SEED 14 - Expanding the brain. Beyond the last frontier.

0. CONTACT DETAILS

0.1 Surname and first name

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0.3 Let us get to know you a little bit through your participation in websites, blogs, social networks, etc.

0.4 What is your background and in which institution do you work?

The contact author* has a degree in Psychology from the University of Seville, a PhD in Psychology from the University of Seville and is a Senior Lecturer in the Area of Psychobiology at the University of Seville. The rest of the team are Psychologists (2), Biologists (1) and Educational Psychologists (1). They are all members of the Neuroscience of Wellbeing research group.

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0.5 Gender: Male

0.6 Age range: 51 – 60 years old

1. ESSENTIAL DIMENSION

1.1 Seed name

Expanding the brain. Beyond the last frontier.

1.2 Seed summary

In recent decades, advances in the field of Neurotechnology, a branch of Neurosciences, have undergone a great development. The main objective of this discipline is aimed at understanding the brain as an interface that allows us to relate to the environment, but through the development of technologies that allow us to visualise its processes and even control, repair or improve its functions. A wide variety of recording techniques are available for the visualisation of brain function, some of them non-invasive such as electroencephalography (EEG), functional magnetic resonance imaging (fMRI) or functional near-infrared spectroscopy (fNIRS), and other invasive ones such as intracranial implantation of microelectrodes. The increasingly in-depth knowledge in the field of Neurosciences is allowing us in recent years, not only to read the signals of the brain, but also to modulate, modify or take advantage of their message. Thus, we now have different techniques that allow us to manipulate specific regions of the brain through electrical stimulation such as transcranial electrical stimulation (tES), transcranial magnetic stimulation (TMS) or deep brain stimulation (DBS); techniques that have proven their effectiveness in improving some cognitive functions and diseases. But, probably, the best indicator of the high degree of knowledge about the functioning of our nervous system is the development of Neurotechnologies such as brain-computer interfaces (BCIs). BCIs are advanced systems that allow direct communication between the human brain and an external device, such as a computer or prosthetic. This type of technology has emerged in recent decades as one of the most promising for the clinic and other fields. By picking up and processing the electrical signals emitted by neurons, BCIs offer an avenue for rehabilitating impaired behaviours, such as communication or movement, in people with severe disabilities. For example, through BCIs, people with paralysis or spinal cord injuries can control robotic devices or prosthetics just by thinking about the movement they want to perform. Also, in people with stroke or traumatic brain injury, BCIs can facilitate the reactivation of damaged brain areas and promote neuroplasticity, through brain stimulation exercises. Outside the field of the clinic, BCIs are notably revolutionising different sectors such as the entertainment industry (video games, allowing players to interact with the game environment only through their brain activity) or the security sector (biometric authentication through the use of unique brain patterns as a form of identification), and opens the door to the development of "metal communication" devices that allow thoughts to be sent, ideas or feelings through a digital neural network.

In short, the development of these interfaces is not only a technical challenge, but also a challenge in terms of understanding our nervous system or adapting computational systems to the complexities of the human brain. This approach expands the brain's ability to interact with the environment through the integration between the biological and the artificial. BCIs are changing the way we relate to machines, opening up new possibilities for the future of humanity, but at the same time opening up an intense debate about the ethical implications of these Neurotechnologies.

1.3 Metaphor. *Is there any metaphor that helps to explain this seed in a more intuitive way? An imaginative text can inspire as much as a poem.*

The metaphor would be based on La Mettrie's concept of "The Machine Man", who saw the human being as a complex machine in which mind and body operate according to mechanical principles, with the brain functioning as the central motor that generates electrical impulses that control both physical and mental functions. In this sense, brain-computer interfaces (BCIs) act as the technological bridge between this biological machine and the external world. Just as an orchestra conductor coordinates his musicians, the brain guides neural signals, while BCIs connect those impulses with technological devices, expanding the brain's capabilities to interact with the environment. Neurotechnology strengthens this connection by allowing the brain to not only regulate its internal functions, but also control external machines. In this way, the concept of "The Machine Man" becomes a contemporary representation of how BCIs integrate the biological with the artificial, blurring the boundaries between the human and the mechanical and creating a perfect symbiosis between body, mind and technology.

