Brain Gain – Discovering Neurosciences: A digital education outreach project for higher education students

Mariana Laranjo, **Sara Amaral**, **Carolina Caetano**, **Sílvio Santos**, **Rita Campos**, **João Peça** and **Catarina M. Seabra** (University of Coimbra, Portugal)

Brain Gain is fighting the 'brain drain' by democratizing information on research and careers in neuroscience through a series of open-access and digital education outreach events targeting higher education students, including online talks, pitch challenges, a podcast and a mentorship program. So far, we have reached over 1000 students and our initiatives have been rated as excellent by participants and scientists. Brain Gain initiatives are proving to be effective in inspiring higher education students, providing different resources on career paths, in the neuroscience field, and strengthening the relationship with scientists and universities.

Democratizing access to neurosciences

Addressing brain disorders and mental health issues is a worldwide concern, and the current pandemic has made us even more caring about mental health. This is also a priority of the current government in Portugal as the number of afflicted individuals has been increasing.

Significant neuroscience research has focused on brain conditions; however, for the most part, the civil society does not have access to the studies that are being undertaken in their country, nor to the researchers and clinical professionals that perform this work, and most likely envision them as inaccessible geniuses. Therefore, we have identified this gap between science and society that needs to be filled to increase neuroscience literacy and contribute to an informed and educated community. Considering these facts, it is crucial to promote neuroscience literacy among the population to raise awareness of brain function and diseases using innovative and accessible approaches.

Another challenge comes from the fact that high school students and undergraduate students in Portugal do not have enough opportunities to learn about the exciting and quickly evolving neuroscience research field. Neuroscience contents are absent in the science curriculum for basic and secondary education due to the complexity of contents, lack of practical resources and inadequate teaching training. As neurosciences may seem intangible and complex, many students are thrown off this career path. Students are rarely exposed to professionals to understand what it's like to be a scientist before performing internships during their master's degree. Besides, it is important to show that it is possible to follow neuroscience-related careers outside academia, such as through scientific illustration, science communication, data science and neurology. Additionally, a high number of university students considered giving up university during the pandemic, due to demotivation and social pressure. Therefore, we consider it crucial to design activities targeting this audience, to avoid a massive 'brain drain' of the next generation of (neuro)scientists, which gave rise to the title of our project 'Brain Gain'.

Fighting the 'brain drain' with digital initiatives

Using innovative digital approaches to deliver and disseminate scientific content, including the research and clinical work in neurosciences, and allowing informal dialogues between researchers, professionals and students, we aim to defy the social boundaries between science and society. Conscious of this gap, we created the pilot project 'Brain Gain – Discovering Neurosciences' in 2020 to promote (neuro)science communication. Each audience requires different care and considerations, indicating that scientific communication needs to be *tailor-made*. For the launch of the project, we defined our

main audience as higher education students. Our main goals are specifically to

- democratize access to research and clinical projects in neuroscience while breaking down complex concepts;
- highlight the excellence in neuroscience research developed by Portuguese researchers;
- inspire students to follow neuroscience-related careers, showcasing career diversity and role models (i.e., 'brain gain');
- create openly available innovative and attractive digital resources to encourage public interest.

To ensure the quality of this project, this project counts on an interdisciplinary team composed of professionals from biomedical sciences, science communication, humanities and social sciences. Together, we created a series of open-access education outreach that include online talks, pitch challenges, a mentorship program and a podcast, as described in Table 1.

