Opportunities for advancing interdisciplinary collaborations between the USA and Spain through the CRCNS program

Report of a Binational Workshop
Madrid, Spain 15th-16th of February 2018
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A binational workshop was held in Madrid in February 2018 in order to gauge the interest in and feasibility of extending the CRCNS program to include interactions between the US and Spain. The workshop aimed to assess the potential interest among the scientific community and the funding agencies in such a joint venture, to evaluate areas of common and complementary strengths, to identify particular opportunities for interactions and student experiences, and to discuss broader issues that may affect collaborations between potentially distinct scientific cultures. We assembled a group of 6 US and 10 Spanish scientists (Appendix 1) for a two-day workshop that consisted of scientific exchange and discussion groups (Appendix 2). The meeting successfully established a line of communication between Spanish and US scientists and gave the opportunity to share scientific interests, to better understand the scientific strengths of the two communities and to discuss issues of environment. Discussions among scientists showed that there is considerable interest and a fruitful ground for interdisciplinary collaborations among scientists and engineers in the two countries.

The state of interdisciplinary neuroscience in Spain

Theoretical and computational approaches to neuroscience are on a firm footing in Spain, with a significant community of researchers using mathematical and statistical methods to analyse network behaviors and brain structure. These researchers have extensive backgrounds in the physical, statistical and computational sciences. Particular areas of strength include statistical approaches to neural networks and the dynamics of networks and plasticity. There is also an active field of graphical network analysis extending to neuroinformatic analyses of cortical networks. Many theoretical researchers already have active collaborations with experimentalists within Spain and further afield. Further, there are a number of highly quantitative experimentalists. Barcelona has a particularly strong concentration with a special focus on the study of complexity, including neuroscience applications. Furthermore, several prominent US scientists have already established links and collaborations in Spain.

The workshop highlighted a number of areas in which collaboration is already occurring and can be further enhanced. A common theme between Spain and US participants was the understanding of emergent properties of complex networks. Several groups in Spain focus on the importance of criticality and emergent network properties that affect global state (as presented by Profs. Deco and Sanches-Vives, Appendix 2) and the ability of the network to

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propagate weak signals (Parga). The experimental studies of Sanchez-Vives and Deco on spontaneous and driven global brain activity are supported by whole-brain modeling that make predictions about response to perturbation. At a more local scale, Yuste's work has demonstrated that cortical activity patterns can act as attractors and be dynamically created by optogenetic inputs. Several theoretical approaches to network analysis were presented that may provide important tools to understand these observed activity patterns, including Buldú's analysis of dynamics and synchronization in complex networks and Makse's application of percolation theory to discover key network nodes. Bielza's work on graphical Bayesian models has already found applications in collaborations with de Felipe's anatomical studies of dendritic branching patterns and would be a natural approach to analyse large-scale EM structural data. Several groups' work elucidates the identification (de Felipe) and computational role (Geffen, Sanchez-Vives, Yuste) of different neuron types.

The climate for extending the reach of interdisciplinary approaches is fertile. Multidisciplinary approaches are well-accepted and broadly under way in this field in Spain, as the speakers' range of existing local and international collaborations demonstrated. However, it is not yet the case that personnel undertaking theoretical and analytical approaches are typically incorporated into neuroscience groups or departments, as has become more common in the US. For example, there is currently no theoretical/analytical group at the Cajal Institute, a major neuroscience center in Madrid, although a number of members do collaborate with theoretical colleagues at other institutes. In terms of academic culture, it was noted that research in the domain of computational neuroscience is generally better supported in Spanish computer science departments, with particular strengths in network analysis, than in physics departments which remain fairly traditional. In general, the area has gotten more traction in newer departments rather than more long-established ones. Working across departmental boundaries within institutions remains a barrier, so that currently there is not as much interaction between theoretical and experimental groups as is desirable.

Domains that would particularly benefit from the CRCNS program include data science and machine learning, which is growing in popularity among students and researchers in Spain as in the US and is an opportunity for recruitment and training of students in this area. Brain-computer interfaces (BCI) are also an area of active student interest, particularly noninvasive BCIs. Neurotechnology, including BCIs, is relatively nascent in Spain and could be significantly enhanced through international collaboration.

