THE USE OF MICROSCOPIC IMAGES TO DESIGN RANDOMIC TATTOOS

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ABSTRACT

This article presents and discusses the process "bio-inspired tattoos," e.g., biologically inspired tattoos created as randomically generated images with visual patterns inspired by neural stem cell cultures. It can be summarized as follows: (i) in vitro cell cultures are cultivated; (ii) images of the cultured cells are taken; (iii) the visual patterns of the cell cultures taken in (ii) are analyzed and translated into a sketch to be used as a tattoo design; and (iv) the sketch of phase (iii) is transferred to skin as a randomic based tattoo art. As processual images which present structural unpredictability these tattoos allow the exploration of the active role of random in tattooing. Here we introduce and present the process of tattoo images based on dynamic biological systems.

INTRODUCTION

The exploration of tattooing as a language is directly related to the process of creation of the image to be engraved into skin. Its traditional process is similar to a concept design in which the professional (tattoo artist) seeks maximum control of the results into the skin. In the other hand the exploration of tattooing in terms of new technologies and processes is incipient. This article presents the development of a new project: "bio-inspired tattoos," e.g., biologically inspired tattoos created as randomically generated images with visual patterns inspired by neural stem cell cultures. During the process in vitro cell cultures are cultivated and images of the cultured cells are taken. The visual patterns of the cell cultures are analyzed and translated into a sketch to be used as a tattoo concept and this sketch is transferred to skin as a randomic based tattoo art. The protocols of the cells' culture phase are mainly based on a sequence of washes and an incubation with primary and secondary antibodies that reveals the shape of the desired structure. This processual image presents structural unpredictability allowing the exploration of the active role of random in tattooing. Neither the tattoo artist nor its user choose a specific image. Here we introduce the concept of tattooing based on dynamic biological systems.

Introduction

Before starting any discussion about the bio-inspired tattoos it is necessary to introduce and present the tattoo procedure highlighting the organic response to the ink and how this organic process is important in tattooing.

Tattoo Procedure

In a simplified form, a tattoo is a skin intervention performed through micro perforations that can be done with sharp materials such as bones, animal teeth, pieces of wood and metal needles. [2] The small variation of these materials and methods related to the practice makes clear that the procedure of inserting ink into the skin remains almost the same during the history of tattooing. After the invention of the electric tattoo machine patented by Samuel O'Reilly in 1891, considerable changes in tattooing were made. However, for over a hundred years the device for performing tattoos has remained essentially the same. [1][2] The difference is that instead of using the hand to perform the up and down movement to insert the needle in the skin, with the electric machine this movement is totally mechanical.

During the tattoo procedure, the needle penetrates the skin at an ideal depth that varies depending on the body part at a value of 1.5 mm to 3 mm. If the ink is inserted in the surface layer or epidermis, it is expelled during the skin renewal process and if it is deposited in deeper layers or subcutis, it is possible to be dissolved in the bloodstream (Fig. 1). The ink is inserted into the dermis, the second layer of the skin and it is not expelled because of a typical inflammatory response of the human organism to a foreign body. With the insertion of the ink, the skin starts a process of inflammatory reactions and necrosis followed by the presence of ink inside fibroblasts.[3] The tattoo "causes micro tissue damages and the body start to produce endogenous substances aimed at its cellular and tissue restoration." [4]

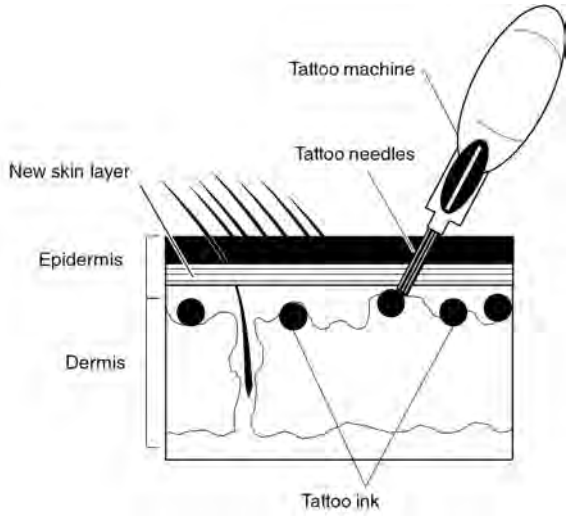

Fig. 1. Insertion of the ink in the skin. *A*dapted by Breno Bitarello. (Source: How tattoos work: http://tinyurl.com/7jfweob).

