

Splicing Boundaries

The Experiences of Bioart Exhibition Visitors

WOLFGANG KERBE AND MARKUS SCHMIDT

ABSTRACT

Bioart can cross the line between the scientific domain and that of arts and may touch the boundary between the living and the nonliving. This study addresses how visitors to a bioart exhibition experienced the hybrid aspects of this form of art. Semi-structured interviews were held with 119 visitors to the *synth-ethic* exhibition in Vienna, Austria, in May and June 2011. Analysis shows that for a majority of visitors the use of bacteria and lower organisms does not pose an ethical problem, whereas integration of higher animals or even humans into the artwork is not readily accepted.

AIM OF THE STUDY

The aim of this study was to investigate visitors' responses to a bioart exhibition. We tried to answer the following research questions:

1. How do gallery visitors judge the use of living organisms in these art exhibits?
2. What role does the issue of boundaries play in the reception of the ethical aspects of this bioart exhibition?
3. How do people experience disciplinary boundaries concerning the art/science interface in these artworks as well as the scientific disciplines involved?

Wolfgang Kerbe (researcher), Biofaction KG, Grundsteingasse 36/41 1160, Vienna, Austria. Email: <kerbe@biofaction.com>.

Markus Schmidt (administrator), Biofaction KG, Grundsteingasse 36/41 1160, Vienna, Austria. Email: <schmidt@biofaction.com>.

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Article Frontispiece. Adam Brown and Robert Root-Bernstein, *Origins of Life: Experiment #1.4*, installation, 2011 [3]. (© Adam Brown) The artist re-enacted the famous Urey/Miller Experiment in an aesthetic gallery installation. Instead of an early-Earth atmosphere, Brown and Root-Bernstein attempt the synthesis of organic molecules in contemporary air in the presence of seawater and induced by electric sparks.

THE BIOART EXHIBITION SYNTH-ETHIC

We hope to provoke our visitors to reflection with this intriguing exhibit, whose meaning may not be apparent at first but perhaps at second glance [1].

The bioart exhibition *synth-ethic* [2] was hosted by the Museum of Natural History in Vienna from 13 May to 26 June 2011.

synth-ethic assembled 10 contemporary artists who in recent years had begun to employ laboratory methods and biotechnology for their own purposes in new contexts and to modify living systems. The artworks were curated under the broad theme of synthetic biology (SB), the aim of which is not only to modify existing organisms but also to design or even create life anew. The aim of SB is to make biology easier to engineer by applying engineering principles to biology. Although these are still the early days of SB, the potential consequences of this scientific and engineering field call for an ethical engagement. The exhibition *synth-ethic* offered perspectives on human intervention in biotechnology and the responsibilities that arise with it. Artists appropriated these technologies for their own purposes, seeing through the mania of novelty, behind the engineering mantra and beyond the constraints of economic return on investment. The artwork presented in the exhibition examined a number of boundaries at the intersection of molecular biology and ecology, architecture and biochemistry, technology and nature, as well as cybernetics and alchemy.

The exhibition featured 10 artists (Article Frontispiece, Color Plate B and Figs 1–8) [3–12]. In addition, Sonja Bäumel provided an exhibit for the entrance hall that was not included in the exhibition itself (*Cartography of the Human Body* [13]).

BIOART AND BOUNDARIES

As of 2005, bioart did not have a widely accepted definition. Hauser stated that year, writing for *Ars Electronica*:

As a medium, Bio Art does not permit itself to be nailed down with a hard and fast definition of the procedures or

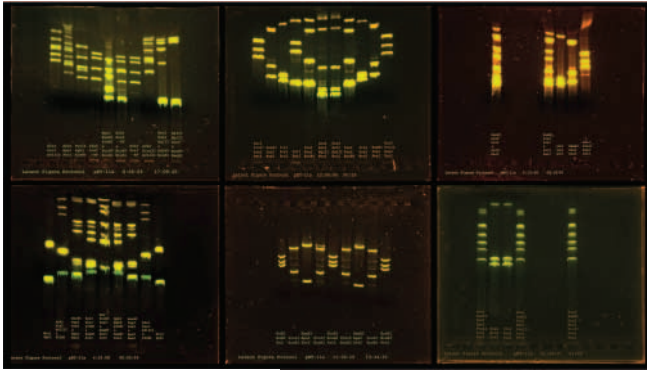


Fig. 1. Paul Vanouse, *Latent Figure Protocol*, installation, 2007–2009 [4]. (© Paul Vanouse) *Latent Figure Protocol* represents manipulations of so-called genetic fingerprints. By using analytic laboratory methods, Vanouse synthesizes significant motifs such as the copyright symbol or the skull and crossbones.



