Simons Center for the Social Brain

Mission

The mission of the Simons Center for the Social Brain (SCSB) at MIT is to understand the neural mechanisms underlying social cognition and behavior, and to translate this knowledge into better diagnosis and treatment of autism spectrum disorders (ASD). SCSB was founded in January 2012 with support from the Simons Foundation Autism Research Initiative (SFARI), and completed its first five-year phase of funding in December 2016. SCSB funding was renewed for a second phase in January 2017, and for a third phase beginning January 2020.

The Simons Center studies mechanisms of autism spectrum disorders in both humans and relevant model organisms and systems, as neural correlates of social cognition and behavior exist in diverse species. Our approaches take advantage of MIT's strengths in genetics and genomics, molecular and cell biology, analyses of neural circuits and systems, cognitive psychology, computation, and engineering.

During academic year 2020, SCSB continued its support for postdoctoral fellows and innovative collaborative targeted projects that involve three to four researchers bridging multiple levels of analysis. In addition, we continued to host events that reach a wide audience, including a colloquium series and a lunchtime talks series.

Symposia and Events

To strengthen its community, SCSB runs a colloquium series, which brings major autism researchers to MIT, and has become the preeminent forum in the Boston area for research on autism and neurodevelopmental disorders. In addition, SCSB hosts a lunchtime talks series featuring postdoctoral fellows and faculty PIs presenting their latest, ongoing research.

As in previous years, the colloquium was held, roughly, on alternate Wednesdays during the spring and fall terms. The lunch talks were held approximately once a month. In AY2020, SCSB hosted 13 external colloquium speakers, and 11 internal lunch speakers as part of its lunch series. Due to the unexpected circumstances of COVID-19, the Simons Center transitioned the spring 2020 events to a digital platform. Over the past few months, we had a number of events including colloquium talks and lunch series talks via Zoom webinars. We have received a lot of positive feedback and are happy to report a much higher than typical attendance.

Research

Postdoctoral Fellowships

We continued our outreach efforts for announcing, receiving, reviewing, and awarding postdoctoral fellowships. Announcements were widely advertised to various departments and centers at MIT as well as institutions throughout the Boston area. As in the past, the grant application and funding cycles occurred in two rounds, September 2019 and February 2020. Due to COVID-19, we are reevaluating our application schedule.

From July 2019 to June 2020, SCSB awarded nine postdoctoral fellowships (including three renewals for a second year of funding). Applications were reviewed by peer review committees that were set up for each round of applications, and overseen by the SCSB steering committee, which met after each round of review.

Targeted Projects

SCSB supports uniquely collaborative, focused projects undertaken by multiple laboratories to explore in depth specific aspects of autism. These targeted projects are structured to require collaboration among researchers in order to quickly and flexibly address pressing questions in autism research. These projects are a vital part of the center's mission. SCSB supported two targeted projects in AY2020. One of these continued from previous years, while the other was newly initiated. The Role of the Thalamic Reticular Nucleus (TRN) in Thalamocortical Coordination, Cognitive Processing, and Sleep in ASD project completed its third and final year of funding in October 2019.

In April 2019, Circuit Mechanisms of ASD-Relevant Behaviors in Marmosets received its second year of funding. This particular project has the four following components:

- Neural circuits for social attention and social reward (Robert Desimone)

- Investigation of striatal circuits in marmoset brain underlying repetitive, perseverative behaviors (Ann Graybiel)

- Mechanisms of switching and prediction in marmoset cortex (Mriganka Sur)

- Molecular measurement and perturbation of marmoset brain networks (Alan Jasanoff)

The Predictive Processes in Autistic and Neurotypical individuals: A Behavioral, Neural and Developmental Investigation project was started with year one funding in July 2019. This project has the following three components:

- Behavioral and electrophysiological investigations of sensorimotor prediction during metronomic and probabilistic auditory sequences (Pawan Sinha)

- Investigations of adaptation to social and nonsocial stimuli (John Gabrieli)

- Developmental studies of prediction in autism, including sequence learning, neural adaptation, and lexical prediction (Jesse Snedeker)

Each of the project teams met regularly to discuss ongoing findings, provide feedback, and share results and ideas between labs.

Major Research Publications

A wide range of publications resulted from SCSB funding. A sample of these is as follows:

Amemori, Satoko, Ken-ichi Amemori, Tomoko Yoshida, Georgios K. Papageorgiou, Rui Xu, Hideki Shimazu, Robert Desimone, and Ann M. Graybiel. "Microstimulation of Primate Neocortex Targeting Striosomes Induces Negative Decision-Making." *European Journal of Neuroscience* 51, no. 3 (2019): 731–741.

