A stage for neuroscience and art: the OHBM BrainArt SIG.

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ABSTRACT

Science and art have been intertwined for centuries, both embodying means for humans to represent, communicate and interpret our external and internal worlds. The collective effort to gather and organize knowledge about the brain blends well with a wide array of human creative activities, from visual and performing arts to interactive media. It thus comes as no surprise that the Organization for Human Brain Mapping has a Special Interest Group (SIG) dedicated to providing a platform for (neuro)sci-art: the BrainArt SIG.

Here, after properly introducing all the main characters, we follow the development of this captivating script: from its grassroots prelude within the Neuro Bureau to its recent online instantiations. In particular, we highlight our three latest Exhibitions (Ars Cerebri, 2019; Neurodiversity, 2020; BigData & me, 2021) and the associated Competitions, not forgetting the scientific visualization sessions that have contributed to the making of brainart a distinguishing feature of the OHBM annual meeting.

KEYWORDS: brainart, sciart, transdisciplinary, science communication, public outreach

Acknowledgements

The Authors would like to thank all the Artists and Neuroscientists that have dedicated time and effort to the SIG's initiatives over the years. V.B. is supported by a postdoctoral fellowship from the institut de valorisation des données. A.B. is supported by the Fonds de recherche du Québec Santé (FRQS) - Chercheur boursiers Junior 1 and the Fondation Courtois. D.L. is supported by a postdoctoral scholarship award from Union Neurosciences et Intelligence Artificielle - Québec and the Fondation Courtois.

Setting the Scene

SCENE:
Set pieces are strewn across the floor and hanging mid-air in disarray.
STAGE CENTRE:
OHBM, solemnly but with an air of happy positivity, is arranging the pieces into a pleasant order.

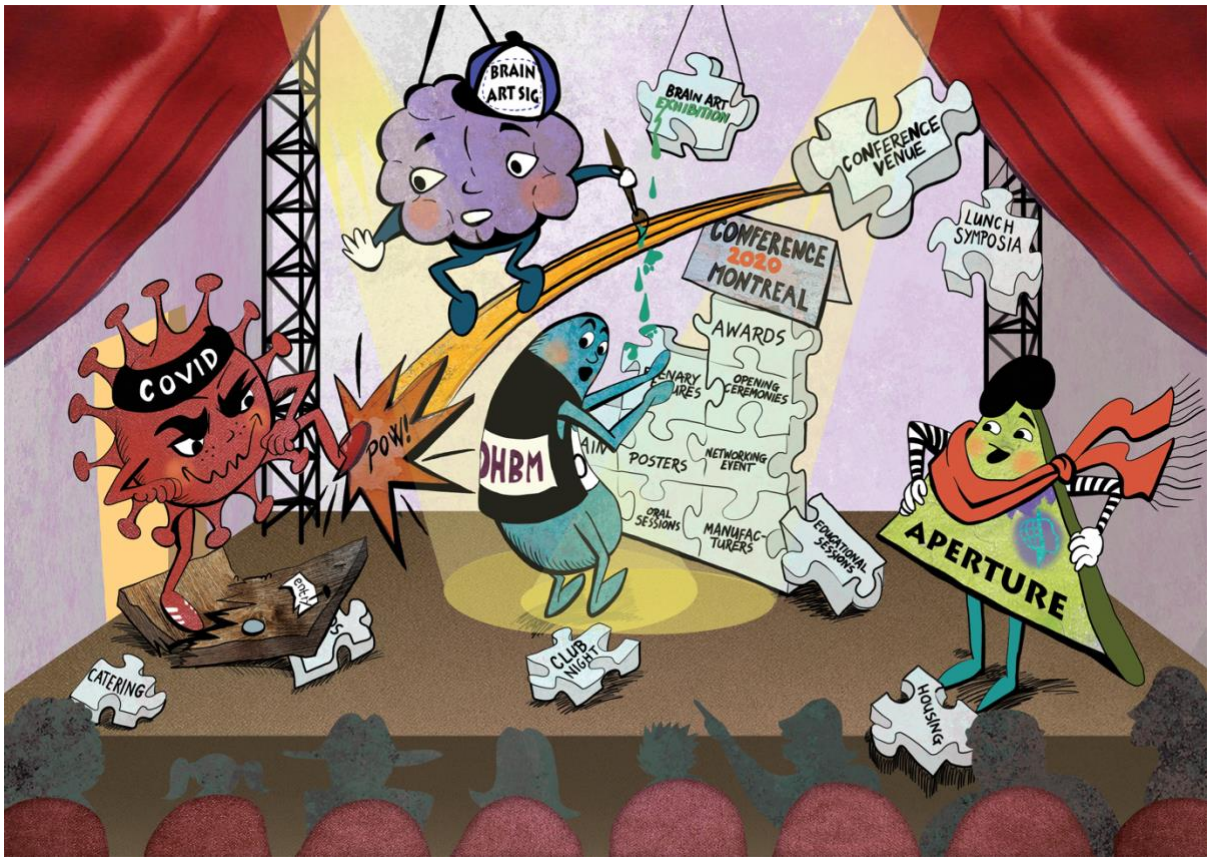

Figure 1. The stage and the characters. Artwork by Zsófia Morvay for OHBM BrainArt SIG.

