Affective-responsive Environments

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Abstract

This paper describes the concepts, media settings, strategies and methods of a media art work and an artistic research project. Both apply psychophysiological biofeedback technologies as affective interfaces between humans and artificial artistically-staged environments. The paper includes a comparison of media art creation with artistic research processes and intends to identify possible synergies.

Introduction

Together with the musician José Navarro and the architect Markus Braach we are currently working on the media art project "*Affective Environments",* supported by cultural funds. As the working title suggests, we experiment with biofeedback-driven environments, applying different media settings to make artistic statements. Interest in this approach also gave rise to develop the artistic research project "*Designed immediacy: Atmospheric experience in an affective-responsive environment"* together with our colleague Dr. Christiane Heibach from the IXDM (see affiliation). In the course of the next two years we will examine affective human perception in a mediated responsive environment, which will be set up as a physical atmospheric ubiquitous computing space in our new critical media lab.

In this paper we will describe the two projects, their media settings, strategies and applied methods. Furthermore, we will compare the approaches of media art and artistic research and look for differences and possible synergies.

The media art approach

Description

"Affective Environments" is a media art project that invites visitors to interact with three spatially arranged installations in an exhibition space. People get intimately involved in a public setting by connecting their breathing, heart-rate and skin conductance to the exhibits, thereby measuring their affective reactions. The psychophysiological data, which are processed in realtime, alter parametric values and create new affective stimuli, establishing a human-in-the-loop feedback system. Visitors get influenced by and at the same time influence an abstract immersive game-world (exhibit 1: *Sense!* VR system), a video narrative (exhibit 2: *Reveal!* AV system) and a group of robotic creatures (exhibit 3: *Inspirit!* Physical Computing system).

For all three installations we apply biofeedback sensing technologies and work on the basis of psychophysiological interaction. Instead of the common categories of involvement, such as initial, reactive or creative interactivity [1], the focus is set on the level of affect in a reactive environment. The work explores possibilities of interacting with artificial environments on a primordial level, by excluding reasoning and decision-making, thus establishing a more intuitive interconnection between humans and artificial surroundings. We calibrate, filter, average and map the biofeedback data to make the systems recognizably responsive but yet as personalised as possible to create an individual experience for each visitor. Since biofeedback only measures the level of excitement, but cannot detect if the respective person is e.g. happy, surprised, scared or amazed about a discovered principle, the context of the staged environment is crucial for the creation of content. In terms of perception psychology, it is questionable whether this approach makes it possible to correctly represent affective reactions to offered stimuli, but it allows to experiment with human computer interaction (HCI) in a new way.

Each of the three installations invites the visitor to engage in a game-like activity, challenging him/her to find a system of rules in an unknown surrounding. However, an

important aspect is that we use the interaction process to make statements. The three-part work addresses questions of consciousness, such as: “What am I?”, “Where do I belong?” and “How can I take influence?”. With the immersive VR installation we intend to create attentiveness towards one's own body and affect and invite the visitor to interplay with his/her surrounding (see Fig 1/2). In the audiovisual installation the visitor is challenged to reveal moving images of stereotypical paradisiacal settings by extracting them from an abstract three-dimensional space displayed on a monitor and headphones (see Fig 3/4). To be successful, the visitor needs to stay calm and produce regular biofeedback data. This interactive process of extracting figurative images and sounds from an abstract data visualisation space is meant to represent the difficulty of finding inner peace and calling in modern society. The last exhibit is meant to engage the visitor emotionally by confronting him/her with robotic creatures. With their own heartbeat visitors can revive an apparently weak creature, but unexpectedly find themselves in a situation of dependence when trying to leave the installation. This installation is meant to address issues like well-intended but inappropriate help, sustainable responsibility as opposed to the missionary chauvinism of Western culture, etc." (see Fig 4/5).