The intradermal process can be summarized as follows: although the skin intensely renews itself due to the constant cell replacement, it does not absorb the pigments because they are in the dermis surrounded by a network of fibroblasts and collagen. Each fibroblast is surrounded by a conjunctive tissue prominent network that holds and immobilizes the cell. The elimination of the pigment particles is prevented due to the restoration of the basal intact membrane (interface between cells and supporting tissues). [3], [4]

This intradermal process of tattoo ink emphasizes the active role of random during the healing period of the body. Factors such as cell and tissue regeneration affect the healing process and the result of the image on the skin. Thus, it is evident that even seeking full control of the process where the resulting image on the skin should be exactly equal to the concept developed by the tattoo artist, the artist can not accurately predict the organic variables involved. This active role of random can be highlighted in artistic projects, where the tattoo establishes itself as an image in process resulting from factors such as self-organization.

Tattoo and Microscopic Images of Cell Cultures

In order to develop the project bio-inspired tattoos we used technologies and processes from cell biology. As artists do not have the necessary knowledge to work with cell manipulation, the whole work was made possible due to an established collaboration with neurophysiology researchers. The laboratory phase is presented next.

Culturing Neural Stem Cells

All procedures described were approved by the Animal Care and Ethics Committee of Universidade Federal de São Paulo (Federal University of Sao Paulo) and were part of Neurophysiology laboratory projects. The first purpose of these images is the observation of migration pattern and analysis of differentiation of neural stem cells. Stem cells from the telencephalic vesicles of mouse embryos (E14) were extracted and cultured as floating neurospheres for 7 days. Neurospheres are heterogeneous cell aggregates derived from a single stem cell that by asymmetric division give rise to another stem cell and also a progenitor cell. The neurospheres correspond to aggregates formed by neural stem cells and progenitor cells. [5]

The culture media used in the phase of proliferation of neurospheres was composed by DMEM/F-12, 2 mM L-glutamine, 20 ng/ml of FGF-2 (fibroblast growth factor – 2), 20 ng/ml of EGF (epidermal growth factor), 2% PSA (penicillin/streptomycin/antifungic solution) and 2% N2 supplement at 37 °C in 95% humidity and 5% CO2. To study migration and differentiation, coverslips were coated with poly-l-lysine solution, washed with MilliQ water, dried in the laminar flux chapel; 30µL of laminin was added to coverslips and incubated for 30 minutes at 37 °C and then washed with DMEM-F12. In order to allow the differentiation, neurospheres were plated onto coverslisps and cultured in differentiation medium (without growth factors) composed by DMEM/F-12, 2 mM L-glutamine, 2% PSA and 2% N2 at 37 °C in 95% for 7 to 10 days.

During the proliferation and differentiation processes, some images were taken using light microscopy to evaluate the growth and the rate of migration respectively. To obtain these images, no special procedure for staining is necessary since the intention is just analyze the morphology of the cells. After in vitro differentiation, the neurospheres, neurons, oligodendrocytes and neural precursors arose from neurospheres and to analyze cell-fate determination is necessary to label the cells with specific markers using the immunofluorescence technique. Immunofluorescence was performed in plated neurospheres previously fixed in 4% of paraformaldehyde (PFA) and blocked/permeabilized in 1% BSA (bovine serum albumin)/ 0.01% Triton for 30 minutes. Primary antibodies against Nestin (1:500, Chemicon) and GFAP (1:1000, Dako) markers of neural precursors and astrocytes respectively were incubated in PBS solution at 4°C for 1 hour. After washing with PBS, the cells were incubated in secondary antibodies Alexa 488 or Alexa 546 (1:600, Molecular Probes) for 30 minutes. After washing with PBS, DAPI solution (1:10000, Sigma) used as nuclear staining it was incubated for 10 minutes. Images were taken in a Nikon microscope at different magnifications (shown in the subtitles) (Fig. 2).

