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**How Metaphors Guide, Teach and Popularize Science**

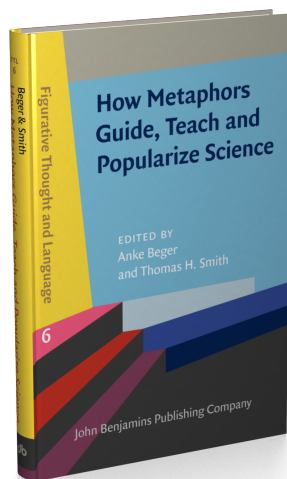
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# Metaphor and the popularization of contested technologies

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This contribution analyzes metaphors in expert bioscientific texts on reproductive technologies from cloning to pre-implantation genetic diagnosis in German print media during the time when, according to some German journalists, restrictive attitudes seemed ripe for change. The study uses systematic metaphor analysis to investigate the *functional* content of metaphors for those producing a text. It shows how conventional metaphors contribute to the popularization of science, as they bring new reproductive technologies into the realm of our everyday experience. For scientists, this work shows the fine line between explanatory use of metaphors and distortions which can harm the reputation of science. It may foster a nonscientist's ability to interpret metaphors in the production of hope in the promise of new technologies.

**Keywords:** ethics, human biotechnology, magazines, high quality newspaper, systematic metaphor analysis, functional content, expert authors, context specific analysis, cross domain mapping, semantic transfer

## 1. Introduction

Metaphors are ambivalent and powerful tools of science and used and reflected as such since Baconian times. There is a consensus not only within this anthology but also espoused within philosophy, psychology, science and technology studies that, within the natural sciences, metaphors play very important *educational* roles (e.g. Cooke & Bartha, 1992; Gentner & Grudin, 1985; Gentner & Jeziorski, 1993; Hesse, 1966; Keller, 1995; Lakoff & Núñez, 2000; Maasen & Weingart, 2000;). Metaphors are often used in areas where meaning is otherwise hard to convey (Schmitt, 2003). They frequently appear in communication between experts and laypeople and are thus a common ingredient in media publications about the natural sciences.

As metaphors are an essential tool in all complex communicative situations (Johnson, 2010), they play a leading role within the public media and popular science. When topics of natural science and medicine are transmitted to the broader public, the communicative situation between speaker and audience is often understood as similar to that within schools or universities: for a long time at least it was assumed that ‘the public’ lacked sufficient knowledge about the natural sciences and technology, especially when taking a specific (and in particular a critical) position regarding the natural sciences (Marks, 2009). It was assumed that the public simply required proper information in order to adopt a more positive stance.

When new technology needs to be explained to a lay audience by means of illustration and modeling, this often comes in combination with humor and mostly aims at convincing the audience of the benefits of this technology (Semino, 2008; Herrmann, 2013). We find such a situation whenever new technology is presented to the public with the aim of a discursive change in favor of these developments, as for instance the introduction of alternative energy, green revolution, education reform or space exploration. Expert discourse going public about contested technology shows a very specific use of metaphors, as this study reveals.

### *Background to the exemplary study*

As a case study, this chapter explores an international expert discourse in German quality print media at a particular historical juncture in Germany: when a political shift from a restrictive to a more open position towards new reproductive technologies seemed possible to some German journalists. Around the year 2000, after a change in political leadership in Germany from the Christian Union to Social Democrats, the new German chancellor tried to propagate Germany as an ideal place for biotechnology industries, while also the German Medical Chamber presented a position paper, which was critically received, urging a new and more liberal law on new reproductive technologies. In this context, the international, mainly Anglo-Saxon, public scientific culture exposed in the articles I will analyze, coincided with a generally critical German discourse on reproductive technology. This situation provoked texts about future reproductive possibilities very rich in metaphoric use.

### *Theoretical background*

The essential criterion for defining a metaphor in this chapter is “cross domain mapping” (Steen, 2010, p. 49) or “semantic transfer” (Cameron, 2003, pp. 59–60). The present analysis classifies as metaphor any word or phrase from a formative

source domain which transfers anything more than its literal concrete meaning to a different (often abstract) target domain (Schmitt, 2003).