Fig. 2. Roman Kirschner, *Roots*, installation, 2011 [5]. (© Roman Kirschner) An analogy to the ideas of the French scientist Stéphane Leduc, who coined the term “synthetic biology,” this installation exhibits a resemblance to inorganic crystal growth with properties similar to organic life forms. With the help of electric current, Kirschner creates a four-dimensional crystal object in liquid solution.



Fig. 3. Art Orienté objet (AOo: Marion Laval-Jeantet and Benoît Mangin), *Que le cheval vive en moi*, installation, 2011 [7]. (© Art Orienté objet. Photo: Miha Fras.) *synth-ethic* featured the outcome of a performance in February 2011 by AOo’s Marion Laval-Jeantet, whose immune system had been prepared for the injection of a cocktail of horse immunoglobulines without inducement of anaphylactic shock. The performance represents a continuation of the centaur myth in which the anthropocentric attitude inherent in our technological understanding is questioned.

materials that it must employ; the “manipulation of the mechanisms of life” assumes a very wide variety of forms both with respect to discourse and technique [14].

Meanwhile, the definition by Capucci and Torrani as well as Gessert [15] that bioart is art composed partly or entirely of living, nonhuman organisms, and/or art created in association with nonhuman organisms, remains in common use. Capucci and Torrani have classified a subset of bioart as biotech art. By this definition, it includes art that contains technologically manipulated biological elements. This manipulation would include genetic engineering, tissue culture and other interventions such as synthetic biology.

One aspect of bioart is its transcendence of boundaries. It can cross the line between the scientific domain and the domain of art [16] and it may touch the border between the living and the nonliving. Although several of the pieces in the exhibition fell within Capucci and Torrani’s definition, this is not so clear for those, such as *Origins of Life* and *Pro-tocells*, that explore the boundary between the living and the nonliving, thus challenging the boundaries of bioart itself.

Boundaries of Life

Are there categories of life? Biologists would answer readily, presenting the whole discipline of taxonomy. However, as regards ethical issues such as the moral status of natural or artificial life, the boundaries must be drawn somewhere other than simply between species.

This leads away from mere biological definitions of life to a broader philosophical discussion. Christian Martin [17] points out that “life” is not a merely descriptive phenomenon but also includes a normative component. He suggests a differentiation of the term *life* into three steps: (1) “mere life,” (2) “prereflexively self-conscious life” and (3) “reflexively self-conscious life.” The prototype for mere life is that of single-cell organisms, whereas self-conscious life encompasses the experience of a “self” in the form of pain. Reflexive self-conscious life entails understanding, judgment and the ability to conclude.

Even in biology, there is no satisfactory definition of life. Most attempts to describe what life is are limited to a list of functional features of life [18]. Molecular biologist Steve Benner describes this approach as a “laundry list” of criteria that must be met for something to be described as life, but any such list necessarily rests on the biases of the person creating it [19]. Therefore it is hard to define a boundary between the living and the nonliving, even from a scientific point of view [20].

Disciplinary Boundaries

Bioart today is a contemporary of synthetic biology. The *synth-ethic* exhibition catalogue made explicit that the new technoscience called synthetic biology challenges our ethical approach toward biotechnology by applying engineering principles in biology. Synthetic biologists intend not only to understand life better but also to utilize it in applications to minimize and optimize, to variegate and transcend life, to design and to standardize it [21].