Brain art events have been regular fixtures at the Organization for Human Brain Mapping (OHBM) annual meetings since 2010. Born as a grass-root collaborative initiative within the Neuro Bureau forum [1], the brain art movement at OHBM became an official Special Interest Group (SIG), known as the BrainArt SIG, in 2019. Thus, the 2019 annual meeting in Rome celebrated not only the 25th anniversary of OHBM, but also the coming of age of our BrainArt exhibitions and competitions [2].

ENTER STAGE LEFT:
COVID-19

As (un)luck would have it, the OHBM meeting planned for 2020 in Montreal fell during a period of our lives that we will not soon forget - both because of the hurdles of the COVID-19 pandemic and because of the versions of ourselves we might have become [3]. Perhaps we, and the world at large, will never be the same again. But it was *never-the-same-again* numerous times in the history of humanity - e.g., the development of the printing pressm, the eradication of smallpox or the discovery and mass production of penicillin (e.g., [4]). During and after major, global events, we amaze ourselves by the resilience, strength, and creativity of which we are capable. Some would even say that hardship

inspires artists to produce beautiful and moving works. We, at the BrainArt SIG, attempted to showcase this.

ENTER STAGE RIGHT:
Aperture

Scientific publishing and conferences are two areas where innovative (and perhaps necessity/adversity-driven) paradigm shifts are needed. Enormous resources are poured into the advancement of science [5,6]. Yet, the current standard for dissemination of scientific ideas/results is largely restricted to text and still images. As for scientific conferences, recent attempts to re-enact poster-halls in a virtual setting (due to COVID-19 travel restrictions) have revealed many limitations in terms of both accessibility and engagement.

Moreover, given the increasing drive to communicate scientific findings to the general public, intertwining science with art provides a powerful means to engage and dialogue with a diverse audience. With this in mind, the journal Aperture, created by OHBM members to enable diverse approaches to sharing and communicating neuroscience [7,8], is set to include scientific art (sciart) and potentially other creative works in their journal content. In fact, the BrainArt SIG's very first contribution to Aperture was running a contest to select their logo!

ENTER STAGE CEILING:
BrainArt SIG

Oh, the stage fright! Did we forget to properly introduce ourselves? We are the OHBM BrainArt SIG [9]. Our overarching mission is to promote a bidirectional exchange between neuroscience and the arts. Exemplifying how mutually beneficial the interaction between disciplines can be, we provide a stage for original, artistic approaches to scientific visualization, as well as room for unconventional and creative perspectives on human brain imaging. We are not entirely alone in this exciting endeavour. Similar efforts exist, such as: *Art of Neuroscience* by The Netherlands Institute of Neuroscience [10], *The Arts and the Brain* by BrainFacts.org [11], the Society for Neuroscience (SfN) [12], and the Brain Project Create A Brain [13].

Although scientific publishing and conferences are often devoid of art aside from the visualizations and illustrations of the accompanying figures, channelling science through art can be educational, motivating and inspirational to scientists and laypersons alike. For example, a pioneer of the field, Nobel Prize winner, neuroscientist, and histologist Santiago Ramón y Cajal created detailed brain cell illustrations, still in use to this day in educational settings [14], that inspired others to create similar works of art [15]. Neurologist and novelist Oliver Sacks wrote moving, best-selling stories about his patients' experiences [16], with some being adapted for performance art, such as theater, film, and dance (e.g.,[17]). Groundbreaking work by primatologist and anthropologist, Jane Goodall, was brought to the world's attention by an amazing filmography work that showed animal interactions not imaginable at the time. Lennart Nilsson, a photographer and scientist, produced ground-breaking photographs of microscopic life and beyond, primarily seeking to *"make the invisible visible"* [18], thereby inspiring others to document science in innovative ways [19]. Rosalind Franklin's famous X-ray photograph of the DNA was a great and cross disciplinary step in scientific history. In fact, this photograph inspired other art forms like a play by Anna Ziegler in 2010 [20]. We could go on and on but let's close with Shama Rahman: a scientist, a neuro-philosopher, a composer, and a singer-sitarist: the first sitar player to perform at the Antarctic Biennale and the first artist-in-residence for the Mi.Mu wearable gloves company [21].

