

Creating order in the mind: Borges' paradoxical mirror

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Abstract

In this essay we propose, based on the ideas of L. Rapkine and J. Monod on the physical reasons for aesthetic appreciation, that the interest of creative scientists in Jorge Luis Borges' works is produced by an apparently contradictory effect: on the one hand, the serenity that these texts induce in the mind of an innovative person and, on the other, the modification of the cognitive balance that causes the complexity of these texts and that operates as a creative force. We illustrate this idea with the specific case of the story "Blue Tigers". We show that this text by Borges, in a reader who is sensitive to it, injects information that puts the mind in a state far from the level of cognitive equilibrium. When it comes to solving a scientific problem, the search for new ways to solve the problem is enhanced by this condition in which the cognitive balance is cancelled. That is the condition in which the creation of new ideas seems possible.

Keywords: Borges' literature; creative cognition; thermodynamics and art; Blue Tigers; text substructure

Introduction

Reflections on creativity originated in the distant past, and were promoted by ancient religious mythologies and early philosophical reflections. With the advances of history and culture, the ancient reflections became a domain of science, whose dynamics and richness is evident today. For a historical perspective on creativity research, see Runco and Albert (2010). A comprehensive description of the many facets of human creativity can be found in Runco (2014). It is interesting to note that the lack of convergence of this area of research towards established paradigms evidences the irreducible variety of modes of creativity displayed by human activity. It is interesting to mention here the theory of "Mental Spaces" proposed by Gilles Fauconnier, and in particular the idea of "blending" as a basis for the cognitive creation of novelties (Fauconnier 1997). (A neural approach to the theory of "mental spaces" can be seen in Mizraji (2017)).

Human creativity is ultimately the consequence of brain activity. In this framework, research on the cognitive and neural bases of creativity show a broad involvement of various brain regions (Shamay-Tsoory et al. 2011, Holm-Hadulla 2013, Runco 2014 [chapters 1 and 3], Ovando-Tellez et al. 2022). As can be seen in the previous references, there are still divergences about possible brain locations related to the various forms of creativity, including creativity associated with transient or chronic mental disorders. Recently, the order-chaos transition has been invoked to account for some aspects of creative ability (Lambert 2020). Let us note that order-chaos transitions have been found in neural models that represent the brain activity of an individual faced with various uncertain and divergent options (Mizraji and Lin 2001).

Let us say, in passing, that the metaphorical expression "creativity of Nature" is not without interest for us. Indeed, cosmological evolution, on a large space-time scale, and the evolution of life on Earth, on a much smaller scale, shows a remarkable creative potentiality. But in both cases, there were physical and contextual conditions that conditioned the routes of both evolutions towards the creation of increasingly complex structures. Descriptions

of these conditions that enabled cosmological and biological evolution are found respectively in the classic books by Gamow (1952) and Jacob (1973).

Here we will deal with a restricted form of human creativity: Scientific creativity. And, as in all forms of cognitive creativity, there are (as in the metaphorical "creativity of Nature"), intrinsic and contextual conditions that allow and expand creative potentialities. In Chapter 12 of Runco (2014) the conditions that enhance the achievement of creative thinking are explored. Let us point out that in the field of science, the search for understanding is a constantly pursued objective. But it is also an objective that, once achieved, has an ephemeral permanence (except in particular territories of mathematics), because advances in knowledge and techniques subject this understanding to continuous challenges (Mizraji and Lin 2017). On the other hand, to solve scientific problems requires the creation of innovative routes to access solutions. This search for innovative paths is widely variable according to the personal styles of the researchers. A study of these styles in the domain of mathematics and physics is found in the classic book by Hadamard (1945). In the case of 20th century biology, these styles are widely documented in Judson (1970).

In this article we will take an approach to analyze the creation of innovative routes to solve scientific problems that is inspired by Rapkine's (1970) and Monod's (1970) thermodynamic reflections on aesthetics, and illustrate the idea through the ability to inject information that a work of art can possess. To analyze this point, we chose a metaphor created to explain the close link that exists between the literature of Jorge Luis Borges and scientists. This metaphor, presented by the author in a symposium on "Borges and Science", imagines that a literary work can be like a paradoxical mirror, in which confused and ambiguous images are reflected transformed into well-defined images. To link this metaphor with the thermodynamic ideas of Rapkine and Monod, we analyze Borges' short story "Blue Tigers". This approach to creativity, inspired by thermodynamics, assumes that the information injected into the cognitive system leads to establishing a state that is far from cognitive equilibrium;

this condition allows, through various possible paths, to flow towards a state of high complexity that is in fact the act of creation. This act of creation combines complexity and order. Here is the close analogy with the physical generation of the biological order, where complexity is a consequence of thermodynamic imbalance.