A fundamental trait of synthetic biology is its interdisciplinary character. To be able to deal with the complexity of biological systems, synthetic biology crosses disciplinary boundaries. So, in a way, does bioart, which crosses not only disciplinary borders within science but also the line between science and art.

In the context of boundaries and biotech art, this study attempted to address the questions mentioned above.

METHOD

Research Design

We carried out 109 semistructured interviews (70 in German and 39 in English) with 119 interviewees who visited the *synth-ethic* exhibition between May and June of 2011. The duration of the interviews, excluding the demographic component, varied between 1 and 12 minutes, with an average time of 3 min 14 sec (SD = 1 min 42 sec). The questions concerned the visitors' general impression of the exhibition, the exhibits that lingered in their minds, general associations and the artistic and scientific aspects, as well as the ethical issues addressed. Interviewees were asked what they thought about the use of living organisms in the art exhibits and finally they were interviewed about their motivation to come to the exhibition. In addition, we solicited demographic details concerning gender, age, education, profession and levels of interest in art and in science.

Participants

A total of 54.6% of interviewees were male. Age ranged from 13 to 67 with an average age of 36.1 years (SD = 14.0); only 4 interviewees were younger than 18.

The interviewees were selected based on the time that they spent in the exhibition. The interviewers (graduate students) chose visitors who had spent at least 5 minutes at the exhibi-

tion. Of the people who were invited to an interview, 33% declined the request.

Participants were also asked to rate their interest in art and in science on a scale from 0 to 7. To obtain an impression of whether people favored art or science, the difference was calculated between the two items. The distribution is shown in Fig. 9, which shows a likeness to a normal distribution, with the mean slightly below zero (−0.54).

This difference between the means of the groups can also be shown with a t-test ($T = -3.802$; $df = 118$; $p < 0.05$): thus the interviewed visitors were slightly more interested in science than in art. However, the graph shows also that most participants had similar levels of interest in art and in science.

Figure 10 shows that the interviewees had on average a high formal education and included many students and academics.

Data Analysis

We analyzed the semistructured interviews using quantitative and qualitative content analysis. For the identification of disciplines, we applied a simple word-count statistic. The art exhibits were counted only once per interview in which they were mentioned (compare Table 1). We mainly analyzed the data using structuring content analysis techniques. Then the quotations were paraphrased, summarized and then coded again using inductive open coding strategies [22]. We used ATLAS.ti software for qualitative data analyses.

RESULTS

Boundaries between Disciplines: Synthetic Biology or Chemistry?

Although synthetic biology was mentioned explicitly in the exhibition guide, and in spite of the title *synth-ethic*, the term *synthetic biology* was mentioned only six times over

TABLE 1. Number of total quotes containing a particular exhibit (Total), compared with the number of quotes about an exhibit in connection to ethics/morals (Ethics).

Artist	Exhibit	Organisms Included	Total	Ethics
Art Orienté objet	<i>Que le cheval vive en moi!</i>	Human and horse	34	10
Cohen & Van Balen	<i>Pigeon d'Or</i>	Pigeon and bacteria	18	8
Tissue Culture and Art Project	<i>Semi-Living Worry Dolls</i>	McCoy cells (Mouse cell line)	31	2
Andy Gracie	<i>Autoinducer_Ph-1</i>	Rice plant, azolla plant, cyanobacteria	29	1
Tour & Chanteau	<i>NanoPutians</i>	None: organic chemistry	23	1
Roman Kirschner	<i>Roots</i>	None: organic chemistry	16	1
Rachel Armstrong	<i>Living Chemistry and A "Natural History" of Protocells</i>	None: organic chemistry	15	0
Paul Vanouse	<i>Latent Figure Protocol</i>	Only indirectly, DNA sample from artist's cells	12	0
Adam Brown	<i>Origins of Life</i>	None: organic chemistry	12	0
Joe Davis	<i>Bacterial Radio</i>	Transgenic bacteria	3	0
Sonja Bäumel	<i>Cartography of the Human Body</i>	Bacteria	3	0

the course of all 109 interviews. In comparison, words relating to genetic engineering, such as genes, cloning or genetic manipulation, were mentioned 30 times, and the term *biology* 33 times. Surprisingly, the term *chemistry* was coded 53 times. This is possibly due partly to the chemical symbols on the exhibition poster and the association of synthesis with chemistry. Furthermore, according to recent survey data, only 17% of Europeans have heard of the term *synthetic biology* [23].

