The Society for Neuroscience 2023 Annual Meeting Report: Advancing the Understanding of the Brain and Nervous System

Neuroscience 2023 (or SfN 2023), the annual meeting of the Society for Neuroscience (SfN), was held November 11–15, 2023, in Washington, D.C. With over 25,000 attendees, this year's meeting brought together many great minds and featured recent advances in the field of neuroscience. There were numerous special lectures, symposia, minisymposia, nanosymposia, workshops, meet-the-expert sessions, posters, ask anything sessions, roundtables, and socials — too many to feature in this report. To narrow the focus, I have selected several different sessions to highlight below.

Presidential Lecture: Receptors, Synapses, Memory, Dr. Richard L. Huganir
The highly anticipated, final presidential lecture of SfN 2023 was given by Dr. Richard Huganir (Johns Hopkins University School of Medicine). His inspiring talk began with the retelling of the beginnings of his scientific journey, dating back to his early life and high school years with experiments in mealworms and goldfish. He then spoke of purifying and reconstituting the nicotinic acetylcholine receptor, characterizing its ion channel properties, and collaborating with David Tank to perform patch-clamp recordings of the purified receptor during his graduate work. With a deep interest in receptor regulation at synapses, his work took a turn in the late 1980s and early 1990s when Gamma-aminobutyric acid A (GABAA) receptors and glutamate receptors were cloned, enabling them to be studied at the biochemical level. In recent decades, his work has focused on α-amino-3-hydroxy-5-methyl-4- isoxazolepropionic acid (AMPA) receptors, in part due to their role in mediating 90% of excitatory synaptic transmission in the brain, with the goal of understanding synaptic plasticity. The focus has been on phosphorylation of AMPA receptors as well as the proteins that interact with them to alter their properties. Results from this research have led to the discovery that receptor trafficking plays a major role in the various forms of synaptic plasticity. He shared his insights into his research on SynGAP as well as some highlights from his work on super ecliptic pHluorin (SEP)-tagged receptors.

SynGAP, a GTPase-activating protein (GAP) that negatively regulates Ras signaling, has high abundance at the tip of synaptic spines. Heterozygous knock-out of SynGAP1 in mice leads to severe deficiencies in memory processes and behavior. Further, these findings in mice reflect human mutations of SynGAP1 in autosomal nonsyndromic

cognitive impairment (cognitive impairment with no additional abnormalities), such that mutations in SynGAP1 in humans are thought to underlie 1% of intellectual disability. This connection to human phenotypes has increased the motivation to better understand how SynGAP is ultimately affecting synaptic plasticity and AMPA receptor trafficking. Dr. Huganir's group has established a working model for SynGAP's interaction with Ras to alter the synaptic connections between neurons upon repeated activation, a process known as long-term potentiation. His group has also gone on to determine that SynGAP competes with transmembrane AMPA receptor regulatory proteins (TARPs) to affect AMPA receptor trafficking, which has implications on long-term potentiation.

Dr. Huganir then gave a brief overview of a different experimental pursuit: to capture longitudinal images of synapses, with the ultimate goal of understanding how the brain chemically changes during learning and memory. His group is using super ecliptic pHluorin (SEP) tagged receptors to detect synaptic plasticity in GluA1 and GluA2 AMPA receptor subunits throughout the brain, which enables visualization of the insertion and recycling of these proteins at the synaptic membrane. Thus far their work has revealed mechanisms by which these subunits are inserted into the plasma membrane — a critical step in synaptic plasticity — and they have ongoing efforts to connect these findings with long- term potentiation.

Symposium: Memory and Timing: The Shared Neural Encoding of Retrospective and Prospective Information

This thought-provoking symposium aimed to merge the gap between memory and temporal cognition, which have largely been studied in isolation despite their interconnectedness.

Dr. György Buzsaki (New York University) discussed what is fundamentally being measured when we consider the concepts of 'space' and 'time', highlighting that the terminology for hippocampal neurons responsible for deciphering this information (e.g., place cells, time cells) is technically irrelevant for the brain. Instead, what is important is how downstream reader mechanisms classify hippocampal messages. Key to this is how the brain determines what events are important versus unimportant from a series of events. Dr. Buzsaki then shared ways to consider an animal's position and trial number (in a sequence of events) to reveal information stored by hippocampal neurons. He emphasized a compelling message: although social constructs or socially agreed-upon units such as seconds and minutes are important for us as humans to communicate, they are more so means of communication and they do not refer to unique/exclusive brain mechanisms.

Dr. Dean Buonomano (UCLA) discussed timing and working memory, specifically defining 'timing' as "the ability to track elapsed time on the scale of seconds in order to prepare for and anticipate future events, generate appropriately timed motor responses, and decode the temporal structure of external stimuli" and 'working

memory' as "the ability to transiently store information on the scale of seconds, and to subsequently use this information in a flexible manner for goal-oriented behaviors and decision making." He shared an overview of different models for how the brain tells time on scales on the order of seconds: ramps, neural sequences, complex dynamics, and short-term synaptic plasticity. These models can be used with computational modeling and neural networks, and they have generally been used separately for timing and working memory. Dr. Buonomano then discussed modeling results indicating that a lack of inhibition may have a larger role than excitation. Although Dr. Buonomano shared data from psychophysical, computational, and neural experiments suggesting that working memory and implicit timing interact, he also highlighted that we should not be searching for single neural mechanisms underlying the encoding of both time and/or working memory because they both may require multiple area- and task-specific mechanisms.

