

Original Research Article

Collaboration between scientists and artists: a research methodological approach to advance science

José de la Fuente^{1,2*}, Sara Artigas-Jerónimo¹, Juan J. Pastor Comín³

Abstract

¹SaBio. Instituto de Investigación en Recursos Cinegéticos IREC-CSIC-UCLM-JCCM, Ronda de Toledo s/n, 13005 Ciudad Real, Spain.

²Department of Veterinary Pathobiology, Center for Veterinary Health Sciences, Oklahoma State University, Stillwater, OK 74078, USA.

³Centro de Investigación y Documentación Musical CIDoM-UCLM-CSIC, Facultad de Educación de Ciudad Real, Ronda Calatrava 3, 13071 Ciudad Real, Spain.

*Corresponding Author's Email:
jose_dela Fuente@yahoo.com /
josedejesus.fuente@uclm.es
Phone: +34 926295450. (J.F.)

The changing complexity of scientific systems throughout evolution involves conserved molecules that function in the regulation of biological processes. While scientists have gained molecular information by the global identification of genes and molecules across species, as well as discovering specific molecular interactions, the big challenge now is to develop dynamic ways to analyze this massive amount of data and formulate key questions on how these molecules/interactions affect biological functions, such as development and immunity. These discoveries will be fundamental for the identification of key groups of molecules or interactomes which can be targeted for applications such as vaccines and therapeutics. Toward the goal of broadening of our perspectives we developed a collaboration with selected artists, both visual and musical. While scientist-artist collaborations have been reported previously, these recent studies were based on our research on the characterization of the highly conserved proteins Akirin/Subolesin. Through collaborations with scientists and artists from multiple disciplines we developed new methodological approaches for accelerating the discovery process which directed us to pursue key questions that otherwise may have been overlooked. This innovative methodology may likely be applicable to other areas and represent a dynamic approach for the advancement of science.

Keywords: Innovation, Method, Music, Science, Visual art

INTRODUCTION

Possibilities of combining science and art in mixed methods research

Innovation is fundamental to face scientific challenges. Science requires reasoning strategies that are effective for accomplishing epistemic goals based on empirical evidences to accept or withdraw a hypothesis, and practical goals focused on the social impact of research (Thagard, 2004). During the investigation process, it is possible that decisions on experimental design and interpretation of results are affected by concepts that frequently get lost during research. In this context, mixed methods research contributes to reduce the risks posed by these limitations. Herein, we proposed a collaborative

method research by combining science and art perspectives.

Science inspires artists in multiple forms, and art inspires scientists by promoting the exploration of new questions or new methodological approaches (Guardiola and Baños, 2003; Keats, 2018; de la Fuente *et al.*, 2018; Longo and Longo, 2020; Artigas-Jerónimo *et al.*, 2020). These facts support the proposal that art may have biological basis (Schulkin and Raglan, 2014; Veis, 2017). For scientists, art stimulates the power of curiosity, which is frequently lost during research, and ask questions that are relevant for the investigation. Artistic and musical representations could translate into complex or unrecognized concepts and provide a way to better under-

