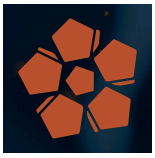

ART ^ NEUROSCIENCES

SEED 11 - The invisible choreographer and the silent cry of the cells

0. CONTACT DETAILS

0.1 Surname and first name:

Principal: García González, Daniel

Support: Gómez Cruz, Clara; Fernández de la Torre, Miguel

0.2 Contact e-mail address: danigarc@ing.uc3m.es

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

Some published articles about our work:

1. Scientific papers:

- https://doi.org/10.1002/adma.202312497 (main, technical)

- https://doi.org/10.1002/aisy.202400638(perspective on the field of mechanomedicine)

2. Divulgation articles:

- Article on the technology we have developed: https://www.elmundo.es/ciencia-y-salud/salud/2024/05/30/6650959ce9cf4a593b8b457b.html

- Video with informative talk at the event "El País con tu Futuro":

https://youtu.be/JIgKrlfjTK4?t=13085

- Another video, this one on the entrepreneurial side:

https://emprendedores.es/ideas-de-negocio/ideas-futuro-2/

3. More information about us:

- Group page: https://www.multibiostructures.com/

- Video interview national award:
https://www.youtube.com/watch?v=EOYlQYwAB6Q

- Description and participation in Academia Joven de España:

https://academiajoven.es/academicos/academicos-academicos/daniel-garcia-gonzalez/

4. Social Media:

- LinkedIn:

Daniel: https://www.linkedin.com/in/daniel-garcia-gonzalez-416821113/

Clara: https://www.linkedin.com/in/clara-gomez-cruz/

Miguel:
https://www.linkedin.com/in/miguel-fern%C3%A1ndez-de-la-torre-062466102/

- X: @DanielGMadrid11 (Daniel); @ClaraGomezCruz_ (Clara)

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

García González, Daniel: Industrial Engineer (UC3M) and PhD from UC3M/ University of Oxford

Gómez Cruz, Clara: Biomedical Engineer, UC3M/Institut Pasteur PhD

Fernández de la Torre, Miguel: Neuroscientist, UAM PhD

0.5 Gender:

García González, Daniel: Male

Gómez Cruz, Clara: Female

Fernández de la Torre, Miguel: Male

0.6 Age range:

20 - 30 años (Clara)

31 - 40 años (Daniel y Miguel)

1. ESSENTIAL DIMENSION

1.1 Seed name

The invisible choreographer and the silent scream of the cells.

Explanation: the *invisible choreographer* is the magnetic field, which is not seen and is capable of penetrating biological tissues. And *the silent scream of cells* refers to the electrical responses of cells and the breakdown of communication between them before a magneto-mechanical performance (see metaphors below).

1.2 Seed summary

The project is motivated by the need to know the role of mechanical variables on biological processes, such as the rigidity of the cellular environment or forces transmitted from it to the biological system. To address the challenges arising from the project, we have set up a highly multidisciplinary team, with the participation of researchers with very different profiles: biologists, neuroscientists, chemical, industrial and biomedical engineers, among others.

In this project we have created a platform to reproduce pathologies such as the effects of a brain impact on neurons or astrocytes, the process of skin scarring or the progression of tumours, and to facilitate the development of new drugs and therapies. To do this, we use intelligent and biocompatible materials that respond mechanically to magnetic stimuli, so that we can simulate the forces that take place in these pathologies on cellular systems. All this has been possible through

the combination of physical theories, computational models, material synthesis and developments of technological platforms, such as a 4D printer.

This technology has been used to understand structural, mechanical and functional changes in brain cells (astrocytes) reproducing inflammation in the brain or a blow to the head. With this we understand how the mechanical forces on these cells change their structure and impact the process of transmitting electrical signals between them, which alters their communication and translates into cognitive failures, memory loss, etc. In addition, it is worth highlighting the translational nature of the research, which is being implemented in external national and international laboratories. In this sense, we have founded the spin-off 60Nd S.L., whose objective is to generate new methods to reduce animal experimentation and optimize the development of medical treatments, including biomechanical and mechanobiological considerations in them.

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.*

Below, we explain three metaphors that help to understand the mechanical effects on cellular processes:

1. We imagine cells as "little people" that perform their functions on a mechanical substrate (what for us would be the floor, or the surface of the table on which we work). The properties of this substrate determine how optimal our processes will be. For example, when we run on the beach, it costs us much more than when we do it on asphalt, due to the rigidity and composition of the substrate. Something similar happens to cells, and they are able to migrate and perform their functions more optimally under certain mechanical conditions.

2. The signals that run through our body when we perform any action, for example, grasping an object, are "electrical" signals that go from our brain to our hand in this case. We can imagine a large electrical network that supports these communication processes. In this sense, if we mechanically damage a cable, the electrical signal will not be able to propagate optimally, even if the signal is lost. In our body, when we mechanically damage the cells and support of the nervous system, something similar happens worsening the communication process.

