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« Realities of illusion »

### Towards creative vicariance

*Interview with Alain Berthoz*

#### **Alain Berthoz**

Alain Berthoz is an engineer and neurophysiologist, a member of the Academy of Sciences (since 2003) and honorary professor at the Collège de France (perception and action physiology chair from 1993 to 2009). He is one of the leading experts in integrative physiology. He focuses his researches on the multi-sensory control of look, balance, locomotion and spatial memory. He has published numerous books, including *Le Sens du mouvement* (Odile Jacob, 1997), *La Décision* (Odile Jacob, 2003), *La Simplicité* (Odile Jacob, 2009), *La Vicariance, le cerveau créateur de monde* (Odile Jacob, 2013), *Anticipation et prédiction. Du geste au voyage mental* (with Claude Debru, Odile Jacob, 2015). See the works of Alain Berthoz on Collège de France web site: <http://www.college-de-france.fr/site/alain-berthoz/travaux.htm>.

#### **Marie-Hélène Tramus**

Marie-Hélène Tramus is a teacher in arts and technologies of image at Paris 8 University and president of the Labex Arts-H2H's scientific committee. She conducts researches on the behavior and independence of virtual entities, as well as on the issues of the creation process and participation of the spectator, as renewed by digital interactivity. Her works have resulted in collective digital creations: computer-generated films, interactive installations, virtual and augmented reality artistic devices, including *Sur-impression* (2009), *La Funambule virtuelle* (2000-2006), *Danse avec moi* (2001), *Corps et Graphie* (1997), *La Speakerine de synthèse* (1990), *La Plume* (1988).

#### **Abstract**

This interview raises the issue of the realities of illusion, based on the interpretation of the vicariance concept developed by Alain Berthoz in the book entitled *La Vicariance. Le cerveau créateur de mondes*, published in 2013 (Odile Jacob). A series of issues are examined: the difference between illusion and hallucination; the dual dimension of vicariance as substitution and creation; the link between vicariance and the notions of diversity and one's own environment; the processes of creation in relation with this vicariance strategy; and finally virtual reality as a vicariant reality, in which avatars constitute doubles allowing for the immersion in these virtual worlds.

Keywords: illusion, reality, vicariance, artistic creation, virtual reality, avatar

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## Full text (PDF file)

### Interview

**Marie-Hélène Tramus.** The idea of this interview came up after reading your book entitled *La Vicariance, le cerveau créateur de mondes*.<sup>1</sup> The objective is to determine whether this notion of vicariance paves the way for an original perspective on this issue of the realities of illusion.

**Alain Berthoz.** Before we tackle the issue of the relations between illusion and reality, let me first make a distinction between illusion and hallucination.<sup>2</sup> As far as I am concerned, or the brain in any case, illusion is a solution found by the brain when confronted with an ambiguous situation, while hallucination is completely made up by the brain. They are often mistaken, since artists happen to play on both levels. If we take the example of M. C. Escher, certain figures associate illusions produced by the brain in an ambiguous situation with “false” realities that are the products of his mind.<sup>3</sup> This distinction is crucial, because the concept of vicariance – which is one of the simplifying principles of what I call “processus simplex,” one of the ways evolution has found to quickly and efficiently solve complex problems—addresses both aspects in humans: the conflict resolution I call illusion, and the creation of worlds, or in other words, hallucinations.

**Marie-Hélène Tramus.** Could you please define this notion of vicariance, which you consider as an essential strategy in our interaction with the outside world?