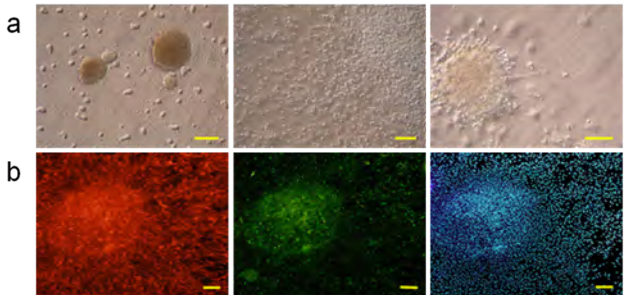

Fig. 2. (a) From left to right, light microscope: Cells cultured as floating neurospheres (magnification 200x), differentiation of neurospheres (magnification 200x) and higher magnification showing neuron morphology (400x). (b) From left to right, fluorescence microscope: GFAP+ (red) and Nestin+ (green) showing the astrocytes, neural precursors. The nuclei were stained with DAPI (blue) (magnification 200x). Calibration bar: 100µm.

Biologically Inspired Tattoos

Bio-inspired tattooing is a process of creation of abstract tattoos based on autonomous systems. The focus here is not only the end result on skin, but the entire process. Although the method to insert the ink in the skin is the same as conventional tattoos, bio-inspired tattoos differ from these tattoos in which what will be tattooed on the customer is governed by his choice and not by the tattooist. The common procedure in tattooing is closer to a development of a craft: the customer chooses an image and this image is tattooed on his skin by the tattooist. In the case of bio-inspired tattoos, the user (canvas/tattoo user) acts as a collaborator. He does not choose what will be tattooed on him. It is not about buying a pre-determined or chosen image that will be transferred to his skin, but to be opened to what is proposed by the tattoo artist in his creative process. The artist acts by transforming and translating the images in each step of the process from nature (cell cultures, translated into photos, photos translated into drawings, drawings translated into paintings that are translated into tattoos) to its application to the body, which in its turn will be in constant change until their utter destruction (death).

Due to its dynamic, the whole process of bio-inspired tattoos is opened to the interference of random, however, due to the role of the artist, we can speak here of controlled random. In other words, the process itself generates opportunities and outcomes which are not intended and planned by the artist, but that would end up being incorporated into the process by the artist. Despite these interferences, the potential of the process of creation of bio-inspired tattoos is in the fact that the whole process, although opened to contamination and interference, be planned, designed and governed by the tattoo artist, who acts as a conductor of contaminant variables.

These tattoos are meant to compose the body following its fluidity and anatomy. The bio-inspired tattoos are supposed to be seen as a process focused on understanding both the specifics of tattooing and the human body and consequently the behaviors of the materials used during the process. Each tattoo is designed to fit a specific body part of a specific person. Factors such as fit and flow as well as depth and readability (the tattoo overall must be visible when seen from a distance) are crucial in the process.

Bio-inspired tattoos

Earlier steps of the concept and process of creation of the cell inspired biotattoos include the development of tattoos based on natural forms like trees (Fig. 3) and plant tissues like xylem and phloem (Fig. 4). As cells are micro structures self organized in a way to form something in a macro scale such as a limb or a tree for example, this step of the process was planned to make clear that the use and organization of visual small structures to achieve an overall sense of fluidity would be explored on a tattoo concept. In this way subsequent tests were started with the translation of images of cultured cells to pencil sketches and digital paintings (Fig. 5) that could be transferred to the body as a tattoo design.

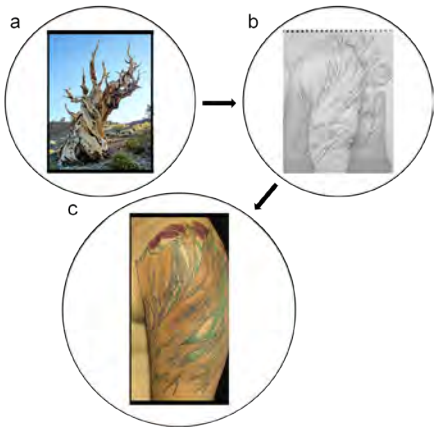

Fig. 3. Early steps of bio-inspired tattoos, tattoo (c) based on an ancient bristlecone tree (a) was adapted from a sketch (b). Source: (a) http://tinyurl.com/kt68gsp. and (b) and (c) by Breno Bitarello.