To bring the brain art spirit to the OHBM community, the BrainArt SIG holds two main events each year during the OHBM annual meeting: a BrainArt Exhibition and a BrainArt Competition. The Exhibition invites established artists (and fellow scientists with artistic alter-egos) to showcase their

works. Each year, an overarching theme is chosen that is timely and relevant for our community, such as the *notion of self* in 2012 [22], different *levels of thought and scales* in 2017 [23], or *transmodal dynamics* in 2019 - our first exhibit officially as a SIG in Rome. In fact, the 2019 Rome exhibit, Ars Cerebri, brought forth interactive (e.g., real time performances) and multimodal (from poetries to audio-visual contributions) fruits of creativity that stems from, or is inspired by, neuroscientific research [24].

The Competition, open to OHBM members and the global community beyond, garners numerous submissions every year. It makes for a challenging job for our judges, OHBM members who appreciate the arts and recognize the additional dimension it adds to our society. The Competition award categories are often tailored on the general theme. For instance, in Rome, inspired by the Muses, we had five awards: Calliope:1D (i.e., short texts with or without accompanying images), Erato:2D (i.e., drawings, photos, paintings), Clio:3D (i.e., sculptures and installations), Terpsichore: real-time performances (e.g., singing, dancing, live sketching), and Melpomene: the results of failed attempts, bugs, or artifacts [Fig 2].

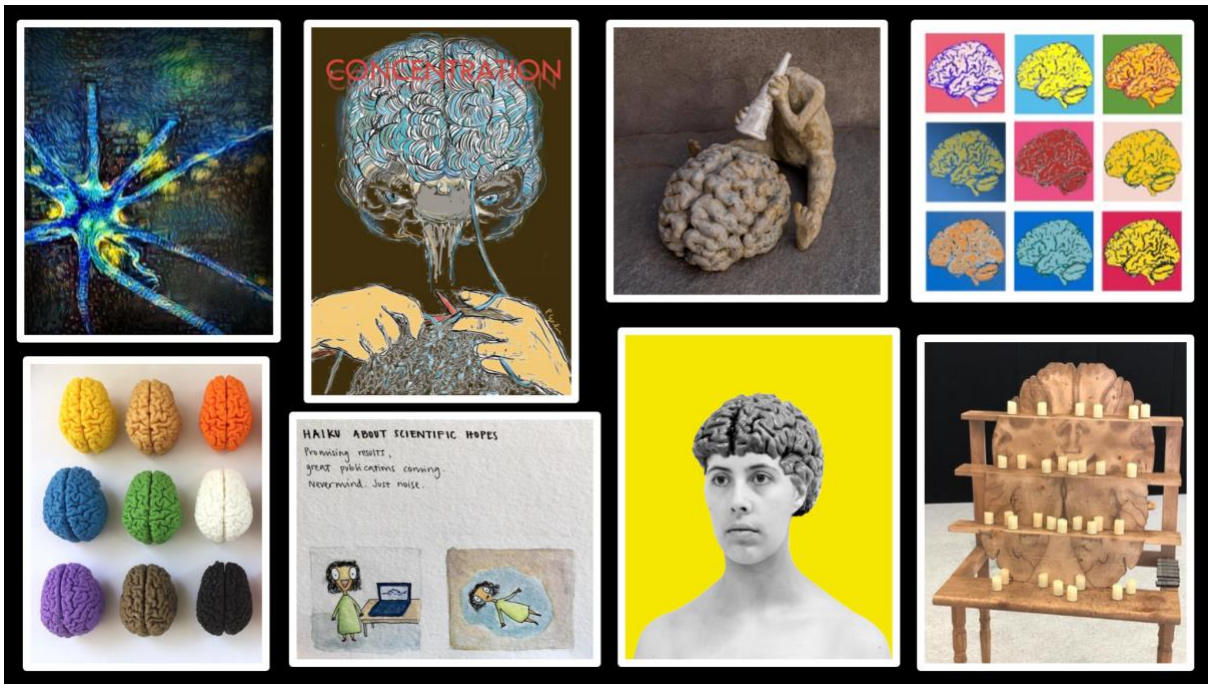

Figure 2. Miscellaneous collections of pieces from the 2019 Exhibition and Competition. From top left to bottom right: Starry Neuron by Lingyan Wang; Concentration by Patrizia Garberi; Inseparability: self-decapitation in the name of science by Catalina Fabar; A portrait of the brain by Cheng Wang; Name the brain by Malin Bjornsdotter; Haiku about scientific hopes by Catalina Fabar & Martin Irani; Self-portrait by Vania Panes Lundmark; Devotional by Celesti Kozub.

