

## Protean Art in the Multiple Disciplinary Interaction between Artists and Scientists

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**Abstract:** The interaction and collaboration between artists and scientists contribute to innovative approaches to face scientific and social challenges. Protean art reflects like in biological systems the ability to change its nature, appearance, and behavior. Art is also protean in its role and significance for scientists. In this commentary, I reflect my experience on the implication of protean art manifestations in the interactions between art and science. This personal perspective uses visual art and musical algorithms to illustrate how these interactions impact on inspiration, collaboration, investigation, instrumentation, communication, and illustration. The application of protean art algorithms in science would contribute to multiple disciplinary research to advance in resolving complex problems with scientific and social impact.

**Keywords:** Science; Art; Music; Education; Protean; Collaboration; Communication

### 1. INTRODUCTION: PROTEAN ART AND COLLABORATION BETWEEN ART AND SCIENCE

To develop a complete mind: Study the science of art; Study the art of science.

Learn how to see. Realize that everything connects to everything else.

Leonardo da Vinci

Science requires innovative and reasoning strategies to achieve epistemic goals based on empirical evidence to accept or withdraw a hypothesis, and practical goals focused on research social impact [1, 2]. In scientific strategies, mixed methods research reduces the risks associated with experimental design and interpretation of results. In this context, the collaboration between art and science provides mixed methods contributing to innovative approaches to face scientific and social challenges [1, 3, 4].

It has been proposed that art may have biological basis [5, 6]. Protean art reflects like in biological systems the ability to change its nature, appearance, and behavior. Protean origin refers to “of or pertaining to” the Greek sea god Proteus, son of Oceanus and Tethys, who could change his form at will to assume different variable shapes (<https://www.etymonline.com/word/protean>). Accordingly, protean art manifestations could include both visual art and music. For scientists, visual art and musical representations could translate into complex or unrecognized concepts to better understand and approach scientific challenges in a multiple disciplinary form [1, 3, 7-10].

These evidences support that science benefits when visual and musical artists get involved in research [11, 12], which in my experience as disclosed in this commentary impacts on inspiration, collaboration, investigation, instrumentation, communication, and illustration.

### 2. EVOLUTION AND IMPACT OF INTERACTIONS BETWEEN PROTEAN ART AND SCIENCE

Since ancient times art has a role in communication (e.g., [13]). Animal-animal and human-animal interactions were represented in ancient cultures [Fig. 1A]. Another example representation of human-

animal interactions is the bee and spider representations in the stairs of knowledge at the 16<sup>th</sup> century Escuelas Mayores building in Salamanca, Spain [Fig. 1B]. Its iconography is inspired by 15<sup>th</sup> century Flemish engravings. The bee on the left sucks from a flower to make honey. The spider on the right sucks from the same flower to produce poison. It represents the struggle between the good (“florepulchronobili, apes mellacollignut”) and the bad (“ex hoc vermes frivoli forte hariunt”) [14]. These representations translated into scientific questions early in history as illustrated in the Journal Des Scavans, the first scientific journal published in Europe and crucial to the development of the scientific revolution[15] [Fig. 1C].



**Figure1.** Art representations evolved from communication to scientific implications. (A) Ancient cultural representations of animal-animal and human-animal interactions. Images correspond to Egyptian (ca. 200-year BC) and Nepali (17<sup>th</sup> century) monuments, a 3<sup>rd</sup> millennium BC Neolithic terracotta idol from Mediterranean Sea area, a 1200-1500-year BC Taino zoomorphic crocodile amulet in carved stone from the Greater Antilles, and African tribal monkey wooden mask.(B)Bee and spider in the stairs of knowledge at the 16<sup>th</sup> century Escuelas Mayores building in Salamanca, Spain. (C)Journal Des Scavans De L’an M.DC.LXXVI, par le Sieur G.P.A.D.C. - in Amsterdam, by Pierre le Grand, 1677. Book and Mediterranean, Greater Antilles and African pieces courtesy of KGJ Collection, Ciudad Real, Spain. Images and design by the author.

Personal experience on the implication of protean art manifestations in the interactions between art and science show how scientists and artists interact in multiple forms with impact on inspiration, collaboration, investigation, instrumentation, communication, and illustration[8, 16-33] [Fig. 2].

**Inspiration.** Art inspires scientists by raising research questions with experimental and social implications [19, 20].

**Collaboration.** Collaboration between both musicians and visual artists with scientists contributes to facing scientific challenges through novel qualitative and quantitative methods [8, 21, 22].