BOUNDARIES: THE ACCEPTANCE OF LIVING ORGANISMS IN ART EXHIBITS

Analysis of the interviews shows that for a majority of the visitors, the use of bacteria and simple organisms does not pose an ethical problem, whereas the integration of higher animals (e.g. pigeons/horses), let alone humans, into the artwork is much less well accepted. For 91 interviewees, it was OK or even positive to use living organisms. Only 15 visitors judged it entirely negative. Three interviewees had a clearly ambivalent attitude toward the use of living organisms in the exhibits. However, there were 16 statements on limiting the use of living organisms or cells for arts projects. These interviewees argued that using microorganisms is acceptable but did not readily tolerate the use of vertebrates—for instance, pigeons, horses or human beings.

Furthermore, when comparing how often the exhibits were mentioned in total with respect to ethics, the ones that featured vertebrates came out much higher, indicating that there are clearly ethical issues involved (Table 1).

ETHICS IN GENERAL: A NEED FOR BOUNDARIES?

As mentioned above, when questioned about the ethical aspects of the exhibition, many respondents alluded to two of the art exhibits, in which birds (8), a horse and a human being (10) were involved. For two respondents the ethical issue of the exhibition was the involvement of animal experimentation.

For some respondents the exhibition concerned interfaces between nature and the artificial (2), between technology and nature (2), between science and art (1) or between technology and life (1). They clearly articulated the transcendence of these boundaries in the exhibition.

Many respondents (12) claimed a need for boundaries as regards the development of the technologies in the exhibition.

Some were afraid of science or technology pushing or crossing these boundaries (2). With respect to ethics, the interviewees were reminded of the discussion about genetically



Fig. 4. Revital Cohen and Tuur Van Balen, *Pigeon d'Or*, installation, 2011 [8].
 (© Revital Cohen and Tuur Van Balen) By using “biobricks,” Cohen and Van Balen try to manipulate bacteria in the intestines of pigeons to make the pigeons defecate a soap-like substance. *synth-ethic* featured installations for feeding these pigeons and for using them to clean the windshields of a car, freeing them from the stigma of being “flying rats” and turning them into flying cleaners.

engineered food (4), genetically modified organisms (1) and genetic engineering in general (2), but also of stem cell research (2). Many thought about ethical implications of these applications in a positive (9) as well as in a negative sense (2) and about future possibilities (3). Some spoke about the mechanization of life (2). In a negative light, potential misuse for economic interests was discussed (2). One respondent was reminded of a chemical computer. Some stated that the ethical aspects of the exhibition imply that we have to take care of the environment, nature and limited resources (8). This results in a great responsibility (5) that we have.

Others found ethical challenges in the manipulation of organisms and in the interference with life or nature (12) or even the creation of new life (3). God as creator was mentioned three times. The interviewees also talked about human enhancement or eugenics (6).

Several respondents discussed the question of the use of organisms for art exhibits in the context of general ethical questions (10). One respondent was afraid of the incalculable results of these developments. Interviewees also thought this development to be unstoppable (3). Some others underscored the importance of estimating consequences and of technology assessment (4). Two interviewees said that there should be more information for the public and more science communication about these issues.

THE ART-SCIENCE INTERFACE/BOUNDARY

The Art Aspect

While 32 people did not respond to the question about ethics, only 9 did not want to say anything about the artistic aspect of the exhibition. The predominant response, when viewers were asked about the exhibition, was a positive one. The art was characterized as creative, interesting or aesthetic

(28). It was also frequently seen as something new, novel and unknown (18).