In regards to its social role, the term metaphor will, in this article, be applied according to Weinrich's broader concept of metaphor (Weinrich, 1980). Weinrich's concept of the metaphor intersects with that of Lakoff and Johnson (1980), who agree with Weinrich that metaphor is a constant component of the collective memory and thus a structural element of social relationships. Furthermore Blumenberg (1960) and Lakoff and Johnson (1980)<sup>1</sup> claim that metaphors are neither arbitrary nor without effect, but rather give structure to social relationships and even function as "orientation for our *future* actions" (Lakoff & Johnson, 1999, p. 179; see also Koller, 2003, p. 115). The application of conceptual metaphor analysis and Lakoff and Johnson's theory of conceptual metaphor support the notion that conventional metaphors are used automatically, and non-deliberately (Steen, 2010, p. 43; Koller, 2003).

In contrast to this broad understanding of the prominent sociocultural role of metaphors, more recent studies in the field of systematic metaphor analysis reveal the context-specific *functional* content of metaphors (Schmitt, 2003). Focusing on the specific functionality of metaphors they also take into account the contextualization of their current use. To this end, Halliday's three meta-functions of language are usually quoted (see e.g. Cameron, 2003; Goatly, 1997; Herrmann, 2013; Koller 2003; Semino, 2008; Steen, 2010): Halliday (1973, 1978) differentiates between the interpersonal, the ideational, and the textual function. According to the interpersonal function of metaphors, a phrase can be understood as an interactive 'event', where "the speaker adopts for himself a particular speech role, and in doing so assigns to the listener a complementary role which he wishes him to adopt in his turn" (Halliday, 1994, p. 68). Thus, identities and relationships are created and negotiated.

The ideational function of language enables us to represent experiences as coming from a specific perspective, from which, in turn, reality is (re-)constructed. The textual function serves to make a text coherent. The present contribution is therefore mainly interested in the ideational and the interpersonal attributes of metaphors. This means that (metaphoric) texts contain "actualized meaning potential" (Halliday, 1978, p. 109), i.e. the possibility to fill gaps in a text. According to Koller (2003), this corresponds with Lakoff and Johnson's description of metaphors both highlighting certain meanings and masking others. During the process of mapping, only certain characteristics of the source domain are highlighted, whilst others remain hidden.

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1. See Jäkel (1997, 1999) on Blumenberg as a predecessor of the Cognitive Theory of Metaphor.

In respect to the interpersonal level, the metaphor is a discourse component which transcends an individual instance of speech or text. For example, it can involve the context of different (academic) disciplines or institutions. However, in contrast to metaphors only used in public texts, those metaphors used in the communication between scientists, thus within the scientific community, tend to be technical terms which have become conventionalised in scientific communication. Some of them are background metaphors:<sup>2</sup> background metaphors are necessary professional, and thus irreplaceable, metaphors, ultimately added to the dictionary.

Such necessary background metaphors can be divided along the line between clarity versus richness. “Clarity” as a feature of scientific metaphors means exactness, at least in scientific writing for scientists (Gentner, 1982, pp. 124–125), which gives way to “richness”, meaning the amount of content that is transferred from the source to the target domain. Necessary background metaphors are culturally significant and understood beyond the field of the scientific discipline. They are fundamental in providing the field with an overall intellectual and functional model or central scenario, which is often fictional. The TEXT metaphor in genetics is an example of such a necessary background metaphor. There are other necessary metaphors which do not count as background metaphors and which are technically very specific and limited. They do not abound in richness but are clear to the scientists in a specific discipline. Such metaphors are conventional for building a common language within a scientific field, but not necessarily in a more general audience’s sense (e.g., Cameron, 2003; Low, 2008; Semino 2008). In bioscience journal articles, Giles (2008) found that such metaphors in the context of cells and genetics were *gene expression*, *colony* or *programming* which could be found in the respective scientific dictionaries as well. Here, I will use the term necessary metaphor only for those metaphors that are specific to the discipline. In contrast, I talk of (necessary) background metaphors when they additionally serve to organize the field.