**Alain Berthoz.** First of all, let us note that the term “vicariance” is truly polysemous and used in numerous fields. In paleontology, it designates the differences between animals sharing the same origin but living on different continents, for example. In didactics, it refers to diversity in the teaching methods. In psychiatry, pain vicariance indicates the fact that the nursing staff might take on the other’s suffering. Fundamentally, the concept of vicariance amounts to the idea of the vicarious, or in other words to the potential substitution of a solution or function for another. According to this idea, it is possible to perform the same tasks with different systems, solutions or behaviours. This constitutes the basis for diversity. My decision to write this book on vicariance results from the assessment that evolution has had to conciliate between universal laws (such as the general laws of motion that I have described in *La Simplexité*<sup>4</sup>) and finding a way to account for diversity, developing this great ability to make the same things through different means. Finally, Jakob von Uexküll has ascribed vicariance with a new meaning, which I call vicariance of use. Von Uexküll takes this wonderful example

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1 Alain Berthoz, *La Vicariance. Le cerveau créateur de mondes*, Paris, Odile Jacob, 2013. English version to be published by Harvard University Press, 2015.

2 Alain Berthoz, *Le Sens du Mouvement*, Paris, Odile Jacob, 1997, p. 274. In English: *The Brains Sense of Movement (Perspectives in cognitive Neuroscience)*, Cambridge, Harvard University Press, 2000.

3 Thus, in his *Ascending and Descending* lithograph, M. C. Escher creates an imaginary three-dimensional architectural structure according to a perspectivist representation, while integrating an impossible staircase creating the illusion of endlessly ascending or descending.

4 Alain Berthoz, *La Simplexité*, Paris, Odile Jacob, 2009. In English: *Simplexity. How to deal with a Complex world*, New Haven, Yale University Press, 2011.

of the flower stem, which is simultaneously food for the cow, a stalk for the lover to present the flower to his/her beloved and a ladder for the ant. At the turn of a century dominated by normative thinking, I wanted to reintegrate this fundamental concept.

**Marie-Hélène Tramus.** Is it possible to consider artistic creative processes as vicariant? In the same way, can we regard artistic creations as singularities arising from the subjectivity of an author, painter, filmmaker or writer, far from the universal laws? Does the notion of vicariance allow us to go beyond the traditional issue of reality versus illusion in arts?

**Alain Berthoz.** First, I would like to comment on the frequent use of the word “reality.” Multiplicity lies at the heart of this singular concept. This is why I wanted to overhaul von Uexküll’s thinking,<sup>5</sup> and especially his notion of *Umwelt* [environment, background, one’s own world view]. For instance, the tick only perceives reality in terms of butyric acid and heat. When the poor animal senses something hot and smelling of butyric acid, it drops and feeds on its victim, and then it dies. “Reality” is largely determined by the sensory, perceptive and interpretative tools that evolution has provided us with, in accordance with our needs. What makes the human being original—I develop this thesis in the essay on vicariance—is precisely his ability to avoid the determinism that confines him in a reality intrinsically linked to his needs and sensory tools, through the remarkable ability of his brain to implement the vicariant processes he is provided with, in order to escape reality or *his* reality. Evolution has endowed us with a certain number of mechanisms—for example remembering our way through our movements or using a map, holding a glass in different ways, etc. Evolution has given us a series of vicariant tools enabling us to quickly solve a problem in different ways. In my opinion, artists resort to the capacities of the human brain and use these tools to play on “the expression of reality.” For example, we only possess a limited list of movements and gestures. Michel Bret, you and I have studied the latter in the project called *La Funambule virtuelle*.<sup>6</sup> We are governed by very strict rules of natural motion. We have applied these rules to *La Funambule*, so that you could then break them and arouse an emotion. You have used your brain to create solutions which evolution had not provided for, without resorting to other tools than those we were naturally given. It is this interaction, and a very interesting one if I may say, between the functional versatility provided by vicariance and our brain’s desire or ability to reorganize these synergies differently that constitutes the pivot you are looking for in the relation between reality and illusion.

**Marie-Hélène Tramus.** Can’t we extend these multiple “realities” pertaining to the brain-body of earth’s varied species and their particular *Umwelt* to the worlds created by artists? Metaphorically speaking, can we regard the latter as a “variety” within our human species, which is capable of inventing singular worlds through this sensorimotor, perceptive and cognitive capacity of our interaction with the world?