Some saw the exhibition as very artistic (7), others did not find the exhibition very artistic (10) or were ambivalent (4). Some interviewees stated the exhibition did not suit their taste (3). Eleven respondents stated that the exhibition was not an art but a science exhibition. The art was believed to be inspiring for science and art projects (2), critical or provocative (3) but on the other hand also as hard to classify (3) and hard to understand (9). Some respondents described the art aspect as strange, awkward or disturbing (9), some as offbeat (2). The exhibits were classified as abstract (3), sometimes too abstract (1). One person said that this was chemistry seen through the lens of the artist; one called it conceptual art and another high-tech. One respondent said that this kind of artwork is connected with great effort on the part of the artists. Three persons said they had expected something else.

The Aspect of Science

While 30 statements about science were entirely positive (e.g. “interesting”), 23 respondents claimed that they did not have enough knowledge to understand the scientific aspects of *synth-ethic*. Another 10 complained about a lack of good description or explanation of these aspects, and 4 persons complained about a lack of time for understanding the scientific aspect. Two respondents made ambivalent remarks about the science in the exhibition.

Some interviewees regarded the exhibition as a good way of teaching science and as science communication (5); some found it inspiring for future arts or science projects (4). The exhibition was described as very scientific (5), mysterious (2) and high-tech (2).

Three people identified the scientific aspects of the exhibition as chemistry.

Two respondents claimed that the scientific aspects of the exhibition must be judged exhibit by exhibit.

Several visitors had expected more as regards the aspect of science (6); four people said that it was an arts exhibition and not a science exhibition; others said that the science in the exhibition was nothing special (5). One visitor classified the science in the exhibition as useless, while others asked about the relevance of the scientific aspect (3).

DISCUSSION

How do gallery visitors judge the use of living organisms in art exhibits? In accordance with Martin's [24] normative approach toward life, gallery-goers made a distinction between different “categories of life.” As was shown above, the use of “mere” life, such as bacteria, does

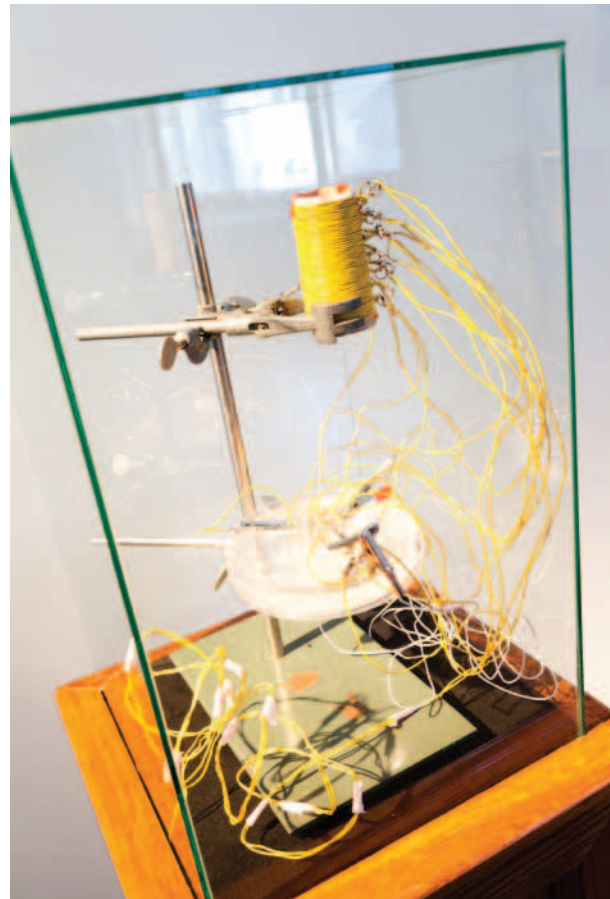


Fig. 5. Joe Davis, *Bacterial Radio*, installation, 2011. (© Joe Davis) Joe Davis reverses the main goal of synthetic biology by applying biological principles to electronic engineering. His bacterial crystal radio consists of a conductive circuit secreted by genetically modified bacteria using genes from orange marine puffball sponges.



Fig. 6. Andy Gracie, *Autoinducer_Ph-1*, installation, 2011. (© Andy Gracie) *Autoinducer_Ph-1* is a semisynthetic ecosystem. It combines three living organisms—rice, Azolla fern and the cyanobacteria *Anabena*—together with computing processes and an electro-robotic component, into an interacting and evolving system. It explores the co-adaptation of living and nonliving entities.