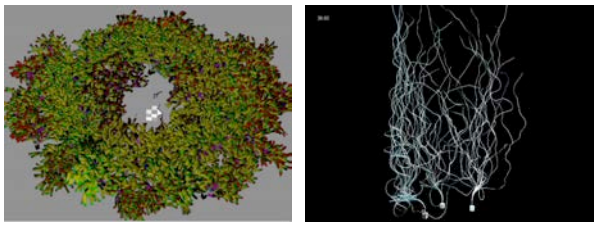

Fig 1/2. *Sense!*, 2014/5, Jan Torpus, Markus Braach, José Navarro. Studies for the VR Space.

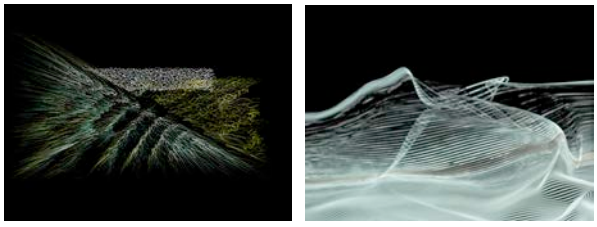

Fig 3/4. *Reveal!*, 2014/5, Jan Torpus, José Navarro. Screenshots of video sequences, dissolved in 3D pixel space.

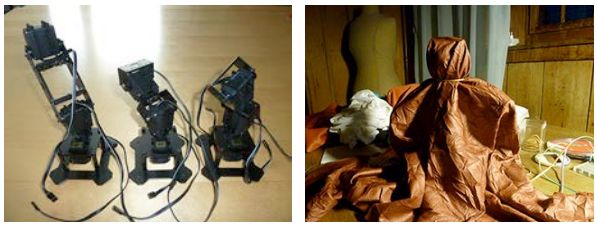

Fig 5/6. *Inspirit!*, 2014/5, Jan Torpus, José Navarro. Robotic arms (based on Trossen Sys.) and skin material tests.

Media and artistic strategies

Although the mode of interaction is the same in all three installations, they are based on different media approaches and artistic and dramaturgic strategies to create experiences and to engage the visitor in a hybrid entourage.

The first installation audiovisually draws the visitor into its virtual space. The perception of image and sound is dominant in this synthetic environment, but the spatial qualities of VR create a lifelike immersive experience and allow free realtime exploration. Sitting on a rotary chair – sensing touch, gravity and centrifugal force – connects the visitor to physical space. These remaining connections therefore have to be designed carefully, using appropriate surface materials and resistance of rotation as much as accurate effects of inertia in the virtual world to create sensomotoric immersion [2]. The spatial situation and appearance of the exhibit, including the biofeedback interaction device and the process of sitting down and putting on the head-mounted display is also important. It represents the transition and the ritualized act of entering the magic circle [3]. Tactical immersion [4] is equally important and accomplished by a game-like structure. The visitor becomes a player and has to find out how to navigate through the virtually staged space. The data tracks of respiration, heart-rate and skin conductance are linked to specific parameters of the virtual world and dynamically alter the immersive scenes. Applying established digital game principles, like a mission to be accomplished, a reward-and-punishment-system or the definition of hierarchical game levels, supports the basic comprehension of the narrative and allows more artistic freedom to create abstract poetic environments and to apply the unconscious biofeedback mode of interaction.

In the second exhibit the visitor gains access to virtual space through a window and is only acoustically isolated from physical space by wearing headphones. The complexity of the media setting is similar to that of an everyday situation in real life, except for its location in a (culturally defined) semi-public space and the access to biofeedback. In new media exhibitions interactive AV-installations with interface devices are common and therefore do not constitute a barrier for entering the non-linear mystery story. The difficulty lies in gaining access to the narrative level during the interaction process: The story wants to be told, but it hides from the spectator. The figurative scenes will only reveal themselves, if the visitor interacts with dedication, patience and calmness. Technically spoken, the visitor needs to produce regular respiratory patterns, minimal heartbeat variability and stable Galvanic Skin Response (GSR) values. It is a game with one major threshold per video scene that is accomplished once the content becomes recognizable. At the beginning of each clip the biofeedback measurements are dynamically represented in an abstract 3D pixel space, and only successful interaction on the part of the visitor

leads to immersion in the preprocessed video scenes. For better access and in order to avoid too much frustration, the system sporadically offers easier entrances and displays a teaser when in idle state to spark the interest of visitors passing by.