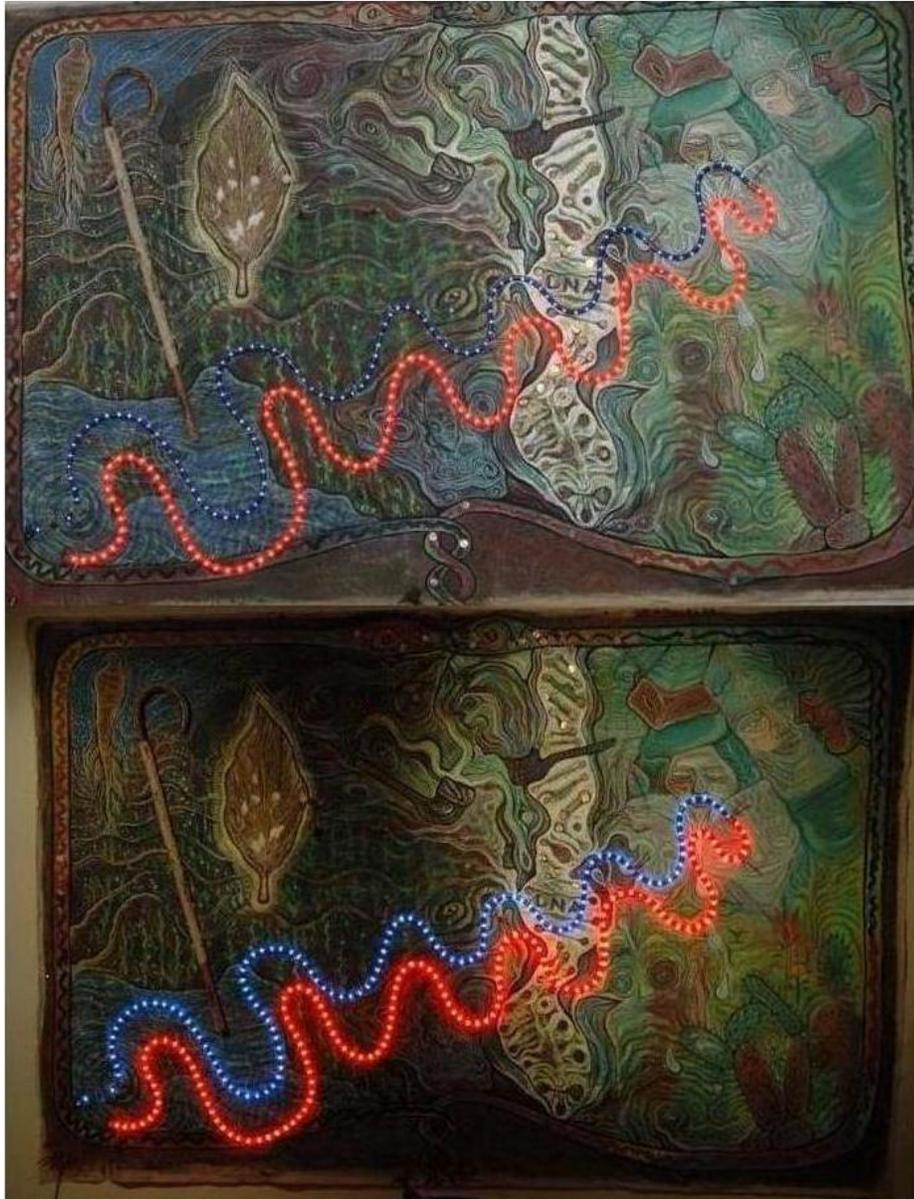


Figure 1. *Asclepius, Babalú and DNA like a wise snake (Asclepius, Babalú y el ADN como una serpiente sabia)* by Leandro Soto, acrylic, metal, wood, objects, paper, electronic wreath and dry herbs on screen, 2002, 149 x 227 cm (courtesy of the artist). In the lower panel the lights of the electronic wreath are switched on to better show this part of the piece.

stand and approach scientific challenges (Riego *et al.*, 1995; Eldred, 2016). The collaboration between science and art has been used for communication in different areas, including translation of social concerns about for example tick-borne diseases and ongoing coronavirus disease 2019 (COVID-19) addressed by scientists (de la Fuente *et al.*, 2015; 2020a). As recently reported, this process supports that science benefits when artists get involved in research (Stevens and O'Connor, 2017). Consequently, the collaboration between science and art is effective for accomplishing both epistemic and practical research goals.

How students perceive art

An informative approach to evaluate how art inspires scientists is the perception of students about this matter. For example, students ($n = 30$) of the course in “Molecular biology of the vector-host-pathogen interactions and vaccine development” of the university Master’s degree in Basic and applied research in game and wildlife, University of Castilla La Mancha, Spain (<https://www.irec.es/en/formacion/master/>) were exposed to the art piece represented in Figure 1 and asked to provide their perception of the questions inspired by this piece.

The students provided a diverse view on how they perceive scientific and cultural aspects inspired by this art piece, which could be summarized as:

- (a) Efficacy of research to advance knowledge to provide culture and intelligence.
- (b) The discovery and functional characterization of the DNA are the basis of all the knowledge of biological systems.
- (c) Studying the DNA is when we really start to know the world.
- (d) A research objective is the origin of a route, which begins its construction from a discovery (hypothesized or not).
- (e) The represented motifs have different connotations, from ethnic/tribal representations to edge, knowledge, evolution, lifecycle, adaptation and complementarity.
- (f) DNA is an essential ingredient of life, which determines the evolution and properties of the whole organism.
- (g) Representation of the Shaman culture.