Within Spain, there is specific interest in and room for further growth in computational neuroscience and neural engineering. Dr Rafael Yuste noted plans for invited visits to several institutions in the Basque Country in early 2018, including the *Brain Center on Cognition, Brain and Language, Nanogune, Biofisika, BioDonostia* and the *Donostia International Physics Center (DIPC)* to give a lecture course in neurophysics. It is possible that interactions like this will lead to a new short course in neuroengineering. Further, industrial and medical collaborations are possible: Dr Jose Carmena discussed experiences from his existing collaboration with the Hospital Universitario Donostia in San Sebastiàn that is hosted and partially funded by Tecnalia, a local industry incubator.[3]

[3] https://www.tecnalia.com/en/

Current funding mechanisms

MINECO is the leading funding organization in Spain, with grants that are in the range of $30-300K over 3 years. They do not include funding for salaries, as these are covered by the institution. Some institutions also supply funding for students. European Union funding supports two relevant large flagship projects, the Human Brain Project, and GRAPHENE, a nanotechnology project. It was perceived among the workshop participants that Spanish funding policy and mechanisms are slanted toward the support of bigger groups. Computational neuroscience groups tend to be small which disadvantages them in a number of national and European funding mechanisms. Thus a program like CRCNS could serve to address this gap.

Student training

There is considerable potential for teaching and growth in computational neuroscience training. It was noted that in Madrid and Barcelona, it could be especially powerful for institutions to pool offerings and resources to create an interinstitutional program.

Both the US and Spain are very interested in student exchange programs to further training and research goals. On the Spanish side, the groundwork for student exchange is already in place. Graduate exchanges are normal: indeed, in some Spanish doctoral programs, students are required to spend some months abroad. This is seen as an ideal opportunity for students to learn and exchange new techniques, both experimental and theoretical. Some university PhD programs require an international component such that students spend some time in another country, including the US. Further, there exist IBRO fellowships to support one-year exchanges for very recent graduates.[4] Considerable value was also seen in US students undertaking research experiences in Spain, to help advance their maturity, collaborative skills and understanding of the broader international research environment.

Intellectual property and the climate for commercialization

The group discussed the opportunities available in both countries for developing intellectual property into companies. This was regarded as a fairly difficult process in Spain. Universities provide guidance but no seed funding, but do assist with filing patents. It was agreed that from experience, while patents may in the end not mean much, nascent companies find them necessary to have in place to secure funding. As in the US, there is a diversity of rules about intellectual property in universities around Spain. In some cases, the IP belongs to the university. Converting from a provisional to a full patent is expensive and the university may not see the process through. That said, the experiences of attendees suggest that the culture is changing to offer more support for entrepreneurship. In some places, one can take a leave of absence for such efforts, although one cannot continue to be funded by grants on this leave. Sometimes a company may provide funding to a lab to work on an idea, although students generally cannot work on industry-related projects. Importantly, in general, there appear to be no aggressive intellectual property controls in place that would serve as a barrier to international collaboration.

[4] IBRO Research Fellowships,
http://funding.ibro1.info/Pub/Pub_Main_Display.asp?LC_Docs_ID=4254

Vertebrate animal experimentation

Vertebrate animal work is in general well-supported by the public in Spain; however, there is very little research on non-human primates. While it is not banned or even especially negatively perceived, under European Union-wide regulations, NHPs should only be used in projects that are considered essential for human health. There would be no cultural barrier for interactions that involve NHP experimentation.

Data sharing

The question of data sharing generated an active discussion in which a range of diverse viewpoints were shared. While the principle of data sharing is widely seen as positive, many caveats were raised and discussed.

Some participants are members of the Human Brain Project, and shared that the HBP charter contains a chapter of regulations about data sharing, which has raised awareness of the topic, if not yet assured compliance. Sharing of electrophysiology data in particular is seen to be highly nontrivial and there are a range of valid objections to the requirement for immediate sharing, including the need for intensive documentation; documentation standards that are time-consuming to carry out; the need for embargo periods to allow the data-generating group to perform a reasonable amount of publishable analysis; and the question of subsequent authorship on research performed using openly shared data. For some experiments that are very difficult and time-intensive, a requirement to share immediately could be perceived as a disincentive to doing the work. It was noted that data sharing can be complex even within closed collaborations. Finally, some theorists' had found that using publically released data can have limited value—it can act as a "teaser" to initiate a collaboration, but that a new project will generally require the collection of new data to advance specific questions.

It is generally agreed that a standardized user-friendly platform is required for data sharing to be as useful as possible. The Human Brain Project is in the process of developing such a platform, but there is a likely two-year timeframe on its development and evaluation.

Conclusions

This workshop demonstrated that there is a fertile ground, scientifically and culturally, for cross-disciplinary collaboration in neuroscience between Spanish and US investigators. Several active collaborations already exist, and specific domains of specialization provide very appropriate opportunities, in particular in the analysis of complex network dynamics and emergent behavior, in anatomical and cell type analysis, and in brain-computer interfaces.