3. In our in vitro tests where we expose a set of astrocytes (brain cells) to mechanical loads simulating a blow to the head, we see an alteration in the dynamics of calcium (electrical signals) where they show overstimulation until they reach a saturation point where they are no longer able to communicate. This is because we damage part of the mechanical structure of cells (their skeleton). We could understand this process as cells that talk to each other but, in the face of external actions, begin to "scream" for help. These overexertions damage their vocal cords (mechanical damage) until they lose the ability to communicate, leading to chaos (which would be cognitive deficits, loss of speech, etc.).

1.4 Keywords (separated by commas)

Smart materials, mechanobiology, mechanomedicine, traumatic brain injury, brain mechanics, magnetomechanics, cytoskeleton, Piezo1, mechanotransduction, calcium dynamics.

1.5 Scientific field (general)

Multifunctional materials, mechanobiology

1.6 Scientific subfield (specific)

Vascular neurosurgery.

1.7 Resources (File)

Attached are, apart from the links indicated above (papers are in open Access at the links):

1. Video showing calcium dynamics in astrocytes exposed to mechanical loads.
2. Video showing one of our magneto-active materials that respond mechanically to magnetic stimuli.
3. Video of one of the actuation systems.
4. There are several talks and interviews in the links provided in point 0.3.

1.8 Resources (Links)

Some published articles about our work:

1. Scientific papers:

- https://doi.org/10.1002/adma.202312497 (main, technical)

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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?

Daniel: blue, green, and red (these are the colors we've been working with to dye and visualize cellular responses).

Clara: pale pink (this is the color of the notebook I used to take notes during the project)

Miguel: silver and very dark blue (the cells evoke stars in the sky firing signals)

2.1.2 What sounds or music does this seed inspire you?

Daniel: La consagración de la primavera de Ígor Stravinski (porque rompía los antiguos esquemas musicales y los deformaba, que es lo que hacemos nosotros con las células para alterar sus respuestas funcionales)

Clara: música clásica con cambios de ritmos muy bruscos que acaban en silencio (porque nuestras células se quedan calladas tras el impacto mecánico después de respuestas caóticas)

Miguel: Banda sonora Interstellar (misma razón que en punto 2.1.1)

2.1.3 What aromas would you associate with this seed?

Smell of the sea (due to the salty smell of the growing medium)

Geosmin (wet soil)

2.1.4 What flavours does this seed evoke in you?

Padrón peppers (because during the rehearsals we were not sure what was going to happen)

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?

Our main motivation was to understand the mechanisms by which mechanics actively influence biological processes, such as wound healing or the response of our nervous system to a blow to the head, generating a series of changes at the cellular and tissue level that affect the functioning of our organs and systems. This seed is key to unraveling these complex interactions and contributing to the development of more effective treatments and therapies.

2.2.2 What metaphysical reflections does this seed provoke in you?

- Influence of the social environment on our behaviors, and how we communicate with our own environment and other people.

- Stellar interactions in the substrate of space, which is subjected to continuous expansion that induces changes in the relative positions of celestial bodies.

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

Sound and visual explosion of color.

2.2.4 What aesthetic dimensions does this seed suggest to you?

We are talking about vascular pathology, with heartbeat, with movement, with circulation. It suggests a dynamic work, which reflects the circulation of blood inside the vascular malformation.

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

See video below with motivation and procedure.

2.3.2 Research process diagram

Video is provided.

2.3.3 Link to the descriptive video of the process

Link to video with a talk where the procedure is explained:

https://youtu.be/TJuF1_Jejks?t=10698

Relevant part for this project: from 3:07:25 to 3:13:53.

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

Materials: polymers, magnetic particles, cells, reagents, etc.

Software: physical models to guide magneto-mechanical testing, and signal processing software.

Equipment: NeoMag (device developed during the project), microscopes, magnetic and mechanical characterization equipment.

3. PERSONAL SUGGESTIONS

We have two independent proposals as suggestions:

1. The proposal consists of creating a work of art inspired by cellular communication and the influence of the mechanical environment on these dynamics, taking as a reference the simile of works where the author poured paint to avoid socioeconomic or cultural influences (e.g., Morris Louis or Jackson Pollock). In this case, the spontaneous signals of the cultured cells (astrocytes and neurons) on intelligent magnetic materials would represent that initial spontaneity, but when external mechanical stimuli are applied, these dynamics change radically, as happens in a blow to the head. Microscopic black-and-white images would be used to capture these signals, transforming them into a canvas where vibrant colors differentiate regions and visually reflect the induced "warping" and chaos. Thus, a parallel is created between the pure and uncontrolled art of the original painting and the biological spontaneity, both inevitably altered by the external forces that shape them.

2. The cells of our brain behave like shooting stars in an internal firmament, firing electrical signals that illuminate the interior of our mind. Mechanical forces act as the trigger for this celestial spectacle, activating or silencing the activity of these stars, and intelligent materials are capable of becoming an artificial firmament, a flexible and disturbing canvas, capable of expanding or compacting in response to mechanics. It is in that movement almost where these shooting stars are able to dance, tracing paths through the universe that we carry inside our minds.

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

4.2 If you want to participate as an artist, what creative means would you like to use?

N/A