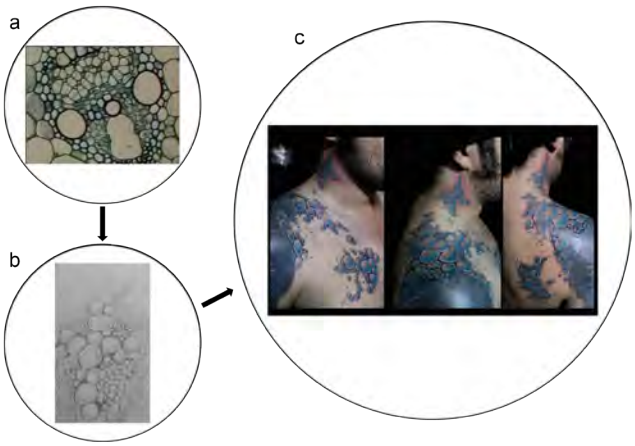

Fig. 4. Early step of bio-inspired tattoo based on plant tissue where (a) is a photomicrograph of xylem and phloem (plant tissues), (b) sketch of (a) and (c) translation of (b) to (a) adapted to the skin. Source: (a) http://tinyurl.com/ldyksuj and (b) and (c) by Breno Bitarello.

Instead of using images found on the internet, books etc., the collaboration with scientists made it possible to build and prepare the references and also to have an archive with photos of the culture cells. In this way the artist would choose and manipulate the references freely. The option for micro structures is due to the fact that as the body is formed by self organized micro structures, it is possible that visual images such as drawings, paintings and tattoos of course, would be planned and conceived as macro structures formed by artistic organization of bio inspired micro structures. In other words, instead of self-organizing images, these images are created by the artist who organizes visual structures in a way to achieve an anatomical overall flowing structure by manipulating the materials and being aware of its specific properties. On the other hand, when the tattoo procedure begins a wide variety of bodily reactions starts. In this way, it is common to see many differences between the tattoo after its transference to skin and the same tattoo after the healing process. Also, since the body reacts to sun, food etc. as time passes some variations can be seen in the tattoo (Fig.6).

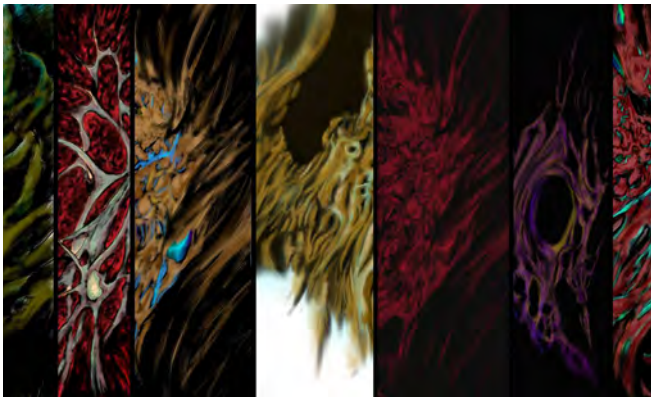

Fig. 5. Digital paintings based on cultured cells. Images by Breno Bitarello.

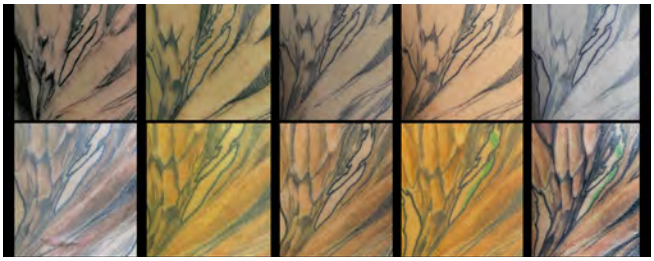

Fig. 6. Variations in the same part of a tattoo. Photos taken in a period of two years. Images by Breno Bitarello.