Fig. 7. James Tour and Stephanie Chanteau, *NanoPutians*, installation, 2003 [11]. (© Biofaction KG, Photo: Arman Rastegar) NanoPutians are organic molecules with anthropomorphic structures. The NanoPutians illustrate the human desire to ascribe lifelike features to even our tiniest technical creations.

not pose any problems to the interviewees. Critical reactions were mainly produced by exhibits that used “prereflexively self-conscious” levels of organisms such as pigeons, and especially with “reflexively self-conscious” entities such as human beings (as in *Que le cheval vive en moi*).

Surprisingly to us, many visitors tolerate the use of living organisms in art exhibits. With a few exceptions, only the use of higher organisms such as higher animals or human beings triggers questioning or disapproval. Not unimportant for artistic biofacts, it seems that using “higher organisms” increases gallery-goers’ awareness and inspires art critiques. *Que le cheval vive en moi* and *Pigeon d’Or*, which were identified as the most ethically irritating artworks in the *synth-ethic* exhibition, went on to win major awards at the Ars Electronica festival a couple of months later. While use of higher organisms alone will not guarantee success and recognition in the art world, it seems to elicit an additional level of complexity and depth that can—when appropriately explored and reflected upon by the artist—help the artwork stand out. Obviously, on the other hand, crossing ethical boundaries just for the sake of it or for its “shock value” is no guarantee of artistic quality.

What role did the issue of boundaries play in the reception of the ethical aspects of this bioart exhibition? One aspect of boundaries is the abovementioned hierarchy of living enti-



Fig. 8. Tissue Culture and Art Project, *The Semi-Living Worry Dolls*, installation, 2003 [12]. (© Oron Catts and Ionat Zurr. Photo: Arman Rastegar.) These dolls are modern tissue-engineered versions of Guatemalan worry dolls. They are here to listen to our worries about biotechnology.

ties with respect to their use as art objects. This was also discussed in the context of ethics.

In addition, people expressed the need for boundaries as regards the regulation of biotechnology in general. The “natural” boundaries between nature and technology should be respected, as well as the limits of what science can provide. What exactly constitutes such a boundary between nature and technology, and where it is (or should be) drawn, seems to be more or less clear to visitors. It has been shown in previous studies that humans do have an intuitive ontology in scientific understanding. Already at around the age of 4, humans develop what is called an “intuitive” or “naïve” biology that helps to distinguish artifacts, plants, animals and humans as all having distinct essences [25]. Apart from those who develop either a personal or professional interest in biology or medicine, this intuitive biology remains as a kind of internal compass for laypeople to navigate in a world inhabited by living and non-living objects. We believe that scientific developments or artistic explorations that may trigger a disillusion of this intuitive understanding may cause uneasiness. To a certain extent, these cross-border activities shake up laypeople’s basic understanding of the world, something that could be compared to learning about the strange world of quantum physics. Few if any visitors whom we interviewed seemed to take advantage of the disillusion of their intuitive biology, e.g. by starting to explore their own understanding of what life is (at least not directly after they visited the exhibition, which is when the interviews were carried out). Instead, a number of gallery-goers seemed to find lacking a clear statement by the exhibition producers and curators about what is right and wrong and how an ethical boundary should be defined.

HOW DO PEOPLE EXPERIENCE DISCIPLINARY BOUNDARIES?

Although many visitors mentioned the hybrid art-science character of the exhibition, visitors still had the urge to assign it either to the realm of science or the realm of art. Of those