Appendix 1: Attendees

Participants

Name	Institution	Country
Javier Martín Buldú	URJC, Madrid	Spain
Gustavo Deco	UPF, Barcelona	Spain
Albert Compte	IDIBAPS, Barcelona	Spain
Luis M. Martínez	Instituto de Neurociencias de Alicante. CSIC-UMH	Spain
Concha Bielza	UPM, Madrid	Spain
Javier de Felipe	Cajal Institute & CTB, Madrid	Spain
Mavi Sánchez-Vives	IDIBAPS, Barcelona	Spain
Joaquín Marro	Universidad de Granada, Granada	Spain
Pablo Varona	Universidad Autónoma de Madrid, Madrid	Spain
Néstor Parga	Universidad Autónoma de Madrid, Madrid	Spain
José Carmena	University of California, Berkeley	USA
Rafael Yuste	Columbia University, New York	USA
Maria Neimark-Geffen	University of Pennsylvania, Philadelphia	USA
Judith Hirsch	University of Southern California	USA
Hernán Makse	City University, New York	USA
Adrienne Fairhall	University of Washington, Seattle	USA

Government observers

Victoria Ley	AEI, MINECO, Madrid	Spain
Joaquín Serrano	AEI, MINECO, Madrid	Spain
Estrella Fernández	AEI, MINECO, Madrid	Spain
Juan José Garrido	AEI, MINECO, Madrid	Spain
Ana Mª Barra Ahijado	AEI, MINECO, Madrid	Spain
Ignacio Baanante	ISCIII, Madrid	Spain
Esther Chacón Campollo	AEI, MINECO, Madrid	Spain
Michele Ferrante	NIMH, Washington	USA
Edda Thiels	NSF, Washington	USA

Appendix 2: Workshop agenda

The binational workshop was preceded by a scientific symposium held at the Cajal Institute, Madrid.

PROGRAMME
14 February 2018

16:30 – Welcome and Presentation *(Juan José Garrido, Cajal Institute, CSIC, Spain)*
15:45 – Rafael Yuste: "Can you see a thought? Neuronal ensembles as basic units of cortical function"
17:15 – José Carmena: "Mechanisms of neural activity exploration and consolidation underlying neuroprosthetic skill learning"
17:45 – Maria N. Geffen: "Excitatory-inhibitory circuits in auditory processing"
18:15 – Hernan Makse: "Cracking the locomotion code in C. elegans"
19:15 – End of the Scientific Seminars

AGENDA
15 February 2018

Funders meeting

12:00 – Welcome and introduction of State Research Agency
(*Estrella Fernández Head of Subdivision, Subdivision for Horizontal S&T Programmes, Spanish State Research Agency, AEI)*

12: 20 – Presentation of National Science Foundation *(Edda Thiels, National Science Foundation, NSF)*

12:40 – Presentation of National Institute of Health *(Michele Ferrante, National Institute of Health, NIH)*

13:00 – Wrap-up

Scientific Workshop on CRNCS

13:30 – Welcoming reception at AEI- MINECO

14:15 – Opening by AEI-MINECO / NSF
Introduction to workshop (*Dr Javier M. Buldú, Spanish Co-Chair, URJC University and Adrienne Fairhall, USA Co-Chair, University of Washington)*

14:30 – Speed topic presentations I: Self-introduction, summary of research, listing of opportunities for collaboration. (10 minutes each: 8 presentation + 2 questions)

1) Adrienne Fairhall (University of Washington, Seattle WA)
2) Javier M. Buldú (University Rey Juan Carlos, Madrid)
3) Gustavo Deco (Universidad Pompeu Fabra, Barcelona)
4) Concha Bielza (Universidad Politécnica de Madrid, Madrid)
5) José Carmena (UC Berkeley, Berkeley CA)
6) Mavi Sánchez-Vives (Institut d'Investigacions Biomèdiques August Pi i Sunyer Barcelona),
7) Rafael Yuste (Columbia University, New York)
8) Luis M. Martínez (Instituto de Neurociencias de Alicante, CSIC-UMH, Alicante)

16:00 – Coffee break

16:30 – Speed topic presentations II (10 minutes each: 8 presentation + 2 questions)
9) Javier de Felipe (Cajal Institute & CTB, Madrid)
10) Néstor Parga (Universidad Autónoma de Madrid, Madrid)
11) Hernán Makse (City University, New York)
12) Albert Compte (IDIBAPS, Barcelona)
13) Joaquín Marro (Universidad de Granada, Granada)
14) Judith Hirsch (University of Southern California, CA)
15) Pablo Varona (Universidad Autónoma de Madrid, Madrid)
16) María N. Geffen (University of Pennsylvania, Philadelphia)

18:00 – End of Day 1

20:00 – Dinner hosted by MINECO/AEI

16 February 2018

09:30 – Group discussion of goals (Chairs)

09:45 – Parallel working group session I

10:45 – Coffee break

11:00 – Parallel working group session II

12:00 – Joint session: groups report back
Session I
Scientist working group- open discussion
Session II
Funding Agencies working group- open discussion

13:00 – Conclusions and next steps

13:30 – End of meeting

Lunch