Research involving cell cultures were developed as follows: neural cell cultures *in vitro* were labeled by *immunocytochemistry*. The *immunocytochemical* reveals a visual pattern generated by the random interactions of the cell culture system. During this process, the self-organizing properties of these living material and its were observed and its stages of organization photographed. These pictures were translated in to sketches, paintings and then to human tattoos (Fig. 7).

Since there are many variables involved in, the bio-inspired tattoos require a complex and long process of creation. Initially it is necessary to perform the cell cultures and capture their images. Only part of several captured images are used for the production of the sketches. When selecting the images the focus is the organization of the cells. The way the cells are placed in the picture is essential in the process of translating these images into drawings and consequently in tattoos. The captured image has to fit the structure of the human body. It involves analyzing if the composition of the photographic image is harmonic to a particular part of the body. In this way, the image needs to function not only as photography, but also as drawing, digital painting and tattoo. Also each medium has its own properties and behaviors. An image designed for paper, canvas or screen (digital) surfaces does not necessarily fit on the skin. Unlike these mediums, the skin is presented as a three-dimensional surface with its specific properties (cell replacement, regeneration, metabolism, volume, elasticity etc.).

Moreover, it is necessary to consider the specifics of each part of the bodywhich varies according to muscle morphology and anatomy. The physical structure of the arm is different from the leg, ribs, back and so on. During the process the importance of how the image will fit the chosen body region and how it flows on the body are the main factors that would be considered a specific property of tattooing. What the famous American tattoo artist Guy Aitchison calls fit and flow are, according to him: two sides of the same coin. [1] The development of these tattoos produces new forms of qualitative properties in tattoos. Both the final result of the tattoo and its process of creation are taken into account. One of the main properties of the bio-inspired tattoos is related to the active role of random. Once the tattoo artist works in a translation and adaptation of the images from one media to another (photography/drawing/digital painting/skin) we can talk about controlled random.

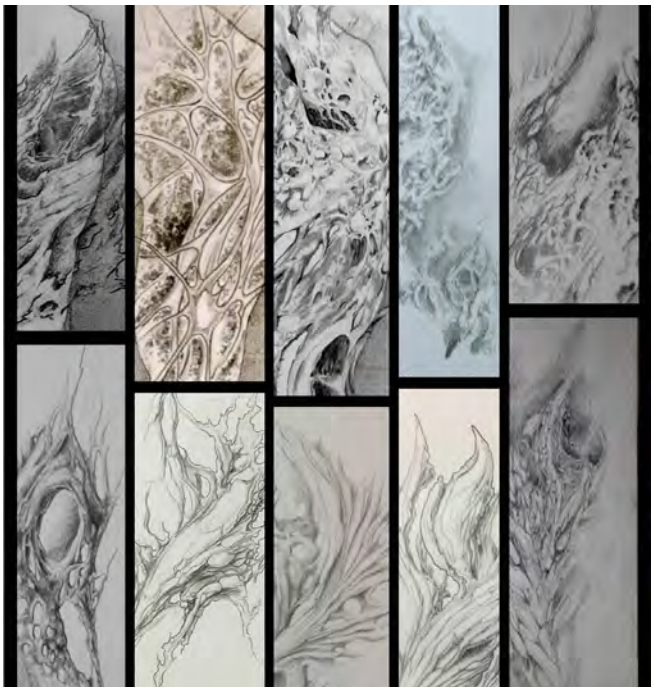

Fig. 7. Digital paintings based on cultured cells. Images by Breno Bitarello.

CONCLUSION

In this paper we described the development of bio-inspired tattoos that presents a new concept of tattoos based on abstract images generated by the self-organization of living systems. The use of natural references when designing a tattoo is not new; however, what highlights the uniqueness of the bio-inspired tattoos is not only its final result (on the skin), but the whole process of creation and the translations and adaptations of the initial reference image. The development of processual images allows new language and technology explorations both for art and tattooing. In subsequent works we will explore the relationships between the bio-inspired tattoos and the use of biology in arts, in specific, how contemporary artists use tattoos in artistic projects.

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