1.4 Keywords (separated by commas)

Neural networks, Brain signals, Neuroplasticity, Neurostimulation, Neurofeedback, Neural modulation, Brain-Computer Interface (BCI), Machine learning, Artificial Intelligence.

1.5 Scientific field (general)

Neuroscience

1.6 Scientific subfield (specific)

Neurotechnology

1.7 Resources (File)

Neurotechnology-related content includes images of brain activity obtained using techniques such as functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and computed tomography (CT), as well as representations of neural networks and advanced devices such as brain-computer interfaces (BCIs) and electroencephalograms (EEGs). Also included are demonstration videos and documentaries that explore the impact of neurotechnology on mental health and in the clinical setting. In addition, recordings of brain waves transformed into sounds are presented, as well as interviews with experts in the field. The content also includes scientific studies on BCIs, neuroplasticity and the interaction between the mind and technology, complemented by interactive graphics and visualisations that illustrate neural activity and its relationship to various body states.

1.8 Resources (Links)

https://theconversation.com/de-las-ondas-alfa-a-las-interfaces-cerebro-maquina-el-auge-de-las-neurotecnologias-201011

https://www.youtube.com/watch?v=6QcY7v9Kio4

https://www.youtube.com/watch?v=FR7X2s0yZTY

https://www.youtube.com/watch?v=jdynP-ZFDNA

2. ADDITIONAL DIMENSIONS

2.1 SYNAESTHETIC DIMENSION

This dimension seeks to associate certain sensory characteristics to the seed.

2.1.1 What colours does this seed suggest to you?

Electric blue could symbolise the precision and energy of brain impulses, while neon green would reflect neuroplasticity and the interaction between the brain and technology. Warm colours like orange and red would highlight brain activity, emotions, and certain body states. White and silver would suggest clarity and sophistication in brain-technology communication, while black would highlight the unknown of the brain. Finally, yellow would represent brain activation and the brain-technology connection.

2.1.2 What sounds or music does this seed inspire you?

The music would combine electronic and organic sounds to represent the interaction between the brain and technology. Effects and pulses that mimic neural activity would be used, along with classical instruments mixed with digital elements, creating a fusion between the human and the technological.

2.1.3 What aromas would you associate with this seed?

The scents could be combined to evoke a sensory experience that reflects the interplay between technology and the mind. Metallic and ozone scents would suggest the presence of neurotechnology devices, while fresh smells such as eucalyptus or sea air would symbolise mental clarity and cognitive stimulation.

2.1.4 What flavours does this seed evoke in you?

Metallic and salty flavours would represent the presence of technology, while spicy flavours, such as ginger and cardamom, would evoke the dynamism between brain-technology connections. The mild and creamy flavours could convey the organicity of the brain.

2.2 EMOTIONAL DIMENSION

This dimension seeks to explore the personal meaning of the seed.

2.2.1 What was your motivation to dedicate yourself to this field of research? What personal reasons lead you to suggest this seed?

Motivation is not one, but multifaceted. Several facets determine this research process. On the one hand, the mere fact of satisfying the craving for knowledge about the neurobiological bases of perception and action of humans, as adaptive complexes that we are. On the other hand, the humble interest in reducing human suffering. Leaving aside the sources of natural suffering such as accidents, diseases and other setbacks that occur throughout life, human beings, as a society and also as individuals, are determined, especially in recent times, to embrace unhealthy habits and get rid of healthy ones. In this society of vertigo and the immediate, more and more people suffer from disorders related to stress, depression, or anxiety and other conditions such as cardiovascular diseases, sleep disorders. In this context, the development of Neurotherapies, BCIs in this case, such as Neurofeedback based on the electroencephalographic signal, or Biofeedback based on heart rate variability, constitute effective contributions when it comes to mitigating all those typical symptoms of affective disorders. Finally, and obviously, the nature of this field of research is currently giving rise to a very intense debate from the ethical point of view that is unavoidable and necessary to stop any "scientific advance" that goes against the last stronghold of our individuality such as our own thinking. Contributing to this debate is a high motivation.