The difference between necessary technical terms and background metaphors marks the differences in the metaphoric use between expert discourse among scientists and expert discourse going public in order to convince the audience. The metaphors differ as follows: (1) With the development of new technology experts develop a specific vocabulary involving metaphors that become technical terms in the specialist discourse. (2) Another set of repeatedly used metaphors develops when political institutions and stakeholders such as industry take a

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2. The ‘background metaphor’ was introduced by Blumenberg (Blumenberg, 1998). This concept refers to those conventional metaphors which make up the fundamental ideas of a discipline and are essential to the development of theories.

position towards this new technology, promoting or rejecting it. (3) A third type of metaphors may be used when the expert discourse goes public about the new developments. These sets of metaphors can show overlaps.

In past decades, analysis of metaphors in the biosciences using different methods and approaches rendered extensive results. Hans Blumenberg (1960, 1983, 1998) was one of the earliest protagonists, presenting diachronic cultural studies of core metaphors and their broader cultural use in the fields in medicine and biology. As public texts of these fields show, the structural function and the pedagogical function of a text often go hand in hand to explain theories to lay audiences (Herrmann, 2013). Describing the use of metaphors in texts on ant colonies, Goatly found that the notion of “ants as an ‘army’” help to organize the whole text (Goatly, 1997, p. 163).

Richness and even fiction are qualities normally found in literary texts. But for journalists working for quality media, though they might use metaphors frequently especially when writing on the sciences are bound to a neutral reporting tone in their texts. They need to keep a distanced and critical perspective, as the Press Code, preventing press from raising unfounded hopes in the public, binds them. This tends to result in a factual, clear tone in their articles. Thus, quality media usually keeps a journalist taboo on propagation of – in the respective country – contested technologies. Sometimes however, we also find richness and fiction in quality print media, as appears to have happened in the material studied here.

Editors, respecting the ethical rules for journalism including the taboo of promoting contested technology may decide to invite others, specifically marked as non-journalists (but experts). Such guest authors and interviewees speak about potential future possibilities of how, for instance, the world regarding reproduction could look like with the merging of reproductive and genetic technologies. Since such articles talk about possible, but as they say for legal reasons, currently non-existent (future) scenarios, an essential characteristic of these essays is that they inevitably contain scientific fiction. In contrast to the journalists, guest authors are freer in expression. These guest authors, identified as such, find themselves unbound from their scientific ethos and liberated from their usually strict way of straight technical writing; this may render them less responsible for proving their claims. In this non-disciplinary medium, when describing future scenarios, they are allowed to be tendentious: imagining the future from their optimistic viewpoint, they might omit potential obstacles or risks in the development and use of the technologies.

### *Purpose of the study*

The here presented study showcases a detailed analysis of such an expert discourse going public about a new development, while embedding it and comparing it to the metaphor use within the expert discourse itself and to the non-expert public stakeholder discourse. In this vein on the following pages I analyze texts published in the public media in which their editors draw on experts as authors and interviewees to sketch the possibilities and future visions offered by reproductive technologies.

This contribution examines the extent to which articles on the subject of the specific field of rerogenetic technologies (i.e. the combination of genetic technology with in-vitro fertilization and cloning) use metaphors in both an educative sense and for other purposes such as convincing the readership.

The next section will explain the specificities of the analysis of expert interviews and essays in public media. Furthermore, it will introduce the method of analysis according to metaphor theory applied to these texts.

## **2. Methods**

The first step in my analysis for this chapter was to concretely define a broad target domain to include reproductive technology on humans in combination with genetic technology and in-vitro fertilization, as well as human cloning. The terms “reproductive technology”, “procreation”, and “genetics” were also included. I conducted a broad, non-systematic accumulation of conventional background metaphors including examination of the use of metaphors in professional journals, dictionaries, and textbooks, as described below.

The texts chosen for this analysis were selected firstly through limiting the publication period to between 1995 and 2003.<sup>3</sup> This time period was defined in response to Graumann’s (2002) observation that the ethical debate about human bio-technology in reproduction, especially cloning, was initiated in Germany by the birth of the cloned sheep Dolly in 1997.