The *Brain Gain Online Talks,* the first initiative, were launched in 2020 in collaboration with SPN, the Portuguese Society for Neuroscience. We organized an online series of educational outreach talks, approaching neurosciences from different points of view, including technology, diseases and therapies, cognition and careers. We invited Portuguese neuroscientists, neurologists, science communicators and other neuroscience-related professionals to talk and discuss about their work and engage in dialogue with the audience. To motivate students' participation, at the end of each day, we held a live quiz focused on the content of the talks, and the winner was awarded a 1-year SPN membership. The events were disseminated through our social media pages and also by contacting student associations and the directors of bachelor's and master's degree courses. Through registration forms, we were able to confirm that we successfully attracted students from universities and high schools. We hope to sustain this yearly initiative as an open and remarkable event in Portugal that honours neuroscience. Following this idea, we launched an openly available *Brain Gain Podcast*. By publishing the audio recorded from the Brain Gain Online Talks, we provide an opportunity for additional audiences to listen and learn with neuroscience experts. To standardize the episodes, we had previously asked the invited speakers to follow a structured presentation, answering specific questions such as "what are the main challenges when communicating neuroscience with the public?" This podcast is now a unique resource for students interested in pursuing these careers or those who are just curious and interested in knowing more about these topics. The current podcast analytics show that 90% of listeners have ages between 18 and 44 and are from countries including Portugal, Netherlands, Belgium, USA and Brazil. This indicates that this resource may be interesting not only for students but also for other professionals. We believe podcasts are important non-formal educational approaches and privileged storytelling tools, as they have the advantages of being (1) easy to follow, (2) a time-efficient form of communication, (3) accessible, (4) easy to deliver via social media and (5) a privileged vehicle for more engaging forms of communication.

The *Brain Gain Challenge* was our latest initiative designed to capacitate students with science communication skills and to create educational resources. This consisted of a competition where students were challenged to present a 3-minute pitch about a discovery from the neuroscience field that had inspired them (Figure 1). We provided workshops on pitch preparation, creating figures and graphical abstracts and video editing, using a learn-by-doing strategy. The competition was streamed online, and the awarded pitches are available on our online platform (www.braingain.pt). The awarded students have the opportunity to perform a 1-week internship with an SPN member at a Portuguese research institute with follow-up online mentoring – a pilot of the Brain Gain *Mentorship Program*, with the goal of further supporting their career decisions.

There are several challenges of maintaining online events, since there has been a huge increase in this type of activities recently. We see a reflection of this in the number of registrations throughout the years; however, this has not compromised the overall success of the event, as the number of participants per day has been similar. In this line of thought, we plan to diversify our initiatives, using additional media outlets such as ebooks. For our next online event, we also plan to follow up more closely and in the longer term to more accurately quantify the impact of attending these events on students' academic paths.

Neuroscience in non-formal environments impacts students' academic choices

Science communication initiatives in non-formal environments are a powerful tool to empower and engage society and build trust in science. These initiatives can further contribute to science education by increasing scientific literacy and awareness and dissolving gaps between different academic actors. Non-formal environments complement formal and informal education, by allowing new interaction strategies that rely on informality, proximity, and personal experience, between communicators and the public. The feedback from students that have participated in the online

Table 1. Brain Gain Initiatives and Metrics. This table summarizes the Brain Gain initiatives, including the main goal of each activity, the type of involvement from scientists and students, the number of participants and their rating (from 0 – poor to 5 – excellent), collected until January 2023

Brain Gain Initiatives	Launch Year	Main Goal	Neuroscience Professionals			Higher Education Students		
			Involvement	Number	Rating	Involvement	Number	Rating
Online Talks	2020	**Democratize access to neuroscience research and careers**	Speakers	51	5	Q&A	1156	4.7
The Brain Challenge	2022	**Provide science communication skills and create educational resources**	Trainers and jury members	8	5	Pitch presentations	18	4.6
Mentorship Program	2022	**Support career decisions**	Mentors	7	On-going	Interns and mentees	9	Ongoing
Podcast	2022	**Share the audio of the online talks for additional audiences**	Speakers	51	–	Listeners	30	–

Figure 1. Top: Brain Gain initiatives (top). Bottom: Example of the closing ceremony of The Brain Challenge, featuring the project coordinators and the students.

sessions and in the mentorship program reflects the positive impact of these initiatives in their career paths.