Borges' mirror

Art has a singularly important effect on scientific creation. Many scientists know that when their minds are caught up in a difficult problem, when they are sometimes in an overexcited and even turbulent and confused state, immersion in some form of art often produces a pleasant calm. In this sense, the art of Jorge Luis Borges and scientific researchers have had an extensive and privileged relation. In particular, the reading of a text by Borges, at the same time that it can produce such a pleasant calm, paradoxically, can introduce the mind into the strangest and, at times, disturbing worlds. In this essay, we wish to avoid an exhaustive survey of Borges' work, which was so extensively analyzed (see for instance García-Osuna et al. 2018). Instead, we prefer to illustrate this idea with the specific case of a remarkable Borges' story, which has not been extensively studied: "Blue Tigers".

Based on the existence of this link between Borges' literature and scientists, in 1997 the University of Buenos Aires organized a symposium called "Borges and Science". Scientists from various areas participated in this symposium. Implicit in the basis of the symposium was the following question: "Why is Borges' art so attractive to so many scientists? In 1999, to commemorate the 100th anniversary of Borges' birth, the lectures of the symposium were published in a book (Slapak 1999)¹. One of the lectures sought to

link Borges with memory and thought (Mizraji 1999).

Mizraji (1999) exposed, among other things, a conjecture that tried to explain part of the impact of Borges' literature on the mind of a scientific researcher. The conjecture was expressed as follows:

"Allow me a reflection on Borges and scientists. Borges today is almost a character from the mythology of the future. And in the present it is almost an object of social idolatry. This public nature of Borges and his work contrasts with the fact that for many readers, and especially for many scientists, Borges is like a very personal friend, who belongs to the private circle, and with whom they have non-transferable experiences, and confidential dialogues. Why is it like this? Probably for many reasons that I cannot explain. But for those of us who work in science, one of these reasons may be the following: Borges' work seems like a mysterious mirror in which our ideas or our uncertainties are reflected in such a way that, contravening the usual laws of reflection, they are returned with more sharpness and brightness. The enormous intelligence of Borges, the strength of his thought, introduced into his writings a very complex material that has the power to reconfigure, specify and enrich confused and blurred ideas that sometimes we scientists have in our minds when we go to his texts"

This conjecture about a metaphorical order-generating mirror seemed to be at that moment both plausible and inexplicable. Boido (2014) offered his own comments on this Borges' mirror. But to two texts published in Leonardo, suggest a possible

¹ In 2016, a large cultural event lasting several weeks was organized in Buenos Aires to honor Borges 30 years after his death. Science also had a prominent place there. The report of this activity is a document entitled "Fictions of an infinite time" and can be obtained at the

Borges Center of the University of Pittsburgh (https://www.borges.pitt.edu/sites/default/files/files/CCK%20Borges-Ficciones%20de%20un%20tiempo%20infinite_to_2016.pdf).

justification to the plausibility of that conjecture. The texts were Louis Rapkine's and Jacques Monod's commentaries on aesthetics, occurring between 1945 and 1950 and published in *Leonardo* (Rapkine 1970, Monod 1970). In fact, the present comment on the cognitive impacts of Borges' work, also intends to be a tribute to the ideas on the nature of aesthetics of two extraordinary scientists such as Louis Rapkine and Jacques Monod, ideas that until very recently remained almost inaccessible.

Reflections of Rapkine and Monod on thermodynamics and aesthetics

In this paper we want to argue that within the framework of scientific creation, the influence of a work of art may have the capacity to stimulate the creativity of a researcher. With this purpose, we want to put in contact two territories gathered in the aforementioned ideas of Rapkine and Monod. These territories are aesthetics and thermodynamics. As we will see immediately, Rapkine and Monod were two researchers relevant to the history of biology in the 20th century.