Prologue: bull's-eye on the BrainArt SIG

Now that the scene is set and the main characters properly introduced, let us dive into the plot. Overall, our aims are to (1) encourage artistic approaches and perspectives to understanding brain structure and function in health and disease, (2) facilitate the development of novel approaches for the visualization of scientific data, and (3) provide a model of interaction between disciplines while enhancing the outreach of OHBM.

Examples of our first aim include the "*Dream Sessions"* and "*Mandala Flow State"* projects. The *Dream Sessions* project is an art and neuroscience initiative that seeks to confront the subjective perception of dreams with an objective, quantitative analysis through EEG recordings [25]. The project was undertaken by professional artist Nathalie Regard and neuroscientists Roberto Toro and

Guillaume Dumas. Julia Scott's *Mandala Flow State* video described a virtual reality neurofeedback platform, showcasing the potential of cross-disciplinary collaborations between visual art, meditation practice, and electrophysiological measures [26].

Our second aim is highlighted by our collaboration with the OHBM Open Science (OS) SIG during the OHBM Annual Hackathon event. For this event, the BrainArt SIG organizes the "*Brain Visualization*" session. The overall goal of the session is not only to provide instruction on brain visualization, but to make brain visualizations novel, creative, aesthetic and fun for the community [27]. A beautiful visualization is not just an aesthetically appealing graph, chart, or coloured brain. Effective visualizations are essential to organize data, display results, and communicate information, as well as to change the way we perceive the world [28].

The BrainArt SIG's efforts to reach individuals and groups beyond the OHBM community are multifaceted. First and foremost, we invite professional artists whose work we admire to our annual exhibition, providing a platform for them to share their talents. Overall, we strive to facilitate dissemination of brain art to individuals who would not otherwise have direct contact with this form of communication and thinking. For example, we actively collaborate with the OHBM Diversity & Inclusivity Committee on certain children-friendly activities. In 2019 in Rome, we provided a drawing corner, adjacent to our main exhibit, where children in attendance could freely draw, paint, and craft. Similarly, during the 2020 virtual meeting, we facilitated access to online artistic resources that children and their families could enjoy at home [29-30]. During that difficult year, we also sought to provide those attending the Annual Meeting online ways to cope with pandemic-induced stress. To this end, we facilitated the creation of a guided meditation video, "*A Stillness of the Mind*", a collaboration between academic and video artist Dan Lloyd and meditation and yoga instructor Tanya Dawe [31], which was made available for all conference attendees. The images, frame by frame, are from a single subject rest state run, courtesy of the Human Connectome Project. Finally, in 2021, we held our first (of many) *Fireside Chat* sessions with both the artists and neuroscientists involved in our annual exhibit in attendance - where we discussed topics like how science inspires art (and vice versa), brain art and our sense of self, and how cutting-edge scientific research in its infancy may well read like a science fiction novel [32].