Barak, Boaz, Zicong Zhang, Yuanyuan Liu, Ariel Nir, Sari S. Trangle, Michaela Ennis, Kirsten M. Levandowski, Dongqing Wang, Kathleen Quast, Gabriella L. Boulting, Yi Li, Dashzeveg Bayarsaihan, Zhigang He, and Guoping Feng. "Neuronal Deletion of *Gtf2i*, Associated with Williams Syndrome, Causes Behavioral and Myelin Alterations Rescuable by a Remyelinating Drug." *Nature Neuroscience* 22, (2019): 700–708.

Jouravlev, Olessia, David Zheng, Zuzanna Balewski, Alvince Le Arnz Pongos, Zena Levan, Susan Goldin-Meadow, Evelina Fedorenko. "Speech-Accompanying Gestures Are Not Processed by the Language-Processing Mechanisms." *Neuropsychologia* 132, (2019): 1–16.

Nakajima, Miho, L. Ian Schmitt, Guoping Feng, and Michael Halassa. "Combinatorial Targeting of Distributed Forebrain Networks Reversed Noise Hypersensitivity in a Model of Autism Spectrum Disorder." *Neuron* 104, (2019): 488–500.

Qing, Bo, Elizabeth P. Canovic, Aleksandar S. Mijailovic, Anna Jagielska, Matthew J. Whitfield, Alexis L. Lowe, Elyza H. Kelly, Daria Turner, Mustafa Sahin, and Krystyn J. Van Vliet. "Probing Mechanical Properties of Brain in a Tuberous Sclerosis Model of Autism." *Journal of Biomechanical Engineering* 141, no. 3 (2019): 1–10.

Rao, Siyuan, Ritchie Chen, Ava A. LaRocca, Michael G. Christiansen, Alexander W. Senko, Cindy H. Shi, Po-Han Chiang, Georgios Varnavides, Jian Xue, Yang Zhou, Seongjun Park, Ruihua Ding, Junsang Moon, Guoping Feng, and Polina Anikeeva. "Remotely Controlled Chemomagnetic Modulation of Targeted Neural Circuits." *Nature Nanotechnology* 14, (2019): 967–973.

Reed, Michael D., Yeong Shin Yim, Ralf D. Wimmer, Hyunju Kim, Changhyeon Ryu, Gwyneth M. Welch, Matias Andina, Hunter O. King, Ari Waisman, Michael M. Halassa, Jun R. Huh, and Gloria B. Choi. "IL-17a Promotes Sociability in Mouse Models of Neurodevelopmental Disorders." *Nature* 577, (2020): 249–253.

Shain, Cory, Idan A. Blank, Marten van Schijndel, William Schuler, and Evelina Fedorenko. "fMRI Reveals Language-Specific Predictive Coding During Naturalistic Sentence Comprehension." *Neuropsychologia* 138, (2020): 107307.

Smith, Hayley, Alice S. Carter, Erik Blaser, and Zsuzsa Kaldy. "Successful Attentional Set-Shifting in 2-Year-Olds with and without Autism Spectrum Disorder." *PloS One* 14, (2019): 1–17.

Tang, Xin, Jesse Drotar, Keji Li, Cullen D. Clairmont, Anna Sophie Brumm, Austin J. Sullins, Hao Wu, Xiaoxiao Shawn Liu, Jinhua Wang, Nathanael S. Gray, Mriganka Sur, and Rudolf Jaenisch. "Pharmacological Enhancement of *KCC2* Gene Expression Exerts Therapeutic Effects on Human Rett Syndrome Neurons and *Mecp2* Mutant Mice." *Science Translational Medicine* 11, no. 503 (2019): 1–13.

Uddén, Julia, Annika Hultén, Katarina Bendtz, Zachary Mineroff, Katerina S. Kucera, Arianna Vino, Evelina Fedorenko, Peter Hagoort, and Simon E. Fisher. "Towards Robust Functional Neuroimaging Genetics of Cognition." *Journal of Neuroscience* 39, (2019): 8778–8787.

Impact

Over 80 investigators across 16 departments, labs, and centers at MIT and 14 Boston-area institutions, are engaged with SCSB as investigators or as postdoctoral mentors. SCSB has supported 45 postdoctoral researchers as Simons Fellows.

SCSB researchers have published over 270 original research papers (some publications in AY2020 are highlighted above) and obtained over $51 million in external funding from SCSB-supported, early-stage research or targeted project research. A significant number of Simons postdoctoral fellows have obtained faculty or independent research positions.

Administration and Governance

SCSB continues to be run by a small administrative core in which each individual performs a wide range of functions. In AY2020 the team included: Mriganka Sur (director), Eleana MacPhail (administrative manager), and Alexandra Sokhina (administrative assistant II, events coordinator).

Postdoctoral fellowship applications were evaluated by review committees, constituted with six to eight reviewers from across MIT and area institutions based on their expertise and with representation from SFARI. The committees met twice a year, for each round of funding. Targeted projects were reviewed by SFARI and by external reviewers commissioned by SFARI.

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