My corpus comprises texts from so-called quality print media, magazines and newspapers of high circulation, i.e. *Frankfurter Rundschau*, *Frankfurter Allgemeine Zeitung*, *Stern*, *Die Zeit* as well as *Süddeutsche Zeitung*, *Focus*, and *Der Spiegel* (Informationsgemeinschaft zur Verbreitung von Werbeträgern, 2000), and further from the best-selling magazines of popular sciences, such as *Geo* and *Spektrum*

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3. The material used for this article, as well as parts of the analysis have been published in a different context (an analysis of the change of the notion of health with assisted reproductive technologies combining cell and genetic technologies) for the first time in Bock von Wülfigen (2007).

*der Wissenschaften*, as well as individual findings in the feminist journal *EMMA* and the philosophical journal *Ethica*. While the aim in forming this corpus was to carry out more extensive discourse analysis of the broader context, the corpus for the more detailed analysis of metaphors was then limited by selecting only articles which argued in favor of more liberal regulations of new reproductive technologies in Germany.

The selection process resulted in a final corpus of 35 articles. Only after this selection process did it emerge that all of these German articles were either interviews with or contributions by experts from the natural sciences and medicine mainly stemming from abroad. After what was said in the introduction about the difference of writing rules for journalists in quality media and the less strict rules for guest authors, it may not come to any surprise that these texts were rich in metaphors. These authors might be said to use fiction as a literary tool.

My methodology is based on systematic metaphor analysis (Schmitt, 2003), which links the insights of cognitive linguistics and conceptual metaphor theory (Lakoff & Johnson, 1980) to the systematic reconstruction of metaphoric patterns.

As said in the introduction, it is the ideational function of language that enables us to view and reconstruct text as belonging to a specific perspective. Furthermore, on the interpersonal level, the metaphor transcends an individual instance of text. It can for example span over different disciplines. In the type of texts I discuss in this chapter, which are mostly translations from English to German, there are additional factors, which make it nearly impossible to discern an individual author and thus an intended meaning by the use of a specific metaphor. In most of the cases I discuss, English-speaking experts are not only edited by journalists but also translated. Translating these German words back into English for the purpose of this publication shows a difference between the English and the German terminology that should be pointed out: Many German metaphors, for being centuries old terms, serve as technical terms, such as “Ei” (egg). Contrast this to English, where words are often Latinized (e.g. “ovum” as well as “intervention” or “manipulation” instead of “Eingriff”) and seem more technical. So, where in German many metaphoric words used in this corpus seem automatically to embed reproductive issues and respective technologies into a pre-modern world of the farm, the corresponding English words do not.

The first reading of such metaphorical use could suggest that the respective authors intentionally seek to provide reproductive high-tech with normalcy by relating them to the harmless beauty of botany and gardening. This could give the appearance of metaphors chosen and used deliberately. The term “deliberate metaphor” is generally claimed to have been introduced by Goatly (1997). According to Steen (2010), deliberate metaphors are used to provoke a change of opinion or to motivate the audience to perceive a topic from a different perspective. However,

in the texts discussed here, the gardening metaphors were, in most of the cases, not originally used by the natural scientists but by those who translated their texts and interviews; we can assume their intentions may not be the same as those of the scientists.

Additionally, as these terms are necessary metaphors in biology, it is even difficult to omit their use. So, instead of trying to claim deliberate metaphor use and find 'real' meaning and intention in the utilization of specific metaphors, the focus here is to recognize the functions of text in a larger institutionalized field (natural sciences and medicine).

### 3. Results: Metaphors on the threshold to a new era

As will be detailed in the following, the metaphorical world of the essays and interviews making up my corpus conveys a gripping narrative. To capture this narrative I propose an allegory that is suggested by my findings: To the degree laypeople approve of reproductive genetic technologies they will make their way from a DANGER-prone (3)<sup>4</sup> present in which we practice conventional conception without reprogenetic aid by taking a JOURNEY (4) to a better future, the latter represented by metaphors bundled under the notion of the COLONY (5) and enmeshed with the metaphoric field of VISION (6) of a desirable future. The journey culminates in humankind being able to MANAGE NATURE (7). To make reading easier, my numbering of the groups of metaphors corresponds to the story told through metaphoric use. Together these metaphor groupings transmit the fascination of the speakers with the possibilities of reproductive medicine in combination with genetics.