Research on aesthetics is so abundant and diverse that here we will limit ourselves to commenting on some aspects regarding the biological and neural bases that try to explain why the aesthetic feeling arises. An important approximation for the understanding of aesthetic perception is to define the factors that determine whether a person feels that they like or dislike a work of art. An interesting experimental work on the dimensions of aesthetic perception was published by Biaggio & Suppliee (1983). The source of aesthetic emotion has been the subject of numerous works that try to link this emotion with its biological bases and education (Mastandrea et al. 2019). A comprehensive theory of aesthetic emotion has been published by Menninghaus et al. (2019). For details of the neurobiological bases of aesthetic

perception obtained by neuroimaging methods, see Cela-Conde et al. (2004) and Chatterjee & Vartanian (2016).

Let us now turn to thermodynamics, the other protagonist of the Rapkine and Monod lectures. In recent decades, the investigation of the relationship between information and thermodynamics has increased, a relationship already hinted at by the founding researchers of statistical mechanics (J.C. Maxwell, L. Boltzmann, and W. Gibbs). An important book compiling foundational works on the link between thermodynamics and information has been published by Leff and Rex (1990). The article by Parrondo, Horowitz and Sagawa (2015) contains an updated technical vision on the thermodynamics of information. A recent analysis that complements these results is in Mizraji (2021).

One fact that makes Rapkine's and Monod's views on aesthetics and thermodynamics singularly interesting (despite the fact that these reflections are from the late 1940s) is that they bring together two territories that do not normally cross. Here is a suggestive and creative blend, to use the concept of Fauconnier. Except for the great intrinsic beauty that thermodynamics has as a science, it is not usually invoked as the foundation of the aesthetic conception. For this reason, we are especially interested in bringing these ideas out of their relative oblivion because, as we will try to argue in this paper, they can be unexpectedly contemporary.

Louis Rapkine was a researcher at the Pasteur Institute in Paris whose physicochemical approach to biological phenomena had a strong influence on the future work of the young Jacques Monod². Rapkine's text on aesthetics, which appeared in 1970

² In the years following his lecture, Jacques Monod associated with François Jacob discovered the basic mechanism for the control of gene expression and protein synthesis. For this work, Monod and Jacob received the Nobel Prize in 1965.

in Leonardo, is based on notes created around 1945 and which had remained unpublished. The largest part of this Rapkine text described the thermodynamic processes that lead to associate entropy with order (the lower the entropy the higher the order). He then emphasized the fact that the increase in entropy of natural processes is the basis for the irreversibility of time. And at the end of this note there is a twist in which Rapkine associates the aesthetic sense with the "desire to stop the flow of time". Then, Rapkine (1970) added this interesting comment:

"We have seen above that the process of ageing is a process that tends to maximum disorder in the system. Art is an expression of an urge to counter this phenomenon-it creates order."

Around 1950, Monod gave a lecture where he commented on Rapkine's ideas on aesthetics (a tribute to Rapkine, who had died in 1948 at the age of 45). The fragment published in Leonardo in 1970 belongs to that lecture. In this text, Monod (1970) added this comment to Rapkine's reflection:

"A work of art can be considered a source of energy for viewers, in that it possesses the properties of a structure with a high energy potential which may be transmitted to them."

The complex neural modules that make up the human cognitive system are those that can process this source of energy mentioned by Monod (beim Graben & Potthast 2009; Pomi, Mizraji & Lin 2018). In this framework, the elaborate information offered by a work of art becomes a source that generates order when it is processed by complex cognitive systems. Music offers a paradigmatic example of this situation (Nagy 2020, Blutner & beim Graben 2021).

In the next section we will show the complex substructure contained in Borges' short story "Blue Tigers" and then we will interpret this complexity as

an injection of information capable of pushing the reader's mind out of a state of cognitive equilibrium.

The subtle substructure of Borges' literary art

In 1997, Robert Silvers published the book "Photomosaics" which illustrated his computational invention through wonderful images (Silvers 1997). Silvers photomosaics were images with a substructure made up of hundreds or thousands of small images that gave the overall image a fascinating intimate structure. Subsequently, Silvers's invention led to the creation of a variety of free software with variations on his original idea.