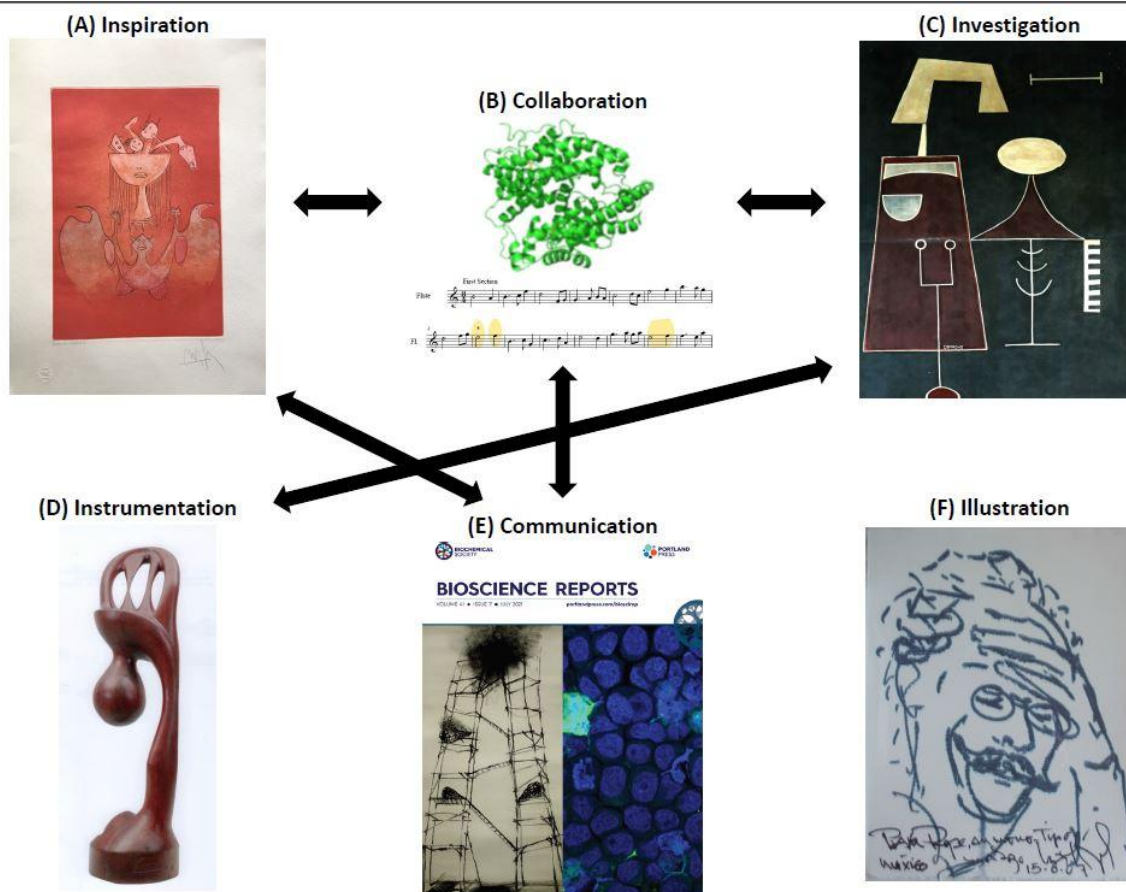
**Investigation.** Art challenges and inspires scientists to apply scientific approaches to address investigations in art [23-25].

**Instrumentation.** Development of methodologies to approach scientific questions through the collaboration between scientists and artists [1, 7-9].

**Communication.** Collaboration with artists contributes to communicating to the public challenges faced by science and society [26-31].

**Illustration.** Using art pieces as part of figures in scientific publications [29, 32, 33].

Furthermore, a network of interactions illustrates how some of these categories despite their main objective are interconnected [Fig. 2], thus supporting how protean art algorithms contribute to multiple disciplinary research. For example, some art pieces serve as communication, inspiration, and collaboration to address scientific questions [Fig. 2]. Artists could also contribute to answering questions related to self-care, traditional medicine workshops, sharing, and the environment and the development of Pictorial Narrative Mapping qualitative analytic technique [34, 35].