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5 Alain Berthoz and Yves Christen (eds.), “Neurobiology of the ‘Umwelt’: How Living Beings Perceive the World,” *Research and Perspectives in Neurosciences*, Heidelberg, Springer-Verlag, 2009.

6 Michel Bret, Marie-Hélène Tramus and Alain Berthoz, “Interacting with an intelligent dancing figure: artistic experiments at the crossroads between Art and Cognitive Science,” *Leonardo*, vol. 38, no. 1, 2005, p. 46-53.

**Alain Berthoz.** Is the artist a special creature? We all are special creatures, this is the founding principle of vicariance. The association of epigenesis and experience makes the human being a truly unique creature. In my opinion, engineers are creators too. A plane is an improbable creation. Engineers also contribute to reconstructing the world in a different way, to making an original use of strengths and forms. In the same way, scientists and mathematicians look for and discover new concepts. The question remains as to what is specific to artists in these interactions between reality and illusion.

**Marie-Hélène Tramus.** Can we affirm that artists are characterized by the fact that they focus their research on a kind of pleasure, related to a close attention to forms—be they gestural in dance, plastic in visual arts, acoustic in music, etc.?

**Alain Berthoz.** I disagree with you when you say that artists essentially look for pleasure. Consider Nolde and the German expressionists for instance, who question the pleasure of form so much that they inspire anguish and horror (*cf.* Munch's *The Scream*). They had foreseen the coming atrocities. The artist resorts to forms as much for pleasure, as to potentially express fear, anguish, horror, or any kind of emotion.

**Marie-Hélène Tramus.** Indeed, but is this close attention to forms, and its resulting practice, what enables artists to create works likely to convey very diverse emotions?

**Alain Berthoz.** Then, it would be interesting to reflect on the nature of what a form evokes—whether it is horror, anguish or pleasure. Following on from Dutch physicist Jan Koenderink's work, we are currently working on the brain's geometry with mathematician-geometrician Daniel Bennequin and Israeli mathematician and physiologist Tamar Flash. In my opinion, one of the essential questions currently being raised on perception is the following: what are the geometries of our brain? Which leads to another question: do artists—painters, sculptors, dancers—create shapes that correspond to the geometries in which our brain likes to operate?

This research is based on the generalization of the two-thirds power law, which links the curve of the trajectory to the tangential speed of the gestures that we make (as we walk or draw) and constrains perception. We are currently trying to go much further than describing the laws of natural motion, in order to understand these underlying geometries. Three years ago, we discovered that these laws of natural motion do not simply fall within Euclidean but also non-Euclidean geometry and we dedicated a publication to that discovery. The idea behind all this, on which we do not necessarily agree with mathematicians (this is a major debate), is that the geometries discovered by mathematicians correspond to geometries of the brain. When artists create shapes that are not necessarily Euclidean ones, they reveal the extraordinary fertility of the brain's functioning, by expressing it in a space—I use this term on purpose—that is way more complex than the one we are used to, that we are taught in school and that is the Euclidean space.

When Picasso would paint a portrait from various perspectives at once, he would simply show that our brain offers us the opportunity to change perspectives, through specialized or specific units allowing for the manipulation of these points of view. In other words, artists are discoverers of our brain's functioning in a way. They escape the dominant cultural norm to reveal ways to grasp reality and above all, show our brain's operating modes, the latter thus being vicariant in the sense that I used in my book, that is not only in the sense of the substitution of a function

for another, or varieties of use, but also in the sense of a true ability to create new combinations.

**Marie-Hélène Tramus.** This reminds me of the geometric ornamental motifs designed by Persian craftsmen, indirectly influenced by Greek mathematicians. Five hundred years ago, they empirically developed sophisticated techniques, such as the girih (pentagonal paving), the mathematical model of which was not formulated before 1974 by Roger Penrose (quasi-periodic paving<sup>7</sup>). Interestingly, a similitude was found between the structure of these quasi-periodic pavements and that of quasicrystals, discovered in 1982 as part of atomic-scale observations<sup>8</sup>. Now can we go back to the issue of shapes, shapes of objects, shapes of movements, shapes of sounds, etc.?