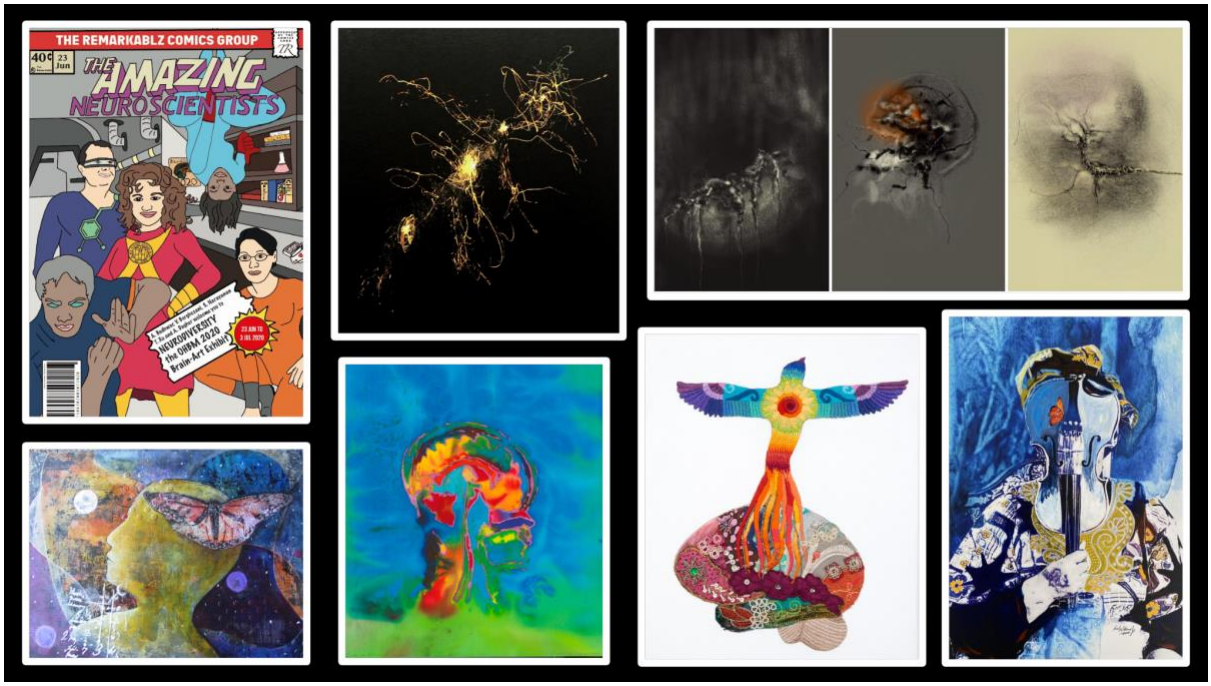

Figure 3. Miscellaneous collections of pieces from the 2020 Exhibition. From top left to bottom right: BrainArt SIG by Katy Alexander; Neural Communication No 35 by Richard Bright; Anxiety drawings by Liz Atkin; Searching by Urmila Das; Self-portrait by Elizabeth Jameson; Rising Phoenix by Laura Bundesen; Uplifting spirits #6 by Kunle Adewal.

Act 1: Neurodiversity

In 2020, the BrainArt SIG chose to focus on diversity, and specifically on *neurodiversity* [33]. Here, it should be noted that OHBM officially recognized the value of actively promoting and fostering diversity within its membership in 2016, thereby establishing the Diversity and Inclusivity Committee (DIC)[34]. Since then, the DIC has tirelessly worked to initiate and establish positive changes on the topics of diversity, equity, and inclusion (DEI) [35]. Drawing inspiration from these efforts, the BrainArt SIG developed their exhibit *"Neurodiversity"* along three axes [Fig 3].

First, we focused on promoting groups traditionally underrepresented in science, technology, engineering, and mathematics (STEM) fields, and neuroscience in particular. Second, we strived to highlight artwork by neurodiverse populations, for whom art can provide a means of communication, therapy, solace, or pleasure. Finally, we celebrated the geographical, ethnic, and cultural diversity of the OHBM community. As examples of Axis 1, we highlight the works of two featured artists, Katy Alexander and Kunle Adewal. Alexander's project "*The Remarkablz"* [36] not only illustrates how science superpowers can be found in the most unexpected and unconventional settings, but also focuses on increasing the diversity of scientist role models for children [37]. Adewal, an artist and development practitioner from Nigeria [38], aims at changing the narrative surrounding aging and dementia via his series of artworks in *"Uplifting Spirits"* [39]. In Axis 2, neurodiverse populations were represented by many artists, among whom Liz Atkin, a London-based visual artist with compulsive skin picking disorder, contributed a video recording and a collection of her recent works from the series of drawings "*#CompulsiveCharcoal"* [40], and Elizabeth Jameson, a mixed media artist with multiple sclerosis, also provided pieces from her collection inspired by her brain scans [41]. Axis 3 highlighted artworks in the Competition category *"Neurodiversity & Hope"* and are described below.

The 2020 Competition received 11 submissions from the OHBM community and beyond to celebrate diverse geographical, ethnic, and cultural richness [Fig 4]. These submissions include still images, animation, 3D printed brain outlines and paintings from children and a person living with Alzheimer's disease. Moreover, besides the brain art submissions for the "neurodiversity & hope" category, we also received a total of 74 original works including paintings, digital images, sculptures, and videos across 3 other categories: 2D images (N=55), 3D installations (N=14), and failed attempts (N=5) [42].

At the 2020 OHBM Hackathon *Brain Visualization* session, we hosted three talks [43]. Leonardo Iaccarino from the University of California, San Francisco, introduced basic strategies and principles to generate pleasing, yet informative and statistically correct figures. Using concrete examples from his research, Iaccarino walked the audience through the four-dimensional space delimited by *complexity vs. simplicity, partiality vs. completeness*, highlighting that reaching the optimal corner requires time and commitment. Reinder Vos de Wael from McGill University presented a recently developed toolbox (i.e., BrainSpace) for calculating the gradient of the brain connectome and visualizing the cortical surface [44]. Qawi Telesford from Nathan Kline Institute had a hands-on tutorial about analyzing the networks and visualizing the layout of the graphs using a state-of-the-art graph analysis tool Gephi [45]. Given the success of this first edition, visualization-dedicated talks, tutorials, and live Q&A have become a core element of the collaboration between BrainArt and OS SIGs.