The allegory is of humankind that is in danger as long as it is still under the yoke of nature, but which is already on a journey to a prosperous colony with visions of a future in which it is able to itself manage nature. As later sections show, this allegory corresponds to a distinct central scenario (Koller, 2003) that runs through these texts. It portrays fundamental, liberating cultural values that have governed the development of natural sciences and technology for centuries. Already in its very beginning first enlightenment empiricists used a morally laden narrative of the journey with biblical connotations similar to what we find in the here presented corpus. Politicians preparing the public for the Human Genome Project build the connection between this long tradition of the journey metaphor and the recent

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4. To ease reading, this overall journey from the primitive present times to a better future is in my representation indicated by an upward numbering of the metaphors. Metaphors in quotes that further describe the context are not numbered, but just quoted as usual.

scientific discourse going public on new and contested reprogenetic technologies. This central scenario underlines the motivation and function of the texts.

Subsection 3.1 first depicts the typical conventional metaphors found within the discourse of this discipline and that are typical for the context of reproduction and inheritance and of abundant use even within science. These are the metaphoric fields FRUIT (1) and TEXT (2), detailed in the following subsection. Then Subsections 3.2 and 3.3 present the metaphors apparently specific to the biomedical discourse on innovation found in the analyzed corpus. After that, Section 4, relates the results to the question of the educational function of metaphors and uses of the journey-allegory and metaphor in the history of natural science.

### 3.1 Conventional metaphors in reproductive genetics in popular media

As mentioned above, finding numerous background metaphors, in Weinrich's terms, stemming from the field of botany in the texts analyzed is commonplace within German discourse on reproduction and was to be expected.<sup>5</sup> These background metaphors furthermore are necessary metaphors (i.e. they are inconspicuous and difficult to replace, as no other acknowledged terms exist for the phenomenon). In the 35 articles analyzed, the metaphoric field of the FRUIT (1) appears to metaphorically describe the embryo or fetus: for example in terms of "chances of **implantation** of a selected embryo" (1.1), "**implanting the fruit**" (1.2), "**implanting** into the uterus" (1.3), "**fruit water**" (amniotic fluid, 1.4), "**planting forth**" ("Fortpflanzung": meaning reproduction or generation, 1.5), "impregnation" ("**Befruchtung**", 1.6), "hyper-intelligent **offspring**" ("Sprössling", 1.7), up to the "**germline**" (1.8), and "family **trees**" (1.9). Terms such as "to **stem** from" (1.10), "**stem cells**" (1.11), and "**cultivating stem cells**" (1.12) also come from the field of botany.

TEXT AND WRITING (2) is another source domain of many metaphors in the articles studied: be it an actual book or a text in computerized form. Both the metaphors of the 'genome as book' and those of the DNA as a code taken from cybernetics can be taken for background or even necessary metaphors. The use of metaphors stemming from printed books is clearly dominant in the articles. Examples of metaphors closely associated with printed text which were used in the corpus include the "**write error**" ("Schreibfehler", 2.1) or "**letters**" (of "genetic material", 2.2.); that we are still working on "**deciphering** the human genome" (2.3)

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5. Where the English translation differs much from the botany-related German notion, I use a direct translation to show the botanical meaning. Where there is no way of directly translating, I include the German term in brackets.

whilst the “**syntax and grammar** are yet largely unknown” (2.4), which would demand “ten thousand RNA-**transcripts**” (2.5).

These findings are in accordance with Christina Brandt’s critical analysis of Lily Kays’ theory. In Kay’s examination of references to writing and codes in genetics since the 1950s, she concentrates on information sciences (Kay, 2000), while Brandt views the popularization of the writing metaphor as not based upon informatization (referring to Schrödinger, 1992), but in an “experimentalization of the genetic code” (Brandt, 2004, p. 15) referring to Crick (1958). This discussion will play a decisive role later on in my discussion.

Below I will explore metaphors which appear in various of the articles analyzed and which stem from specific conventional source domains that here form background metaphors (as do some of those already mentioned above), but which furthermore seem to be specific to particular text types and the historical situation of reproductive genetics which will be discussed later.