**Alain Berthoz.** It is the whole issue of the concept of shape, acoustic shape, etc. that is raised here. Nowadays, neurobiology essentially regards the brain as a system consisting of paired oscillators, a rather simplistic view, yet quite close to reality. It describes our brain as a set of oscillation generators covering frequencies ranging from fractions of a Hertz to hundreds of Hertz. Besides, these oscillating networks are collaborating, competing, echoing each other. This means that in our brain, the image of a painting is not a photocopy.

We are currently working with Professor Philippe Kahane,<sup>9</sup> in collaboration with Jean-Philippe Lachaux,<sup>10</sup> on intracranial recordings performed in Grenoble on epileptic patients. Now we know that when one perceives a shape, frequencies are activated in the so called gamma band, comprised between 40 and 150-200 Hz. The brain is indeed a series of oscillators. Not only are we here leaving the geometric shape as depicted on paper, we are also entering the space-time continuum.

The Nobel Prize for medicine has just been awarded to John O'Keefe, May-Britt and Edvard Moser for their work on the hippocampus. They have discovered in the entorhinal cortex the presence of neurons that code space according to a grid divided up in equilateral triangles (this is absolutely geometric). To explain this division, some of the current models suggest that these entorhinal cortex neurons receive oscillating activities from different frequencies. The interaction between these various oscillations would induce spatial *patterns*, as is the case with light interferences. So if we want to get to the bottom of things and understand what artists try to reveal to us, one should not content oneself with the mere idea of the appearance of shapes—a line drawn on paper, a dancer's gesture, a melody—when using the word “shape.” Neurophysiologists draw our attention on the fact that complex mechanisms underlie these shapes.

**Marie-Hélène Tramus.** What about the field of virtual reality? In the literal sense, it is fundamentally vicariant. As pointed out by Philippe Fuchs,<sup>11</sup> *virtual*

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7 Roger Penrose, “Role of aesthetics in pure and applied research,” *Bulletin of the Institute of Mathematics and its Applications*, vol. 10, 1974.

8 Homeira Abrishami, *Génération de motifs persans*, PhD thesis in aesthetics, sciences and art and technology, digital image option, under the supervision of Marie-Hélène Tramus, Université Paris 8, 2010, p. 199-201.

9 CHU de Grenoble, service de neurologie et de psychiatrie, unité épilepsie.

10 INSERM U1028 - CNRS UMR5292, équipe DYCOG du Centre de recherche en neurosciences de Lyon.

11 Philippe Fuchs, Alain Berthoz and Jean-Louis Vercher, “Introduction à la réalité virtuelle,” *Le Traité de la réalité virtuelle*, third edition, Paris, Les Presses de l'École des Mines de Paris, vol. 1, “L'homme et l'environnement virtuel,” 2006, p. 3-21.

*reality* means “vicariant reality” in English, or in other words a “substitute” reality. In your opinion, is this vicariant virtual reality (a pleonasm) able to generate both virtual simulation worlds that would replace the real world (flight, surgery, chemical molecules modelling simulators, etc.) and imaginary worlds created by artists, worlds in which people immerse themselves and interact?

**Alain Berthoz.** Nowadays, the association of technology and creativity (not only the artists’ but also—and I insist on that point—the engineers’) has resulted in an amazing proliferation of virtual reality techniques, taking on traditional forms (such as video games played with joysticks or gamepads), or taking the body movements into account (in the exact same way as what you call *performance art*). These different virtual reality modes indeed resort to the vicariant properties of the brain, the versatility of which does not simply allow to enrich the representation of the world on a screen, but also to give people the impression that they are in another world.