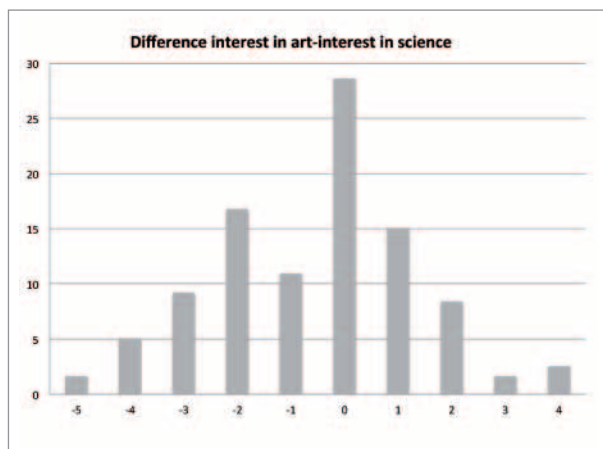


Fig. 9. Difference between the respondents' interest in art and interest in science, both measured on a scale from 0 to 7. The value -5 means that the respondent rated his or her interest in science 5 points higher than that in art; on the other hand, a value of $+2$ means that the interest in art was 2 points higher than the interest in science. A 0 means that art and science were of equal interest. (© Wolfgang Kerbe)

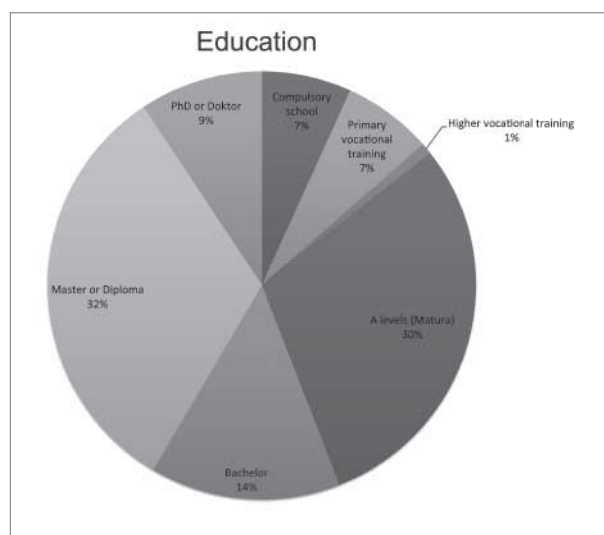


Fig. 10. Educational background of interviewees, $n = 119$. (© Wolfgang Kerbe)

who saw it as a science exhibition, many complained about a lack of information about scientific facts and scientific background information. In other words, they saw the exhibition as a science communication activity that used artists to show the science in an aesthetically pleasing way but felt it was not satisfactory in terms of its “real” goal, namely informing about a particular scientific field.

In a way these visitors called for help, since they expected the provision of more information and cognitive tools in or-

der to establish categories and cognitive boundaries. Those who saw the exhibition predominantly as an art exhibition had less difficulty with the limited scientific information offered.

Synthetic biology, the scientific gravitational center of the exhibition, clearly has not arrived in the minds of contemporary gallery-goers (and other laypeople) yet. Most gallery-goers approached the exhibition within the frames of either (synthetic) chemistry or genetic engineering. Given the lack of previous knowledge of the field, the exhibition's mascot and title poster (Tour and Chanteau's *NanoPutians*) alluded to synthetic biology in a rather subtle way. Many gallery-goers did not pick up this lead and linked the exhibition to the better-known (synthetic) chemistry, keeping in mind that 2011 was also the International Year of Chemistry and included a number of chemistry-related events. Without a massive science communication effort, the reference from an art exhibition to an inter- or trans-disciplinary scientific field such as synthetic biology was as ephemeral as the artwork in the exhibition itself (without constant care, feeding, watering and cleaning, most of these artworks would quickly disintegrate, collapse or die).

CONCLUSIONS

Gallery-goers expressed a need for boundaries regarding the advancement of technology and its ethical implications. This wish for boundaries implies the hope of being able to understand and control the new and unfamiliar by restricting it and by defining its clear limits. A lack of boundaries, on the other hand, contributes to uneasiness in the perception of the visitors.

Synthetic biology, as an interdisciplinary discipline, could provide a scheme for understanding the complex allusions of bioart. Bioart generates multiple associations. This diversity shows the success of the unconventional, out-of-the-box character of modern bioart in generating new ideas and inspiring unusual thoughts.

The use of living organisms did not pose any conceptual problems for the visitors as long as it could be restricted to “mere life.” As soon as feeling or even reflecting entities enter the stage, moral concerns appear.