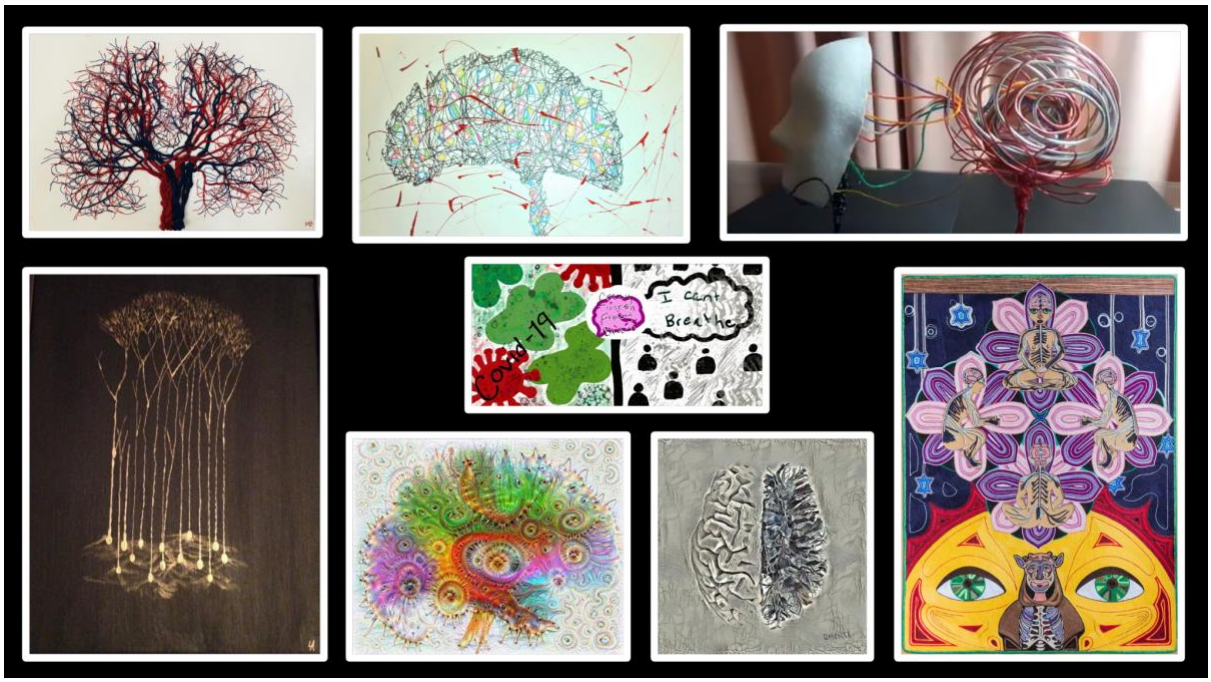

Figure 4. Miscellaneous collections of pieces from the 2020 Competition. From top left to bottom right: The V Tree by Matthew Budde; Ordering Chaos by Mitzi Marquez; Blooming Brain by Jean Lee; Crazy time, crazy brain by Anaiah Calhoun; The golden Arbor by Lizbeth Ayoub; Brain Eyes by Jean-Francois Mangin; Cerebral lithograph by David Moreno; Empathetic person by Roberto Emmanuele Mercadillo.

Act 2: Big Data & Me

At the 2021 OHBM Annual Meeting, the BrainArt *Exhibition* and *Competition* focused on the theme of "*Big Data and Me"*, a topic which resonates with the global community, affecting the daily lives of billions. In an age where large corporations, small businesses, and even our devices constantly collect and analyse vast amounts of data about us and our peers, the questions that relate *Big Data and Me* are intertwined. In addition, the last decade has seen the blossoming of large-scale neuroscience studies (e.g., Human Connectome Project in the US, the UK Biobank, the Longitudinal Aging Study in India), currently queried for insight into the functioning of the brain in health and disease. Therefore, the 2021 events featured artworks that examine the process or critique the idea of using population data to aid or describe the individual. What can we learn about the individual from large-scale data? How is an individual affected by the group they inherently belong to, or conversely, how does group identity change by the inclusion of certain individuals?

Accordingly, the Exhibition had two focal points [46, and Fig 5]: on one hand, inclusivity, diversity, and representation of populations with the lens of the interactions between the two extremes: the individual and the group; on the other hand, the exploration of personal suffering of individuals affected by a brain illness, dedicated to the artistic interpretations of hope and recovery, as well as the popularization of scientific understandings. Examples of the first axis are Rachel Scott and Batool Rizvi's colorful pieces that remind us how advances in our understanding of brain-behavior relationships will come from more diverse and inclusive samples, appreciating racial, ethnic, and cultural variations within human experiences. For the second axis, we explore the world of traditional chinese medicine thanks to Trina Lion and learn to appreciate both the scientific and subjective experiences behind multiple sclerosis and synesthesia thanks to the works of Alicia Lefebvre and Clara Soto, respectively.