In the third installation, the visitor remains in the physical exhibition space and is only digitally connected to the exhibit through the biofeedback human-in-the-loop circuit. The exhibit has a primordial affective impact because of the physical presence of robots resembling creatures with specific behavior patterns. It is just a disguised motor-driven sculpture with a biofeedback interaction device, but the visitor can mentally and emotionally enter the vivid "bonsai scene". Biofeedback becomes visible through rhythmic robotic movements, confirming the visitor's intentional interaction. The objective is to engage the visitor emotionally, to make him/her feel guilty and reflect on the individual experience in retrospect: inquisitiveness, the giving of well-intended and spontaneous help, increasing involvement, assumption of responsibility, excessive demand, irreversible consequences of one's own actions. In order to involve the visitor in this exhibit, it is crucial that the behavior patterns of and correlations between the creatures are empathically recognizable. They have to create a situation of affordance [5], so as to invite the visitor to interact. Since the physical sculpture is rather unusual for an interactive exhibition setting, the interface device is a visual and integral part of the exhibit, meant to encourage interaction.

Biofeedback interaction in an exhibition situation

We gained some insights into biofeedback interaction in artistic settings with the video art installations "*affectiveCinema 1 and 2" (2001 to 2003)* [6], based on realtime GSR measurements. Interacting with an artificially staged object or environment based on personal emotions creates an intense encounter with one's primal self. First of all, showing intimate emotional reactions in a public setting can lead to an uncomfortable situation and cause considerable distress. We are used to being able to hide or suppress what is now suddenly on "public display" and visible to other exhibition visitors. Nevertheless, visitors sometimes become playful and develop surprising ideas as to how they can influence the system. Others uncritically accept the artistic setup as a mirror of emotions and personality and seek confrontation with themselves, at times to the extreme of worrying about their physical and/or mental health.

In everyday life we are expected to maintain control of our material surroundings, we are involved in causal processes and act and react according to our life experience. We are only used to communicate with other humans in affective, culturally encoded ways. Establishing a similar link to the material world creates an unknown and intriguing experimental situation. The installation invites the visitors to attentively observe, contrive and verify modes of communication. On the one hand, the entourage can be seen as a spatially arranged ambient display that mirrors personal emotions as a fancy data visualization, replacing simple diagrams. On the other hand, it can be perceived as a counterpart with artificial intelligence and emotion, which mainly evolves from the visitor's interpretation. This tension between perception of intrinsic processes and encounters with something unfamiliar gives rise to interesting questions regarding people's awareness of their own impact on the respective surroundings and their personal identity.

The artistic research approach

We explore similar questions in the artistic research project "*Designed immediacy: Atmospheric experience in an affective-responsive environment"*, funded by the Swiss National Science Foundation. Departing from a notion of holistic bodily experience and media, developed in current phenomenological approaches, we aim to examine the affective human perception in a mediated responsive environment. We are interested in finding out whether such an intelligent responsive space can be perceived as a *second skin*, as an endogenous but inspiring organ that questions our self-conception and influences our behavior.

We also refer to ubiquitous computing (ubiComp) technologies. While ubiComp is function-oriented and designed to improve modern life style, we intend to make the intelligent networked space emotionally responsive. We want to contribute to the development of our increasingly technology-infiltrated life-world, taking into consideration aesthetic, perceptive and critical aspects. The objective is to explore alternative ways of influencing our surroundings and to find out whether it is possible to recognize the moment when the surroundings take over agency [7]. Smallest alterations of algorithms and parameter values can turn a pleasant entourage into an omnipresent and manipulating data collector. For example: After a while of exploration a participant recognizes that his/her breathing pattern has direct effect on atmospheric changes like color and brightness of light of the surrounding stage. During the calibration process the system calculates average values and afterwards slowly turns from a realtime biofeedback indicator into a guiding metronome. The question is: How far can this go before the person in question realizes that his/her breathing pattern is being dictated by the atmospheric metronome?