João Lourenço, now attending a master's degree in molecular and cellular biology with a specialization in neurosciences, at the University of Coimbra, Portugal, attended the online sessions and was an awardee of the Brain Challenge. In this context, he performed an internship at the Center for Neurosciences and Cell Biology, Portugal, and shared: "*the various topics addressed during the online sessions made me clarify some doubts about whether it was in neurobiology that I wanted to follow my path, helping me to choose a master's degree later*. In 2022 the *Brain Challenge challenged my creativity and stimulated learning about science communication*, something so important in our career as researchers. In conclusion, I think that there should be more initiatives like these, whether at a regional, national or even international level."

Rosário Ferreira, now attending the same master's degree, performed an internship at the Institute of Nuclear Sciences Applied to Health: "The Brain Gain project (...) was very important for me, as it increased my interest in neurobiology and was one of the factors that led me to choose a master's degree in this area."

Diâner Queiroz, was an undergraduate studying psychology who then chose the master's degree in clinical neuropsychology and benefitted from the Brain Gain Mentorship program at the Center for Research in Neuropsychology and Cognitive and Behavioral Intervention, Portugal: "*The mentoring was very important to define medium and long-term goals at an academic and professional level. I was able to implement the suggestions given by my mentor and I also started collaborating on a research project in the area of Cognitive Neuropsychology to deepen my knowledge of technical skills that will be fundamental to do a PhD in this area.*"

Brain Gain initiatives are proving to be effective in inspiring higher education students (Figure 2), which are the next generation of neuroscientists, providing different resources on career paths and the neuroscience field and strengthening the relationship with scientists and universities. We have encouraged students to consider neuroscience-related careers and contributed to increasing literacy in this field and stimulated critical thinking.

Our educational resources and initiatives are now centralized on our online platform, The Brain Gain portal (Figure 3). In the future, our ambition is that this platform can evolve as a place where scientists and students can connect to find opportunities, such as internships and courses. In the future, we plan to diversify our initiatives, using different media outlets such as ebooks. We believe the Brain Gain portal will provide the right platform to connect with a broader demographic of people as our resources will be valuable to the Community of Portuguese Language Countries (i.e., Portugal, Brazil, Angola, Mozambique, Cape Verde, Guinea-Bissau, São Tomé and Príncipe, Equatorial Guinea and Timor-Leste). Addressing brain disorders and mental health issues is a worldwide concern with

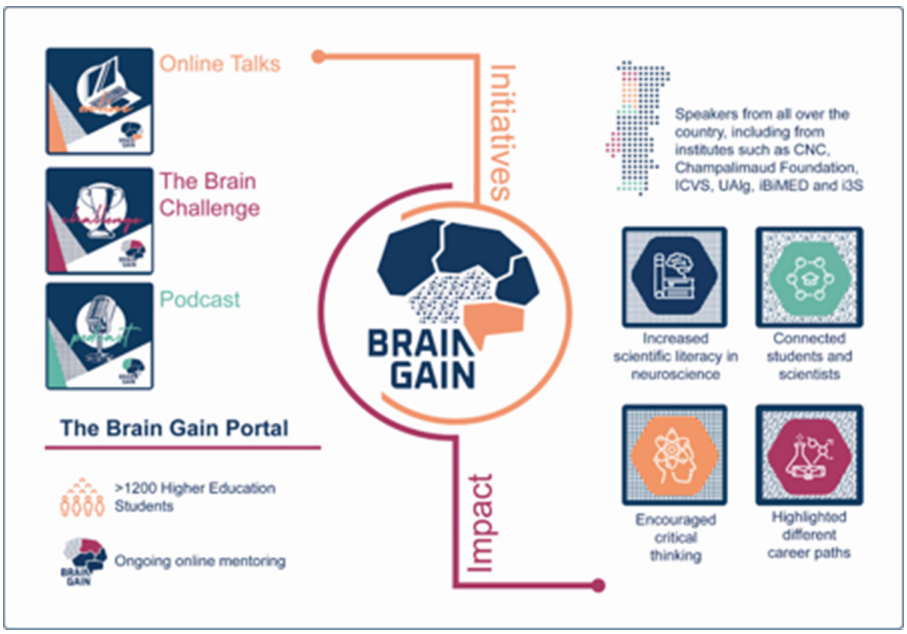

Figure 2. Brain Gain impact: we reached over 1200 students in higher education and have contributed towards career-related decisions.