For the 2021 Competition, we accepted submissions for 5 award categories: Big Data & Me (focusing on the main theme of the year), Beautiful Mistake (anything resulting from an artifact, bug, or failed attempt), Pictures to Prose (poems or short stories) and Still Images, Videos & Animations

[47, and Fig 6]. We received a total of 79 submissions and, as usual, it was not easy for our judges to choose the winners! Oh, and let's not forget that we also helped our newly minted SIG, the OHBM Sustainability and Environment Action SIG, select their new logo [48].

In keeping with our commitment to open science, together with our productive exchanges with the OS-SIG, we (a) established a special award category for our Competition (rewarding the output of hacking attempts) and (b) hosted a tri-partite visualization session [49]. Sofie Valk guided us through the steps required to organize a scientific figure so that it tells a story - *"your data's story!"*. Elvisha Dhamala helped us choose the right tool to visualize network connectivity, comparing the pros and cons of various approaches. Finally, Yufang Yang showed us that it is possible to capture in one single figure something as dynamic, broad, and all-encompassing as the Brainhack community [50].

Figure 5. Miscellaneous collections of pieces from the 2021 Exhibition. Clockwise from top left: Synesthesia by Clara Sato; Brain by Zsofia Morvay; Star brain by Batool Rizvi; Healing is a process by Trina Lion; NeuroDataFlow #9 by Richard Bright; What Thoughts in Her Head by Rachel Scott; Multiple sclerosis with electronic neurons by Alicia Lefebvre; Passing Thoughts #13 by Susan Aldworth.

Outro

The future is bright! Motivated by how the brainart movement is gaining momentum and by the increasing awareness of our activities, we are compiling a busy roadmap to follow and milestones to reach. Although the last two years' online exhibitions threw several challenges in our way, in overcoming those hurdles, we established a solid foundation upon which we plan to grow the SIG further. Our main plan for the upcoming year is to increase our outreach: ramp up our social media presence, publish artists' interviews as blog posts on our new website and seek out further opportunities for the artists and their brain art [9].

Notwithstanding our new goals, we, the members of the BrainArt SIG, maintain our focus on providing a platform that serves both our fellow scientists who seek to channel their artistic aspirations as well as the public at large that yearns to absorb scientific ideas in a more accessible form. In this effort we welcome suggestions and volunteers from the entire OHBM community: let's do this together!