Media and research methods

Amongst other challenges we are exploring design principles and dramaturgic strategies for an affective-responsive physical environment. We will therefore develop an artistic experimental setting, an "*epistemic installation*" [8], to examine the immersion experiences of

invited test persons. It will be based on biofeedback sensing and spatial tracking technologies to capture affect and behavior of a person located in an atmospherically staged room. The person will be connected to the artificially composed space and parametrically influence light, color, sound, movement, etc. and will in turn be influenced by the surrounding atmospheric changes.

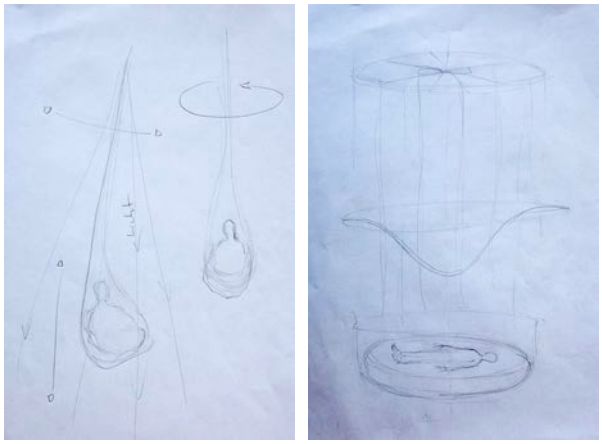

Fig 7/8/9. 2014, Christiane Heibach, Jan Torpus, Andreas Simon, hand drawings of possible spatial setups, © Jan Torpus.

Since connectivity with the involved person is to take priority over artistic expression, we will not work with a predefined script, but will develop the setting bottom-up, based on increasingly complex and multi-layered heuristic experiments. Breathing as a biofeedback input, for example, ensures that the test person can actively influence the setting upon recognizing the connectivity. Sooner or later, she will begin to breathe naturally, providing measurements that can also be analyzed in respect of regularity. We will gradually enrich bilateral sensor-actor scenarios so as to create more complex scenes with various parametric changes and affective response options in order to provide a full atmospheric experience.

While it is possible to measure and combine multiple data channels, strong and clear effects can already be obtained – as described above – based directly on simple, periodic physiological signals such as breathing or heart-rate. A well-researched example that demonstrates the possibility of manipulating direct feedback of a single physiological parameter is known as the "cognitive effect of false heart-rate feedback". The false feedback effect, first described by Valins [9], typically uses only auditory feedback – e.g. a beep to represent the heartbeat – to display a participant's heart-rate. During the experiment this feedback is manipulated and test persons are presented with heartbeats that are faster or slower than the actual, measured heart-rate. By this false heart-rate feedback the test person's appraisal of his/her own psychological state is altered. A positive (amplifying) feedback loop on the actual heart-rate can be invoked, which can even induce anxiety and panic [10, 11]. The real change induced in the person's heart-rate is consistent with the hypothesis of a positive feedback cycle between anxiety and physiological symptoms. Invocation of anxiety in these experiments is evaluated through questionnaires and interviews and by obtaining measurements of the galvanic skin response.

The experiments described above were originally designed to investigate the coupling between two levels of emotional experience: phenomenology and awareness, exploring the hypothesis regarding the coupling between psychological / emotional states and their conscious appraisal [12] (e.g. through the direct perception of physiological parameters). What is interesting in this theoretical model and the corresponding experimental designs for our approach – that aims to control the perception of the environment through biofeedback – is that this invocation of a positive feedback loop on the physiological state of a participant is induced by a) transferring the perception of a physiological symptom to a direct external representation and that b) the feedback is triggered by introducing a manipulation of the display that does not reflect the actual, "true" physiological measurement. As previous research has mostly explored the effect of simple and direct auditory feedback, it is our aim to investigate more complex scenarios and interactions, such as the effect of dynamic, coupled feedback and the use of more complex and combined display modalities such as visual display or haptics.

After basic experiments on human computer connectivity and with acquired know-how regarding multi-sensor and multi-actor systems, we will explore sensor-actor mapping optimizations, temporal sequencing and learning processes, buildup of narrative structures, metaphoric expression, creation of expectations, missions and surprises and hints for free imagination.