Dr. Anna Christine (Kia) Nobre (Yale University and University of Oxford) discussed timing expectations and their role in proactive memories. In doing so, she highlighted how '(selective) attention', which is the anticipation, selection, and prioritization of relevant signals to guide behavior, is both dynamically and temporally structured and is relevant for both external (sensory) and internal (memory) content. There is growing recognition of temporal expectations, flexible aspects of selective attention with structures such as cues, rhythms, probabilities, and sequences. Several studies have indicated an interaction between spatial and temporal sequences that are beneficial for improved performance in tasks and are reflected in electroencephalogram data. The temporal structuring of attention to working memory representations has been explored through a series of studies, with results collectively indicating a highly coordinated and temporally structured re-prioritization of items in working memory according to the timing of when they are needed. In all, Dr. Nobre emphasized that attention functions have a temporal dimension and are not simply ordinal as well as that focal points in perception and working memory are guided by temporal expectations.

Dr. Lila Davachi (Columbia University) focused on the temporal integration and separation of sequential events in memory. She first posed the question of "what is an 'episode' in episodic memory?", or "how do episodic memories emerge from ongoing experience?" In the temporal organization of an experience (sequential representations) there is a dichotomy between discretization and integration – that is, when representations are separated verses integrated as one unit. Dr. Davachi then indicated that both proactive and retroactive mechanisms can support the temporal linking of experiences and described a paradigm her group developed, the Ezzyat-DuBrow-Davachi (EDD) paradigm, to test how different granularities of change define real-world events. Results from this paradigm have indicated that 'boundaries' (e.g., switches in a feature of the events such as a change in color of an object) between events alter the organization of long-term memory by arresting/resetting the ongoing temporal integration that typically occurs within events. Dr. Davachi posited that

content itself is represented in the cortex whereas the sequence representation occurs in the hippocampus. Overall, her work illustrates that boundaries have opposing behavioral effects on timing in-the-moment compared to the representation of time in memory, such that boundaries decrease estimates of time in-the-moment but after time passes and one reflects back on those same experiences they feel longer.

Workshops: Enriching programming to advance one's career

In addition to the more technical and research-oriented sessions, SfN 2023 also had several workshops and other professional development/networking events. These enriching opportunities were highly valuable and insightful, especially for those early in their career. Instead of going into depth on one workshop, I will share some take-aways from several that I attended: two workshops focused on scientific writing and communication, one workshop focused on neurotech start-ups, and one workshop focused on skills and best practices for trainees and junior faculty in academia.

In terms of scientific writing and communication, the key take-aways I gathered from the workshops I attended were to:

- Know your audience.
- Explain concepts as simply as possible.
- Make things short and tell a story starting with the big picture.
- Make sure your 'ask' or primary goal is clearly stated.
- Revise, revise, revise!
- Convey your excitement about your work (because if you are not excited, who will be?!?).

For insights into the neurotech start-up realm, the panelists for this workshop emphasized the following points:

- Find a team you trust. Excellence in team building and teamwork is crucial.
- Be prepared to do everything on your own – but have a team to help you, including mentors.
- Don't get caught up in aiming for perfection.
- Identify key things to solve, and structure a dialogue from there.
- If you are specifically considering founding a neurotech company, aim to know the basics of negotiation, how to patent, and how to pitch your company early and embrace criticism.

The workshop on skills and best practices for trainees and junior faculty in academia was focused on establishing a lab. Key take-aways were to:

- Find motivated people.
- Leverage your networks to gain visibility.
- Do not be afraid to ask for help.
- Recognize that mentorship is one of the most important aspects of one's career (both receiving and giving).
- Identify the priorities for your lab – even going to the level of writing out short-

and long-term goals.
- Delegate tasks and remember that training personnel takes time.
- Start early to secure funding.
- Be aware of what your lab members need and adjust your mentoring style accordingly.
- Be prepared to handle problems in the lab.
- Remember that your people are your legacy.

Closing

In the end, this report only captures a select few of the enriching events and opportunities from SfN 2023. This was my first time attending SfN and seeing and experiencing all the amazing science and energy pulsating in the Walter E. Washington Convention Center every day of the conference left me inspired to continue gathering more knowledge, asking more questions, and conducting more research amongst our stellar neuroscience community.

Anna Hayes is a postdoctoral fellow at the University of Southern California. She wrote this meeting report as part of the Tianqiao and Chrissy Chen Institute Science Writers Fellowship, offered as a distinct SfN Trainee Professional Development Award in 2023, which aims to extend the conversation beyond the meeting with the hopes of sparking new ideas and collaborations.