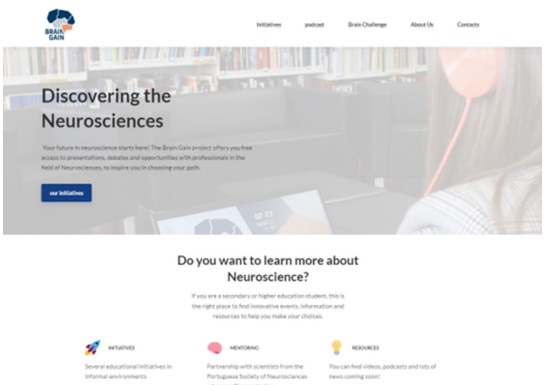

Figure 3. The Brain Gain portal (www.braingain.pt) is an online website that centralizes all the Brain Gain initiatives and educational resources.

increasing expression, and therefore it is crucial to promote neuroscience literacy to raise awareness for brain research using effective non-formal education outreach.

Funding

Biochemical Society – Scientific Outreach Grants; International Brain Research Organization (IBRO) Global Engagement Seed Grant Award; Portuguese Society for Neurosciences (SPN) – Initiatives Support; Institute for Interdisciplinary Research, University of Coimbra (III-UC) – Promotion of Scientific Culture Grant; European Society for Clinical Investigation (ESCI) – Science Communication Grants.

PhD student in biomedicine and experimental biology in the neuroscience field, working at the Neuronal Circuits and Behavior Laboratory at CNC. The main focus of her PhD is to explore the role of parvalbumin inhibitory neurons in the hippocampal circuit function both in normal and neuropathological conditions. Mariana Laranjo has a degree in Biochemistry from the University of Coimbra and has been collaborating closely with the Science Communication Office at CNC, working with different ages to develop skills that are essential for a scientist who works for the benefit of the community. Mariana is the Co-Founder of the project Brain Gain - Discovering Neurosciences, which has the aim of inspiring higher education students to pursue careers in the neurosciences fields.

Head of Science Communication Office at CNC, Coimbra - has been involved in several projects that aim to establish innovative strategies that promote the appropriate communication between scientists and different audiences, and to foster scientific education in biomedical field. These projects include educational projects with a strong interaction with schools, public engagement initiatives, art and science projects, fundraising projects and impact evaluation studies. Additionally, she was enrolled in science education activities based on hands-on models. Therefore, her research interests are science communication strategies, impact evaluation methods, scientific culture and citizenship, public engagement in science, science education, fundraising for biomedical research, and art and science initiatives. At CNC she has the responsibility of national and international public engagement and education projects in order to approach the scientific and non-scientific communities and to increase scientific literacy, a strategy that could contribute to the construction of a truly scientific culture and citizenship. She was involved in the creation of 5 plays, staged by Marionet, and was part of the information team at Rádio Universidade de Coimbra. She is promoter of PubhD Coimbra initiative and member of Pos-doc @ UC initiative.

Public Information Officer and manager of the CNC's social networks. She has been responsible for CNC press releases, media relations, production of multimedia content, and social media presence since 2021. She holds a Bachelor's Degree in Biology from the University of Coimbra and a Master's in Cellular and Molecular Biology from the same University. As CNC's Public Information Officer, she has been involved in several science communication projects, including Brain Gain - Discovering Neurosciences. Her role involves establishing efficient strategies to disseminate and engage the public in these projects. She works closely with researchers from CNC, students, schools, associations, and artists. Additionally, she has been actively involved in public engagement activities and projects within CNC.