We apply evaluation methods from different scientific disciplines like ethnography and qualitative social research (observation, retrospective interview, think aloud protocol, video and audio recordings), quantitative analysis of the collected biofeedback measurements and recordings of the parametric systemic states. Furthermore, we triangulate the results as time-based tracks to be able to synchronize the atmospheric changes and the effects they have on the test person in one media document that can be evaluated.

Comparison of artistic and research approach

After describing a media art and an artistic research project addressing a similar topic, we would like to point out some differences between the approaches and the potential of possible synergies.

The products of media art projects are normally exhibits, like audiovisuals, installations, events or performances shown in virtual or physical exhibition spaces, at festivals or in public space. By creating them, artists or groups of artists want to make a critical statement, show something in its true light or simply tell a story or seduce the senses

with aesthetic enactments. Besides creative satisfaction and artistic expression, the artistic credits are a crucial motivation. The addressees and quality managers of the artistic product are the cultured public audience and the critics and media reporting on it. The goal is to get a strong feedback, be it positive or negative, but the public resonance should ideally have a lasting impact. The process of artistic creation is definitely a process of studies and investigations, but normally it does not adhere to specific rules, methods or documentation processes. Serendipity, lucky failure, random composition and provisional knowledge are also useful components of the scientific lab, but in the artist's studio, where methods and strategies, analysis and synthesis can be adapted to new inspiration and insight at any given time, they find optimized conditions. This freedom of interpretation, composition, and statement are valuable aspects that can inspire and dynamize methodologically restricted research processes. Unproven claims or simple fakes, which are common in the art world, can provide feedback from the public or specific target groups. The most classic approach for bringing art and science together is artistic representation of scientific results, which can be opinion-forming and improve both the commercial appeal and the educational value.

Research objects are normally not expressive or meant to entertain or confront a public audience, but epistemic or the product of solid analysis, knowledge and development processes. Their design is based on a model that directly follows a pre-formulated hypothesis and often appears stripped down and simplified. The desired response is ideally reduced to a single, causal relationship between parameters of the model that are measurable and that can be statistically interpreted. Often – and this clearly distinguishes it from an artistic goal – the subject/observer is not even aware of her reaction and performance with respect to the researched phenomenon.

Although researchers are equally interested in acknowledgment of their scientific work, they are rewarded for the documentation and text-based referenced publications of their findings in the respective communities, in particular when later work of other researchers is directly based on their models and results. In commercially independent research a disproved hypothesis can be equally valuable as an approved one, because it excludes a viable approach in a standardized methodical setting. A promising approach from artistic research for the media arts is to renounce a precisely predefined script and to build the artistic implementation of the content bottom-up on experiments, ethnographic evaluations of audience feedback. This is especially valuable if the media artwork is based on novel interaction or media forms with little existing public media literacy. In addition, an accompanying project analysis and documentation, which in the arts is often kept simple or left to the critics, can be useful for the development process and clarification of the artistic statement.

Artistic or scientific data visualization

In interactive media arts it is a common approach to choose any realtime data stream (e.g. position of transport system items, financial transactions, amount of electro smog, number of visitors in the local exhibition space, etc.) to develop a unique artistic display (virtual or physical) and an extraordinary interface or mode of user interaction to create a piece of art. Only after reading a longer artistic statement the visitor can recognize patterns and distinguish the sophisticated data visualization from a randomly created and purely entertaining audiovisual. This raises some questions: "How explicit should the context of source material and representation be and what makes a data visualization become art?" From the perspective of the sciences the question concerning data visualization is: "How poetic and entertaining can information be treated and what is the added value for the sciences if public perception of it changes?"

Another critical distinction that is deliberately blurred in the presented artistic research approach lies in the difference between artistic and scientific motivation, in particular in the distinction between the subjective response and a participant's appraisal and the model-based, causal interpretation of a quantified, measurable effect. As we aim to evoke affective responses to our installations by experimenting with biophysical signals, we are bound to oscillate between two research modes: artistic impulse and a model-based instrumentalization of measurements.

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