Here we want to argue that part of the capacity of Borges' texts to transfer very complex information is based on including that information in a fluid plot that has a subtle substructure, similar to how mosaic images have a complex internal structure. To illustrate this let us play with an image of a tiger, created using the AndreaMosaic software. Figure 1 shows the tiger image created from 5000 tiles.

Figure 2 shows a detail of the left side of the tiger's face. In that image appear, among others, tigers, the image of Kipling, Blake's tiger, Daniel Defoe's book, Shakespeare, maps of India and Pakistan and Chesterton's face.

As can be seen, this Figure 2 illustrates how the image of the tiger shown in Figure 1 includes much more information than it appears to have at first glance.

These images are here a metaphor, perhaps exaggerated, but as we pointed out before, a text by Borges can be considered similar to a mosaic that contains complex information that is partially hidden by the course of the argument. We will try to illustrate this by commenting on some aspects of "Blue Tigers", one of his latest stories.

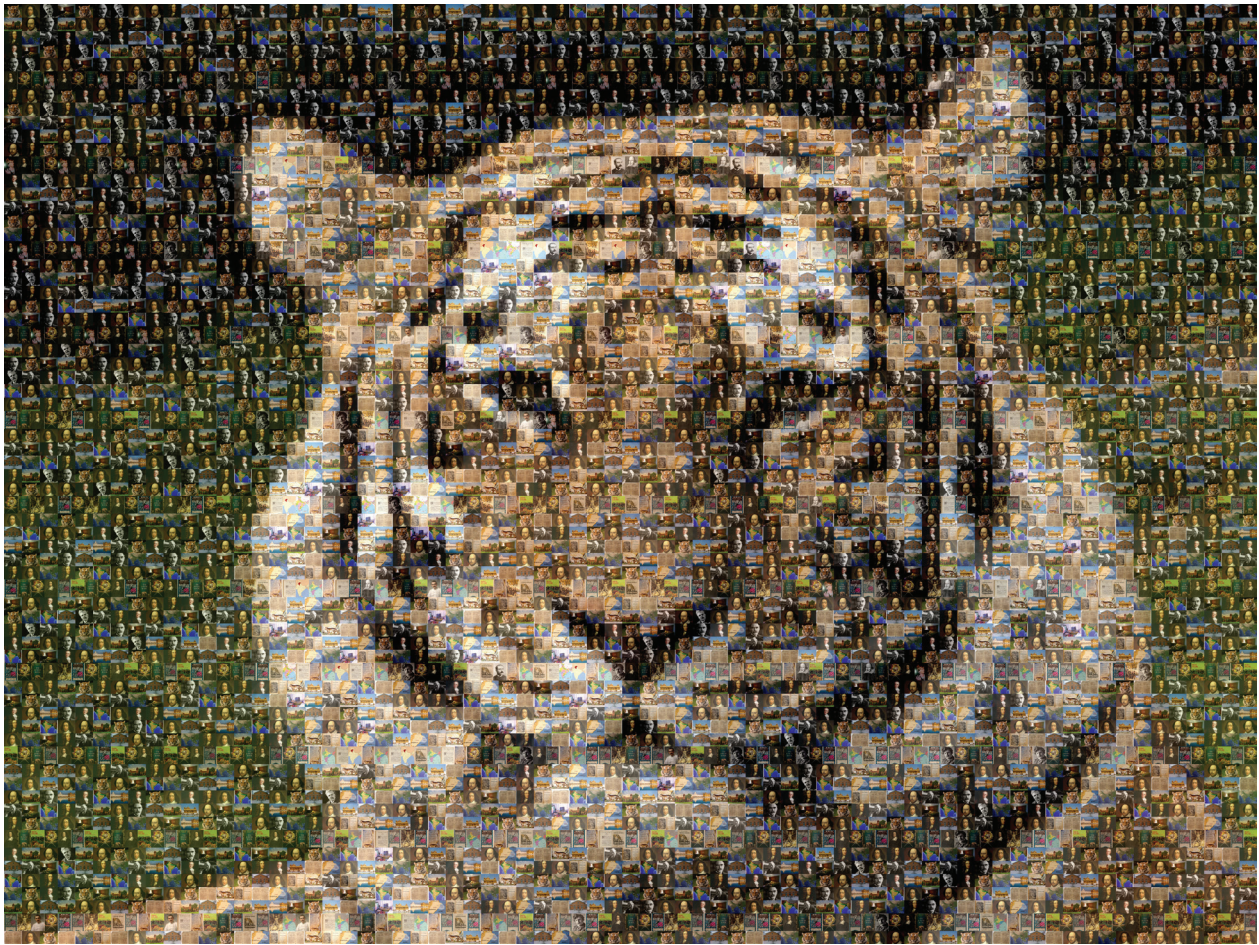


Figure 1: Image of a tiger created with 5000 tiles. The image of the tiger that serves as a template for the mosaic was obtained from Wikipedia Commons (https://es.m.wikipedia.org/wiki/File:Siberischer_tiger_de_edit02.jpg; attribution-ShareAlike 2.5 Generic (CC BY-SA 2.5)). The image was built by the author of this article using the free software AndreaMosaic (<http://www.andreaplanet.com/andreamosaic/>).

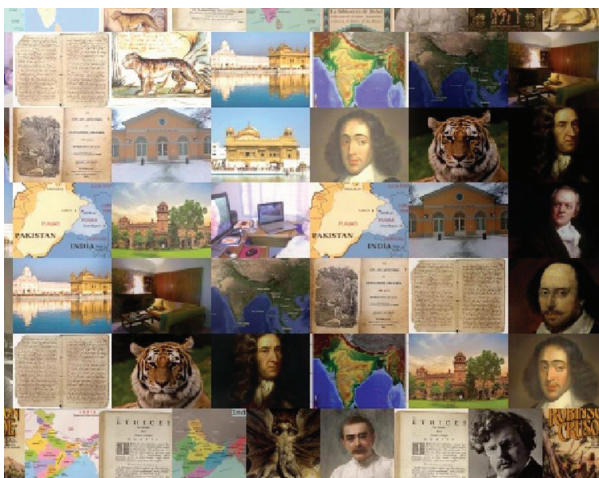


Figure 2: Detail of the left side of the tiger's face from the image in Figure 1

"Blue Tigers" as a test of the idea

"Blue Tigers" is part of the latest series of published stories by Borges. After several publications in various media, this story was finally included in "Shakespeare's Memory", his latest book. "Blue Tigers" (Borges 1999) is a story that already begins with an enigmatic title, and the enigma extends and increases throughout the story. We are not going to spoil the development of the plot, because we must not deprive the reader who does not know the story of the surprises that it holds. But instead, we are going to point out some aspects that show the partially hidden complexity that we mentioned before. About the