LIMITATIONS OF THE STUDY

The very specific exhibition and the specific audience (highly educated) raise the question of validity in the wider context of bioart exhibitions. However, the interaction between art and science, two rather elite areas of interest, seems to be inevitably restricted to an elite—highly educated and curious—audience. Furthermore, the study did not include most scholastic groups who visited the exhibition nor other visitors who only took a short glance at the exhibits.

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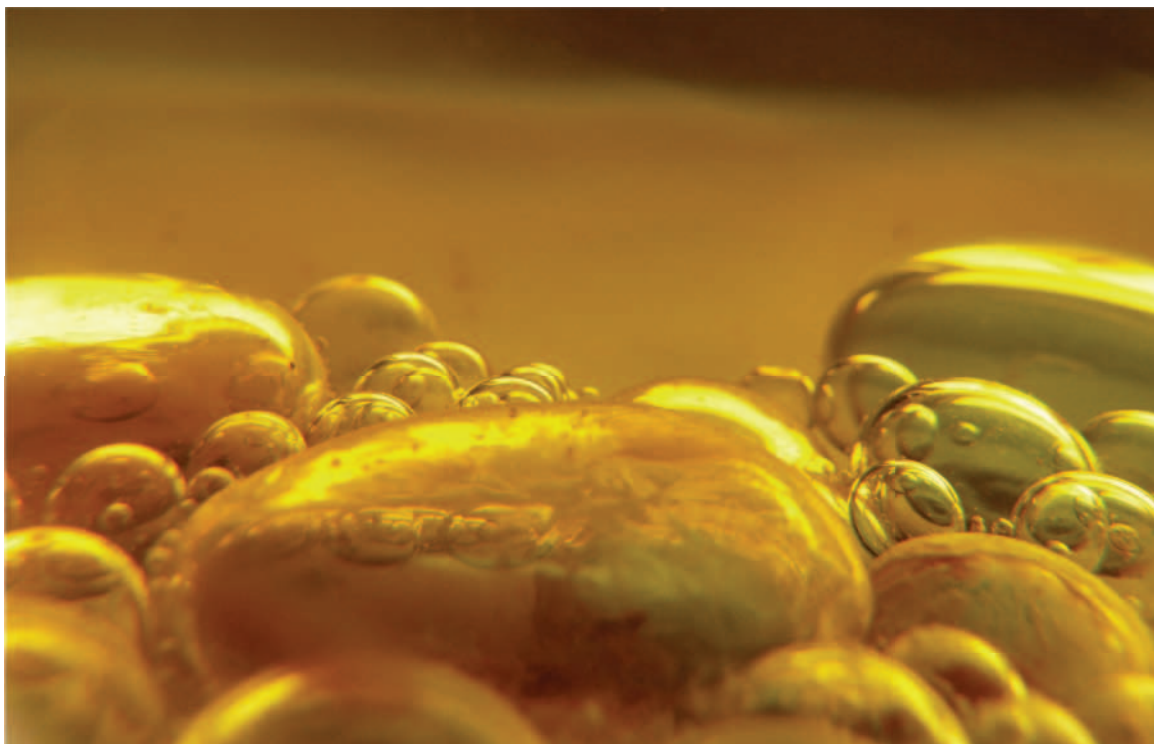
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WOLFGANG KERBE studied chemical engineering at the Vienna University of Technology before starting an interdisciplinary career in sociology and social psychology. His focus of interest is the analysis of communication processes regarding new and emerging bio-technologies.

MARKUS SCHMIDT has an educational background in electronic engineering, biology and environmental risk assessment. He has carried out environmental risk assessment, safety and public perception studies in a number of science and technology fields.

COLOR PLATE B: **SPLICING BOUNDARIES**

Rachel Armstrong, *Living Chemistry*, installation, 2011. (© Rachel Armstrong)
Living Chemistry explores the emergence of protocells or giant vesicles at the interface of oil and water and their complex behaviors. (See article by Wolfgang Kerbe and Markus Schmidt.)

ANNOUNCEMENT

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