**Marie-Hélène Tramus.** How to achieve this illusion of being in another world?

**Alain Berthoz.** I consider the issue of avatars as a major issue. As we started to work together on *La Funambule*, we were in an imitation paradigm. Today, we would rather talk about sympathy, emotional contagion, mirroring system, etc. Little by little, with you, Michel Bret, Bérangère Thirioux and Gérard Jorland,<sup>12</sup> we have developed this paradigm, because we have noticed that the brain is able to feel sympathy, but also empathy (*Ein-füllung*), which means that it is able to put itself in the virtual avatar’s place. In this way, we have brought a new system to light, which is studied in children by Jean Xavier and Soizic Gauthier, in professor David Cohen’s child psychiatry department at the Salpêtrière hospital, in cooperation with psychoanalyst professor François Villa. The issue of the projection of the self in the avatar’s place and intention is a fascinating and difficult one.

At present, an enthralling work is being carried out at the crossroads between digital arts and neurology, and even traditional clinical neurology, on this issue of our ability to project ourselves into an artificial creature. This work sheds light on the issue of the double, implying that we are essentially twofold. There is a twin version of our self that allows us to dream and carry out seemingly real activities while we dream. The brain does not need the outside world to create anything.

On this issue, I am currently cooperating on three works. The first one, with Étienne Armand Amato and Étienne Péreny, focuses on an avatar that allows for the projection of oneself into the virtual world. The second one, with François Garnier from the École nationale supérieure des arts décoratifs, and psychiatrist Simon Lambrey, aims to understand what enables the projection into a virtual world, but also how the avatars are able to communicate with one another in the virtual worlds. François Garnier has designed virtual museums in which two people, each one in their own home, can project themselves through their personal avatars and discuss in front of a virtual painting. He was struck to see how people had the impression to be teleported. We will try to understand the factors conveying this impression of a social communication between the avatars in the virtual world. The third work also focuses on the issue of communication, and is conducted in cooperation with two young artists, Claire Sistach and Soizic Sanson, who immerse

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<sup>12</sup> Bérangère Thirioux, Gérard Jorland, Michel Bret, Marie-Hélène Tramus and Alain Berthoz, “Walking on a line: A motor paradigm using rotation and reflection symmetry to study mental body transformations,” *Brain and Cognition*, vol. 70, no. 2, 2009, p. 191-200.

themselves in virtual worlds. Therefore, the link between neurology, psychiatry and digital arts on this issue of avatars is rewarding as far as the realities-illusion theme is concerned.

These works are very interesting, not only because the youth of today spends hours in virtual worlds creating one or even several avatar(s) to play, but also because these practices now spread to the world of work. There are virtual factories, in which people make their avatars work. Virtual universities are being developed. I would like to emphasize the importance of conducting researches on virtual worlds, firstly because of their consequences in the field of psychiatry, since they can be used for entertainment or mediation purposes, but also because they can serve propaganda, as we are witnessing today, with risks of manipulation likely to induce fanaticism.

**Marie-Hélène Tramus.** There is this double, the avatar, in which we project ourselves, allowing for our immersion in virtual worlds. There are these doubles, the avatars allowing us to “telecommunicate” by gathering us in the virtual world, as if we were really there. Finally, there is this artificial “other,” who would be endowed with behavioural independence. In this perspective, you give the example of humanoid robot HRP2, which uses its legs to go grab an object that is initially out of its range, without the use of its legs for that purpose being explicitly programmed. In your opinion, what is the prospect of these researches?

**Alain Berthoz.** Together with his robotics team, Jean-Paul Laumond—who held the technological innovation chair at the Collège de France for a year—has designed this robot capable of finding a vicariant solution. In this case, it is a typical functional vicariance. In the field of the re-education of neurological disorders, one presently tends to use robots, but this poses a problem, as these robots are programmed and often train patients to the function planned by the robot. In this way, one tries to fix the damaged function, while a good re-education robot would in fact give the patient’s brain the possibility to find a vicariant solution that is not included in its re-education program, just like this humanoid does.