plot, we will only say that when reading "Blue Tigers", the reader calmly and comfortably witnesses the conceptual destruction of our universe.

The basic mosaics of this story are its virtuous and elegant phrases. Those linked sentences create a mysterious atmosphere. But incorporated into his sentences, Borges uses segments of information that reverberate in the reader's mind and color those textual mosaics with unexpected tones. In this story, which is told in the first person, at the beginning Blake's tiger appears as a symbol of evil ("Tyger Tyger, burning bright ...") followed by Chesterton's reflection ("the tiger as a symbol of awful elegance"). There, Borges already gives us two of his eternal "friends", and we readers (if we already know Borges) begin to imagine that he is the narrator. In the following sentences, the author seems to confirm this impression by describing in a zoo that he visited as a child in Buenos Aires, his fascination with a tiger cage, his judgment of encyclopedias by the images of tigers and then Kipling's presence with *Jungle Books*.

All these well-known autobiographical elements of Borges collapse in the following sentences, since the narrator explains to us that, paradoxically, after becoming a hunter, he is a professor of logic at the University of Lahore, who offers a seminar on Spinoza on Sundays and that he is a Scottish man who moved from Aberdeen to Punjab for his love of tigers. Evoking dubious rumors about blue tigers, the narrator mentions the Icelandic name for Ethiopia, *Bland*, which means blue or black land, leading him to believe that perhaps the rumors refer to black panthers. He also mentions the London tabloids where unlikely images of blue tigers with silver stripes appeared. Then the shadow of the blue tiger and a date appear: "Toward the end of 1904, I read that in the region of the Ganges delta a blue variety of the species had been discovered." This takes him to a village, and there Borges introduces us to the jungle. And in the description of the village, Kipling resurfaces and there is a leap into the cosmos. Says the narrator: "Surely one of the pages of Kipling contains that village of my adventure, since all of India, all the world somehow, can be found there."

