joint efforts in qAOP approaches, omics and computational technologies, kinetics and exposure models, databasing and chemical selection, and dissemination and training. The respective WG chairs summarized the available cluster toolbox and the first results of such joint activities.

Finally, the symposium hosted the first activities of the ASPIS academy. The overarching purpose of the ASPIS Academy is to build a platform to comprehensively educate early-stage researchers in new approach methodologies (NAMs) area and its functioning ecosystem. The cluster has committed to this action since it represents a unique dissemination and

implementation tool, allowing, in the long term, the integration of expertise in diverse organisations when entering the job market. The activities performed under the umbrella of the ASPIS Academy comprise training courses, research exchanges, organisation of dedicated discussion fora, and tailored sessions at open symposia.

For RISK-HUNT*3R*, the next critical face-to-face appointment will be its 4th general assembly in February 2023 in Egmond aan Zee (The Netherlands). On this occasion, the consortium will convene to discuss the next steps, focusing on the upcoming project case studies.

RISK-HUNT*3R* press review

In its first project period, RISK-HUNT*3R* has published its progress in several key areas.

The cluster has developed workflows to collate relevant data and parametrize PBPK models. As described by Khalidi et al. (2022) in a recent publication, the workflow SimRFlow is a high-throughput physiologically based pharmacokinetic (PBPK) modelling tool based on Certara's Simcyp® simulator. The workflow comprises three main modules for data collection, simulation, and visualization. This tool aims to be time-efficient for simulating many compounds without any manual curation of physicochemical or experimental data necessary to run PBPK simulations.

Another critical aspect explored by the project is the analysis of toxicant metabolism. During the past few decades, the direct examination of metabolic intermediates in biological samples has dramatically improved the understanding of metabolic processes. In this review by Moco et al. (2022), the authors highlight the contribution of magnetic resonance (NMR) spectroscopy in small molecule biochemistry, specifically in metabolic studies, by reviewing the state-of-the-art methodologies of NMR spectroscopy and future directions.

An example of advanced technologies for hazard identification was shown by van der Stel et al. (2022), using high-content imaging and high-throughput transcriptomics to address mitochondrial perturbation as a critical event in chemical-induced organ toxicities. Omics approaches were also applied in combination with other computational analyses. In Heldring et al. (2022), the exploration of pathway dynamics, in addition to gene expression comparisons, was used to allow reliable translation of cellular responses from cell lines to primary cells. In this publication, the authors studied interindividual variability in DNA damage response (DDR) dynamics that may evoke differences in susceptibility to cancer. DDR dynamics were compared between the cell line HepG2 and primary human hepatocytes. The proposed approach shows that dynamic modeling can be used to improve our understanding of the sources of interindividual variability of pathway dynamics

Significant contributions were also made to RISK-HUNT*3R*'s key toxicological areas. One of these is developmental neurotoxicity (DNT). DNT represents a critical safety concern. However, DNT data from animal studies are available for only a minor percentage of chemicals. In a publication by Blum et al. (2022), the authors explored the feasibility of DNT hazard assessment based on NAMs. An *in vitro* battery (IVB) was assembled from ten individual NAMs developed during the past years to probe the effects of chemicals on various fundamental neurodevelopmental processes. The results show the feasibility of the IVB for IATA-based risk assessment. Another critical area is organ toxicity, including the nervous system. The integration of peripheral nervous system (PNS) models is a crucial goal. There is a large need for functional assays assessing pain-related signals, especially in human-relevant cell cultures. Holzer et al. (2022a,b) describe a novel test system based on human induced pluripotent stem cell (iPSC)-derived peripheral sensory neurons enriched in nociceptors. The results show that the measurement of functional alterations is suitable for pharmacological and toxicological studies related to peripheral neuropathies.

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 964537.

Giorgia Pallocca and Marcel Leist