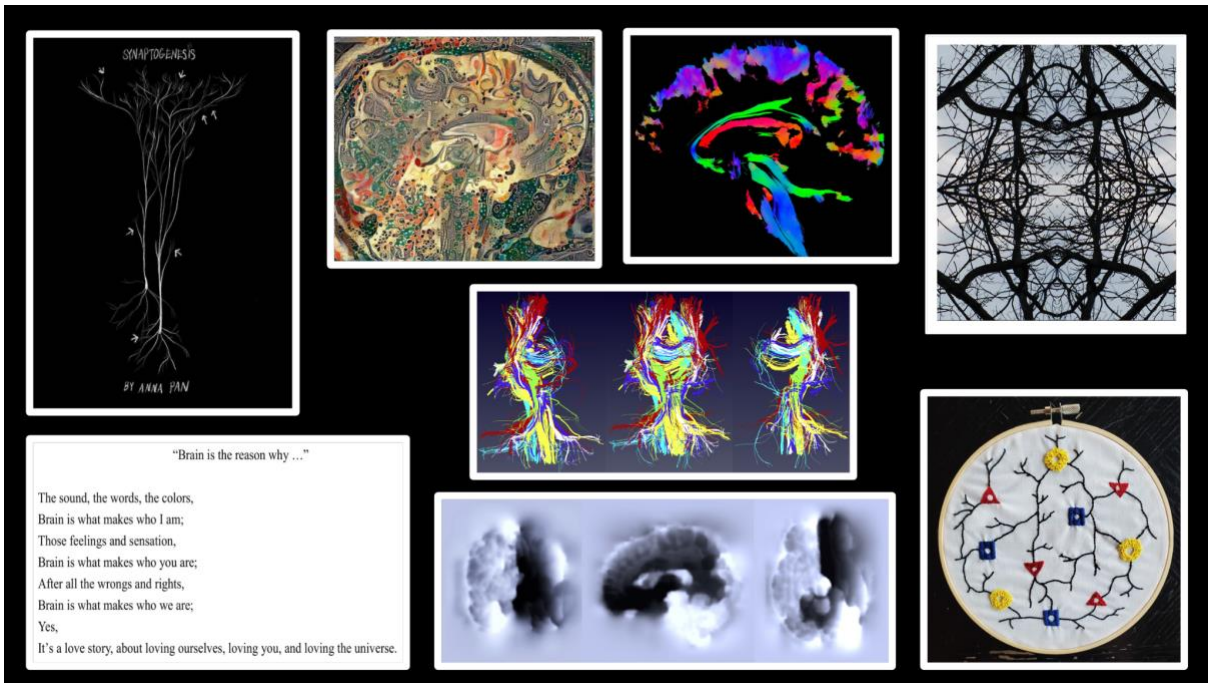

Figure 6. Miscellaneous collections of pieces from the 2021 Competition. From top left to bottom right: Synaptogenesis by Anna Pan; Brain with big data - Ceci n'est pas un cerveau by Nikhil Bhagwat; Machine Hallucination Tractography by Taylor R Kuhn; Complex Symmetry in Brain Circuitry by Rick Garner; Brain is the reason why by Jean Lee; Abstractography by Piyush Maiti; Cerebrocumulus by Michael Granovetter; Stitched by Michelle Sheena.

EXIT STAGE LEFT: COVID-19
Aperture, OHBM, and the BrainArt SIG stand, holding hands.
CURTAINS.

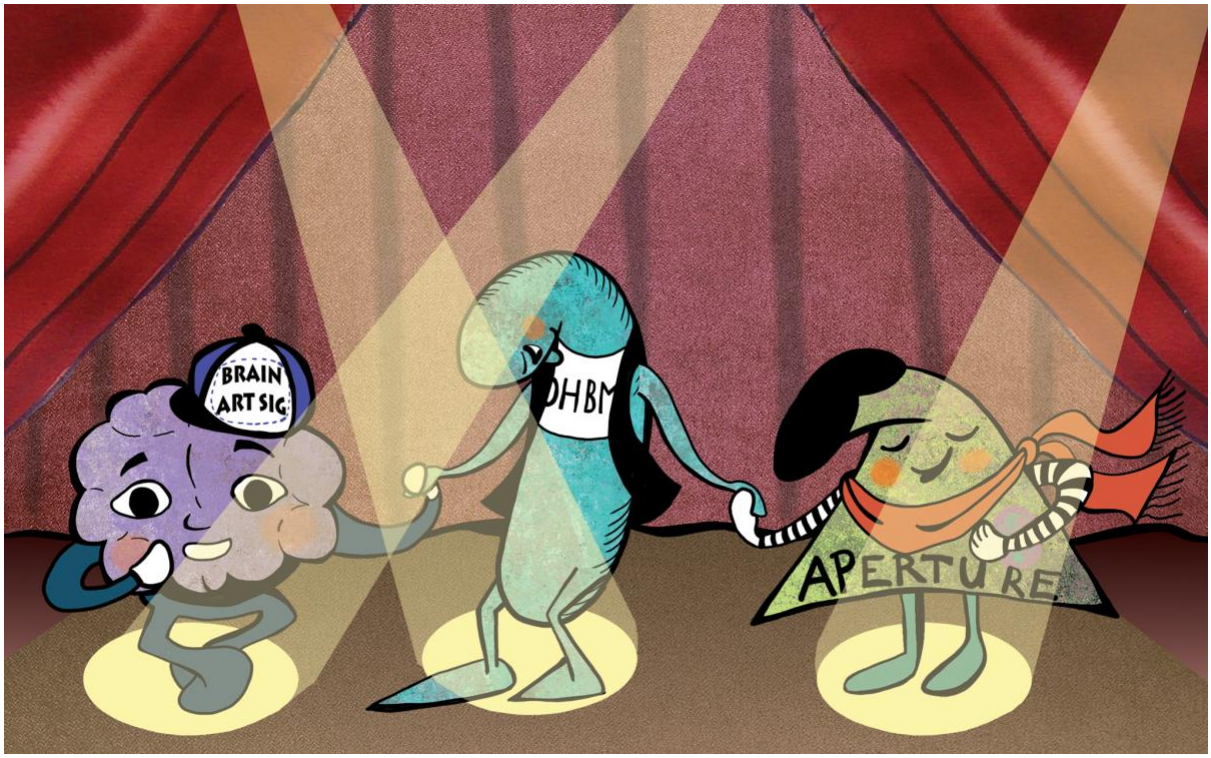

Figure 7. Applause. An encore? Definitely here to stay! Artwork by Zsófia Morvay for OHBM BrainArt SIG.

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