This is how the sentences of the text continue to occur and feed each other until they reach the disturbing areas of the story, the unheard-of findings of this logic teacher, which we cannot mention. However, we can comment on something curious that this Scottish professor relates. At some point he feels that the inhabitants of the village are creating false leads about the blue tigers, and there he evokes Daniel Defoe ("Like Daniel Defoe, the men of the village were skilled at inventing circumstantial details"). Defoe, author of *Robinson Crusoe*, was inspired by the true story of the Scottish sailor Alexander Selkirk, a surname that according to the *Encyclopedia Britannica* is a phonetic version of Alexander Selcraig. The implausibility of what was found led him to mention Behemoth and Leviathan, and an indirect mention of the Roman Juvenal and his statement that black swans were synonymous with the impossible, along with the mention of the Dutch sailor who discovered black swans in the 17th century, in Australia. So, after we follow the protagonist into the jungle and witness his unlikely find and some of its consequences, not far from the end of the story, this Scottish professor who narrates his adventure tells us that his name is Alexander Craigie. Is this similarity between the name of the Scottish sailor who inspired Defoe and this lonely researcher from Aberdeen an unforeseen coincidence, or is it a Borgesian *clin d'oeil*? Many other events occur after the discovery. Then the protagonist returns to Lahore. From this return, science, mathematics, Pythagoras, are present in the story. The story ends before a mosque with a disturbing and enigmatic exchange between the protagonist and a beggar.

Borges' texts as order-generating mirrors: A possible explanation

What is the effect on the reader of a story like the one we just discussed? If the reader is sensitive to Borges and his literature, in the first place an intense aesthetic pleasure arises. One could conceive of a story like "Blue Tigers" seemingly just as effective for

its surprising plot without mentioning other authors or exotic places or strange literary beings. But why are there Blake, Chesterton, a zoo of childhood, Kipling, logic, Spinoza, the Icelandic name for Ethiopia, Defoe, the black swans of the Roman and the Dutch sailor, Behemoth and Leviathan or Pythagoras? Undoubtedly, any reader will notice that these mentions increase the sensation of strangeness, of separation from normal everyday life. We may or may not understand the meaning of these mentions, but in reality that matters little. They fulfill the role of a theatrical set. They create a climate. They help the reader's mind to enter another world.

Let us now turn our gaze towards the links between art and information. Rapkine (1970) indicated that a work of art is a construction that creates order. Monod (1970) pointed out that a work of art is a source of structured potential energy. At the end of his note, Monod made a very important observation:

"If a part of the energy of a physical system is to be transmitted by resonance to another one, there must be specific similarities between the two systems. Therefore, for a work of art, considered as a structure with a very high degree of order and with transmittable energy, to provoke resonance in a beholder, there must be a minimum of specific similarity of experience between the beholder and the content and sense of order in the work of art."

In the case of reading a story like "Blue Tigers", the previous observation indicates that the complex information provided by the story is an emergent of that structured potential energy that Rapkine and Monod talk about, and the cognitive processing capacity of the reader (Mizraji 2021).

Returning to the problem of the effect of Borges' literature on the mind of a scientific researcher, let us assume that it is this emerging information that,

along with aesthetic pleasure, moves the mind out of its equilibrium point. This imbalance, generated by the complex information structure of a text by Borges, can produce the reconfiguration of immobilized ideas, which sometimes hinder the creativity of the scientist and his or her ability to solve a problem. For a researcher fatigued by a difficult problem, a story like "Blue Tigers," with its mosaic structure full of startling facts and events, can cause a dramatic shift in the reader's mind that drags with it (and eventually replaces) doubtful technical ideas associated with the problem, suggesting a new mode of attack, perhaps this time successful. Borges induces both emotional calm and cognitive instability. This instability allows perspective changes in the approach to problems and the possibility of new ways to access the solution. Using thermodynamics terminology, this is equivalent to creating a cognitive gradient that triggers a creative flow toward solving a challenging problem.