Collaboration between science, art and music: a research methodological approach

Methods of arts-based research have been proposed as innovative methodological approaches particularly in social sciences (Cole and Knowles, 2008; Barone and Eisner, 2012; Chilton *et al.*, 2015; Leavy, 2020; Edwards *et al.*, 2017; Gerber and Myers-Coffman, 2017; Archibald and Gerber, 2018). In a recent proof-of-concept study, we advanced further the collaboration between science and art by providing a combined scientific and artistic multidisciplinary approach to address challenging questions in molecular biology (Artigas-Jerónimo *et al.*, 2020). In this research methodology, visual artists suggested the characterization of previously unexplored properties of the regulatory factors Akirin (also known as Subolesinin ticks) (Artigas-Jerónimo *et al.*, 2020). Additionally, the application of algorithms using musical ensembles advanced the representation of protein evolution and the characterization of protein-protein interactions (Artigas-Jerónimo *et al.*, 2020). The results of this methodology advanced research on the function of these proteins and support that the collaboration between scientists and artists from multiple disciplines accelerates the research process and increases the possibility of identifying and addressing scientific questions that otherwise may get lost in the investigation process. In addition, musical language provides new tools for objectives addressing protein evolution and function. Although applied to molecular biology in our study, this mixed methods research methodology could be applied to other areas of biomedical, physical, chemical and social sciences. This experimental approach has contributed

also to the communication and dissemination of scientific research (de la Fuente *et al.*, 2020b).

Scientists and artists working together: The proposal to advance science

Our proposal presented in this paper is to move from exchange of information used in our proof-of-concept study (Artigas-Jerónimo *et al.*, 2020) to interactions between scientists and artists for a more comprehensive and effective mixed methods research methodology for approaching scientific challenges and objectives (Figure 2). We propose that different visual and musical artists interact with various scientists involved in the project focusing on quantum vaccinomics in order to get access to diverse views of the same challenge-question-objective (de la Fuente, 2020). Quantum vaccinomics approaches are based on the proposal of immune protective epitopes as the immunological quantum to advance the design of more effective and safe vaccines (Artigas-Jerónimo *et al.*, 2020; de la Fuente *et al.*, 2020c). The different artistic communications are to be presented to all scientists involved in the project. Musical algorithms will also be applied to data analysis. The participation of students interested in the project is also encouraged.

For the implementation of the proposal, artists are invited based on their trajectory and conceptual art content and interest in science. The artists creating the responsive art will include those involved in plastic arts such as painting, sculpture, film and photography and musicians. They will use painting/drawing and musical scores as mediums of communication. The artists will visit the laboratory to interact with scientists working on quantum vaccinomics for a period of 3 to 4 weeks. Then, artists present their contributions inspired by the challenges, questions and objectives addressed in the project. Artist's contributions will include pieces of visual art (i.e. paintings and drawings) and a brief description of its content according to artist's perspective. Scientists then use artist's contributions to find an inspiration for their research and describe the new hypotheses and directions inspired by these pieces. Scientists and musical artists also collaborate for data analysis using known and newly developed musical algorithms (Artigas-Jerónimo *et al.*, 2020). The results of the project should be presented in multiple ways including an exhibition with a catalog combining art pieces and scientific results, a concert and CD with the results of the musical algorithms and ensembles, and both scientific and communication type publications to present the results of the project to the scientific community and the general public. All these results will be posted on a website created for the project. These activities will be intended to target scientists, artists, students and the general public.



Figure 2. Proposed research methodological approach. Schematic representation of the interactions between scientists and artists for a more comprehensive and effective methodology to approach research challenges and objectives. Art pieces include at center: drawings for the collection *Tipos y costumbres de la Isla de Cuba* by Víctor Patricio de Landaluze Uriarte, pencil on paper, ca. 1870-1880, 19.3 x 14.8 cm, upper right: *Assembly* by Antonia Eiriz, Jagüey wooden sculpture, watch, watch making and metal pieces, ca. 1964, 50 x 20 x 17 cm. Courtesy KGJ Collection, Spain.

In this way the outcomes of the project include (a) artist's perception of science presented on their proposed

pieces, (b) scientist's perception of art and translation into new hypothesis and experiments, (c) development of new

tools based on musical algorithms, (d) new scientific results, (e) communication to the society of scientific challenges and the impact of the results, and (f) promoting the collaboration between science and art to advance research and its social implications. The project will advance science in general and quantum vaccinomics in particular by accelerating the discovery process and creating an environment combining challenge, collaboration, results and satisfaction.

CONCLUSION

The collaboration between scientists and artists from multiple disciplines using this new methodological approach will accelerate the identification and answer to key questions that otherwise may have been overlooked during research. The social communication of scientific challenges and the impact of the results will also advance research and its implications for the society. This innovative methodology may be applicable to multiple areas with global importance including infectious diseases and represents a dynamic approach for the advancement of science.

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