2.2.2 What metaphysical reflections does this seed provoke in you?

On another and more philosophical level, the development and use of BCIs and other Neurotechnologies that clearly go beyond the strictly natural, suppose the emergence of new intellectual challenges that can shed light on the knowledge of human nature. It is clear that, as we express with the title of the seed, with the development of these Neurotechnologies we are going "beyond the last frontier" of the natural. This fact gives rise to new and disturbing reflections on our own ontogenetic entity. What is man now? Who are we now? Those who are ceasing to be, who were, or the new expanded reality we are beginning to be? At the moment, from a biological, genetic point of view, we are still the same species. But we are, for the first time, at a moment in the history of life in which a natural species is generating an artificial species. Is it the beginning of the end of Evolution by Natural Selection that will give way to Evolution by Artificial Selection?

2.2.3 What ethical reflection or challenges would you associate with this seed?

Neurotechnology faces significant ethical challenges due to its ability to interact with the human brain, an organ central to our identity and autonomy. One of the main challenges is to protect the privacy of brain data, as these technologies can reveal sensitive information about thoughts and emotions, exposing it to potential misuse in advertising or social control. The World Health Organization (WHO) has highlighted the importance of protecting autonomy and ensuring informed consent, especially in experimental interventions, where users must fully understand the risks and benefits.

Another key challenge is equitable access, as the high cost of these technologies could limit their availability to certain sectors, exacerbating health inequalities. This is especially relevant in the case of clinical or therapeutic applications that promise cognitive enhancements or personalised treatments. In addition, the use of neurotechnology outside the medical field, such as in work or military contexts, poses risks of manipulation and loss of personal autonomy. Likewise, the possibility of altering brain activity could impact the perception of personal identity, questioning how we define our humanity and what boundaries we should set.

In a global context, the lack of solid regulatory frameworks that guide the development and ethical use of these technologies underscores the need to establish "neurorights" that protect mental privacy, promote equity, and ensure that scientific progress is focused on the common good, as advocated by the WHO in its call to prioritise the safe and ethical use of health technologies.

2.2.4 What aesthetic dimensions does this seed suggest to you?

This seed would suggest a dynamic and multisensory aesthetic, where the interaction between the human brain and machines would manifest itself through colours, lights and sounds that would correspond to neural activity, and brain-technology interaction.

2.3 PROCEDURAL DIMENSION

This dimension seeks to explore the scientific processes that are usually followed when investigating this topic.

2.3.1 Description of the research process

Neurotechnology research fuses neuroscience, engineering, and advanced technology to study, measure, and modify brain activity. The process begins with the review of previous studies and the formulation of hypotheses, followed by the use of techniques such as functional magnetic resonance imaging (fMRI), magnetoencephalography (MEG), electroencephalography (EEG), transcranial electrical stimulation (tES), transcranial magnetic stimulation (TMS) or deep brain stimulation (DBS) to observe brain processes in real time. Next, devices such as brain-computer interfaces are developed and tested in controlled environments to ensure their efficacy and safety, using animal or human models to monitor brain responses and physiological variables. Technological advances improve the accuracy of these devices, allowing for personalised therapies and new forms of human-computer interaction. This cycle of research, development and testing feeds back into practical and clinical findings, driving continuous improvement of medical and technological applications.

2.3.2 Research process diagram

2.3.3 Link to the descriptive video of the process

Magnetic resonance imaging (MRI)
Electroencephalography (EEG)
Bio/neurofeedback team
Brain-computer interfaces
Artificial neural network models
Virtual reality and augmented reality

2.3.4 What tools are typically used in this field of research? Whether instruments, technologies, hardware or software.

3. PERSONAL SUGGESTIONS

Since this seed proposes the symbiosis between the brain and the machine, visceral elements could be fused, such as biological tissues, images of brains and metallic, robotic, industrial, mechanical, synthetic elements.

4. INVOLVEMENT OF THE SCIENTIST ON THE CREATIVE TEAM

4.1 What role would you like to have in the process of co-creating the SciArt work?

Participate punctually in the conceptual discussion and co-creation of the work.