A note on William Gibson and Jorge Luis Borges

We want to transcribe two comments on Borges' work made by William Gibson, author of the stories compiled in "Burning Chrome" and of novels such as "Neuromancer" and "Pattern Recognition". When the publisher New Directions decided to reissue "Labyrinths", the famous collection of texts by Borges in English, William Gibson was invited to write an Introduction (Borges 2007). In grand style, Gibson turned that Introduction into an "Invitation" and gives these elegant and splendid reasons: "In all humility, I can serve no other function, here at the front of this now-venerable collection of his incomparable fictions, than to act, mercifully briefly, as a sort of butler." In one part of this "Invitation," Gibson describes the effect of a text by Borges on his own adolescent mind:

"I do, however, remember the sensation, both complex and eerily simple, induced by my first reading of "Tlön, Uqbar, Orbis

Tertius," while seated in that green chair. Had the concept of software been available to me, I imagine I would have felt as though I were installing something that exponentially increased what one day would be called bandwidth, though bandwidth of what, exactly, I remain unable to say."

Gibson complements this important comment with another, made in an interview conducted by Craig Morgan (2007):

CM "Is this a good time for us to pay a new kind of attention to Borges?"

WG "It's always good to read Borges, but perhaps it's particularly good to read Borges now. These are complex and arguably difficult times we're going through. The deep, metaphysical, culture-encompassing aspects of Borges are very good things to access during chaotic times. There's a lot of perspective to be had. In the course of a paragraph he can give you a sense of what it's like to look fifteen centuries down the hall."

With these two revealing quotes, from a man of literature, we almost arrive to the end this article.

Discussion

In this article, a short story by Borges was used as an illustration of how a work of art can lift a researcher's mind out of stagnation in his search for creative solutions. This stagnation may be associated with a state of cognitive balance that prevents creative thinking. We associate the effect of a work of art with a disturbance that extracts thought from that static situation and places it in a state of imbalance from which it can visualize new perspectives and possible ways to solve problems. Naturally this is not restricted to literature but extends to any form of art capable

of injecting complex information into the mind, according to the particular sensibilities of the people who are facing a problem (think of the music of Johann Sebastian Bach, the painting of Óscar Domínguez or the engravings of Maurits Cornelis Escher).

In the field of science, a very interesting situation occurs, since in general the goal of a researcher is to converge to a solution. Consider the famous Goldbach's conjecture ("every even integer greater than 2 can be expressed as the sum of two primes"). The goal here is to decide if this conjecture is true or false. (In this extraordinary case, a problem with such a simple statement continues to challenge the most talented mathematicians since 1742 and up to now). But let us note that a scientist or a research group confronted with problems must be able to put the mind in a position to generate divergent thinking, showing a wide variety of reasonable routes by which to guide the search. In other words, convergence to a solution usually requires a person or a team to be capable of creating divergent alternatives, where one or several solution paths may arise. Obviously, this is not restricted to the field of scientific research.

The previous considerations raise the important problem of what should be the educational procedures capable of stimulating creativity. A compilation of important works on this topic can be found in Beghetto & Sriraman (2017). Naturally, it is ideal that creativity is stimulated in the stages of initial education, surely the most important in a person's life. But let us think now about science education. It is well known by science professors directing MSc or PhD theses that students with very solid and outstanding backgrounds in their university studies sometimes get trapped in the paths of scientific thought offered by their strong culture and do not manage to access to novel approaches. That is why it can be very important (as many universities do) to complement science training with a good training in arts and humanities that circumvents academic rigidity and encourages exploratory freedom.

Finally, let us point out that within the framework of the ideas mentioned in the first part of this article, that the structured potential energy of a text by Borges, which at the same time is cordial but exotic and subtly complex, makes the reader's ideas submerge in the metaphorical order-generating mirror. Thus, the structured information that emerges from the work of art returns those transformed ideas, empowered by the ability of the text to generate order through that potential energy that Rapkine and Monod referred to. The analogy with the generation of biological order by a flow of energy that -outside of thermodynamic equilibrium- allows the existence of living beings, is close (Jacob 1973, Lwoff 1962). In this case, a text by Borges, in a reader sensitive to it, injects cognitive order and keeps the mind in a state far from the equilibrium level, a condition in which the creation of new ideas seems possible.

It only remains to say that, despite the attempt at rational understanding, which we have dealt with here, of the reasons for the emotional and intellectual effects that a great artistic literature provokes, we are aware that those great works of art that humanity treasures throughout their history do not easily release their secrets.

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