**Figure 2.** Examples of the implications of science and art interactions. (A) Inspiration. Wifredo Lam, *La sensualité de la femme des caraïbes*, aquatint etching printed in three engraved plates, edition of 99 copies plus twenty, 1982. (B) Collaboration. Scientists and musicians. Musical algorithms for the characterization of protein-protein interactions [22]. (C) Investigation. Jorge Camacho Lazo, *Figuras en la noche* (Figures in the night), plaka on cartoon, 1955. (D) Instrumentation. Agustín Cárdenas, *Cuban caoba*, wood, ca. 1961. (E) Communication. Cover image of *Bioscience Reports*, volume 41, issue 7, July 2021. Juan Francisco Elso Padilla, *Granero Infinito II* (Infinity Barn II), from the series *Earth, Corn, Life*, mixed on cardboard, 1982. (F) Illustration. Luis Miguel Valdés, portrait of José de la Fuente, Monotype drawn in ink directly on the press, 2007. Art pieces courtesy of KGJ Collection, Ciudad Real, Spain.

Art is also protean in its role and significance for scientists, and thus a piece of art may lead to multiple interpretations and impact. Using the piece by José Angel Acosta León (no title, mixed technique with watercolor on cardboard, 1961; [Fig. 3]), I conducted a survey to evaluate scientist's views on this piece. José Angel Acosta León (1930-1964) was a Cuban artist with influence of surrealism using human, animal, and mechanical forms in his paintings [36]. The survey included young and senior scientists in the field of health and biotechnology with the question, "From your perspective, what scientific questions and directions raises this art piece?" A total of 53 responses were received with the following contributions:

- (a) A need of One-Health approach to reduce the effect of engine pollutants on human, animal, and environmental health (n = 11 responses, 20.7%).
- (b) How to evaluate the impact of engine and environmental pollution on human and animal health? (n = 10; 18.9%).
- (c) Development of sustainable interventions for the control of endemic and emerging infectious diseases (n = 9; 17.0%).
- (d) Application of multidisciplinary environmental medicine to target human, animal, and environmental health (n = 5; 9.4%).
- (e) Do we need to add a new dimension to the study of host-pathogen interactions by including environmental factors? (n = 4; 7.5%).
- (f) Effective vaccines are required to mitigate the impact of climate change and environmental contamination on the control of infectious and other diseases (n = 4; 7.5%).
- (g) To face the challenge posed by climate change and contamination on health worldwide, we need to promote multiple disciplinary investigations with the application of Big Data and machine learning algorithms (n = 3; 5.7%).
- (h) Development of probiotics to modify gut microbiota and boost immune response for the control of infectious diseases (n = 2; 3.8%).
- (i) Within the context of neuronal connectios, like a cell trying to stabilize contact with the environment and other cells,why the connections are specifically in those directions? and which stimulus (if they are)are those by which the cells have affinity to? (n = 1; 1.9%).
- (j) To advance in vaccine development against endemic and emerging infectious diseases, the combination of antigens using protective epitopes or immunological quantum will advance the development of effective and efficacious vaccines against multiple pathogens (n = 1; 1.9%).
- (k) What are the long-term health effects of air pollution?For how long our planet will support this many people without collapsing?Could the use of 100% renewable energies be feasible in a worldwide scale?(n = 1; 1.9%).
- (l) In the collaboration between scientists and artists I propose to address the question on how artists perceive science and scientists perceive art to advance a dynamic approach for the advancement of science (n = 1; 1.9%).
- (m) Musical algorithms and interactive tools for exploring music composition, analysis, and interdisciplinary learning may be applied to scientific questions and hypothesis to characterize protein-protein interactions and candidate vaccine antigens (n = 1; 1.9%).





**Figure3.** Art piece used in a survey to evaluate scientist's views on this piece. By José Angel Acosta León, no title, mixed technique with watercolor on cardboard, 1961. Courtesy of KGJ Collection, Ciudad Real, Spain.

### 3. CONCLUSIONS

The application of protean art algorithms in science would contribute to multiple disciplinary research to advance in resolving complex problems with scientific and social impact. Approaches to promote the collaboration between scientists and artists to advance research and social communication may include but not limited to (i) Presentation invited artists and the objectives of the activity to the members of the research group, (ii) Stay of the invited artists at the scientific institution for a number of days to exchange ideas and experiences with researchers and students from different areas (ecology, health, toxicology, molecular biology, biotechnology) and develop the art pieces derived from this exchange, (iii) Conduct an act at a cultural institution consisting of a meeting in which the artists will present and explain their vision of our scientific activity in an exhibition with the art pieces produced as a result of these exchanges with researchers. In this meeting, the researchers who exchanged ideas with the artists will also present the challenges that the art works represent for their research activity. It should be open to the public, and (iv) Preparation of a popular science article to be published in a prestigious international journal and press. These initiatives will advance multiple disciplinary research and promote the scientific and social impact of the collaboration between scientists and artists to advance in scientific education, investigation and divulgation.

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