Assistant Professor at the Faculty of Arts and Humanities - University of Coimbra, in Portugal. PhD in Communication Sciences. His main early publications are related to radio and audio (namely media history, public media, participatory media, narratives and podcasting). More recently, Sílvio has been researching and publishing about Digital Media, namely on disinformation, media literacy and education. In the last few years, has been part of several research projects, like Viox19, Radioactive101, and BiPE - Broadcasting in the Portuguese Empire, among others. Sílvio is a professor of radio since 1999. He was also a radio presenter and producer at the Portuguese national broadcaster RTP. Currently teaches mostly radio and multimedia and is vice-dean of the Faculty of Arts and Humanities of the University of Coimbra.

Researcher from the Centre for Social Studies from the University of Coimbra (CES-UC). Has a PhD in Biology from the University of Porto, on evolutionary biology and population genetics. Since 2009 is interested in the areas of Science Communication and Non-formal Science Education, and working exclusively in these areas since 2016. Her current research interests are centred on the study and production of science communication, active learning and public engagement in and with science (citizen science) tools about the relations between biodiversity and human health, interlinks between systems (natural, social, cultural) and (environmental) sustainability. She is interested in interdisciplinary approaches and methodologies that enhance the inclusion and participation of the public, such as context-based education or visual methodologies, and in mixed methods of evaluation of the produced tools. Maintains regular collaboration with national and international institutions (CIBIO-InBIO, Science Museum of the UC, COI, UFRN). Her work has earned national and international recognition, notably the Distinction Award by the Casa das Ciências (House of Sciences) and the Fresh Ideas Scheme pass by ECSITE.

Assistant Professor of Molecular and Cell Biology at the University of Coimbra and Group Leader of the Neuronal Circuits and Behavior Lab. João completed his Ph.D. at Duke University, where he created the first transgenic mice for channelrhodopsin-2 and pioneered the field of optogenetics. He performed postdoctoral research at MIT characterizing animal models for autism, where he uncovered a new role for cortico-striatal dysfunction in autism spectrum disorders. He has completed was supervisor or co-supervisor of 5 Ph.D. students' thesis and of 10+ M.Sc. students. Present interests of his group center on using advanced models to understand how genetic and environmental elements risk factors translate to neurodevelopmental and neuropsychiatric disorders. To achieve this, João uses a combination of molecular genetics, optogenetics and electrophysiological approaches using animal models and human brain organoids. To date his work has led to primary research papers in high-impact, peer-reviewed journals, including Nature, Nature Communications, Molecular Psychiatry, PNAS, and Neuron, and review work in Cell and Annual Reviews in Neuroscience. In 2019 he won "Pfizer Prize in Basic Research", the oldest and one of the most prestigious prizes in Portugal in the area of Biomedical Sciences.

Researcher at CNC exploring the development of 3D brain organoids to understand the impact of genetic alterations on brain development and wiring, and also a Career Advisor and Business Developer at Chaperone. Catarina M. Seabra obtained a PhD in 2017 and trained at renowned institutions in the USA, such as the Center for Genomic Medicine, Harvard Medical School and Broad Institute of MIT and Harvard. Catarina Seabra's work has advanced knowledge in the autism research field as she used cutting-edge technology to identify disease-associated pathways which may be suitable targets for treatment. As an educator, she was invited as Assistant Professor at the University of Coimbra in 2020 to teach experimental classes to Biology degree students. Catarina Seabra has a vast experience in science communication and public engagement. She has organized scientific events and has created opportunities for young students by co-founding projects such as Brain Gain - Discovering Neurosciences, PAPSummer and Maria de Sousa Research Program. In 2018, she obtained a H2020 MSCA Individual Fellowship and was acknowledged for her scientific excellence with two Merit Awards. Email: cseabra@cnc.uc.pt