Conventional metaphors can be located on a space/time axis – ranging from an uncontrolled nature of the present to a managed and controlled nature in the future. As said before, to ease reading, this overall journey from the primitive present to a better future is in my representation indicated by an upward numbering of the metaphors. This axis is limited by metaphors related to the uncontrollable and DANGER (3), such as for instance “**playing the genomic dice**” (3.1), “**playing the lottery**” (3.2), *ibid.*, or the “**randomness of nature**” (3.3). At the other extreme of this axis are very practical metaphors that signal success in MANAGING NATURE (7) such as “having a **firm grasp** on” (7.1), directly translated as “to take a hand in” (“Eingreifen”), and “to **control the genetic equipment**” (7.2). This contrast and the role of technology as the solution are specified in more detail in the following subsections.

### 3.2 From dangerous random procreation without technology to new regenerative technology use

In most of the texts analyzed, metaphors relating to nature that is *not* technologically managed tend to link this situation to risk and DANGEROUS ARBITRARINESS (3). Thus it is deemed a “**nightmare**” (3.4) to have a terminally ill child; being in love or having sexual feelings are described as “a **thunderstorm** of the nerves” (“Nervengewitter”, 3.5) and it is worrisome that we “can’t control what happens during growth” (Wilmut, 1997, p. 220). The arbitrariness of Do-It-Yourself-procreation is described by such imagery as the “unplanned meeting of sperm and egg” (Stock, 2000a, p. 192), “procreation managed by **casting the genomic dice**” (3.6), “**playing the lottery**” (3.7) or “**throwing the genomic dice**” (3.8), where one is subject to the “**randomness of nature**” (Silver, 2000, p. 147) or even

to the “**dice playing nature**” (3.9). So, whenever DIY-conception is described the conceptual metaphor realized by these metaphorical expressions is UNMANAGED CONCEPTION IS A GAME OF CHANCE. Together with the source domain DANGER, insinuated by “**nightmare**” (3.4) and “**thunderstorm**” (3.5), the metaphors portray DIY-conception as problematic and scary. While the above metaphors describe the phase before we even knew of the possibility to combine reproduction and genetic biotechnology, other metaphors are employed to describe the phase where we decide to use them. The decision-making phase as to whether or not to combine new genetic and reproductive technologies (for example whether or not preimplantation genetic diagnosis or genetic therapy should become standardized or whether cloning should be applied in reproduction) is described in the articles as an insecure but promising JOURNEY (4) across a certain space, as a “parting of the **ways of evolution**” (4.1) with “**glamorous prospects**” (6.1).

Metaphors relating to a “**turning point**” (4.2) from technologically unmanaged reproduction to the use of reproductive genetics are also often used in the articles to describe this decision-making phase as “marking a **crossover**” (“Übergang markieren”, 4.3) into a different world or even to a “**revolution**” (Reich, 2000, p. 204; Stock, 2000b, p. 125). The metaphors suggest a technology-euphoric utopia, describing the beginning of a journey into a new world, comparable only to the past transition from medieval ages into modernity. The new science of reproductive genetics is viewed as a *path* into this new world, which we will have to decide upon. The movement within a temporal space is often mentioned. This includes references to the ‘future path’, such as the “**path of life**” (4.4), “**life track**” (“Lebenslauf”, 4.5) or “a small **step**” into the future (4.6). The irrevocability of decisions is expressed in such metaphors as “we are at the parting of the **ways of evolution**” (4.1), the “**path into the future**” (4.7), to “**tread into unknown waters**” (4.8), “to measure this **journey**” (“diese Reise durchmessen”, 4.9) or “inaccessible **destination**” (4.10). There appears to be a non-contradictory association with those pioneers connected with other metaphors from the field of the historical COLONIES, who first enter new paths to claim wild and unfamiliar territories. Thus US-Americans are perceived as a “**pioneer people**” (5.1) in terms of their use of cloning and other new reproductive and genetic technologies. On the other hand, we also find the warning that such a “disputable **pioneer activity**” (5.2) would happen outside of public control if cloning were not legalized.

Many articles relate developments in the field of pharmaco-genetics to what we can call the riches of the COLONIES (5): to the exploitation of promising resources in mining, saying that “scientists struck a **gold vein**” (5.3). Since gold was mainly salvaged in the colonies, this description of genetic ‘discoveries’ belongs to the same field of imagery as the “**pioneer activity**” (“Pioniertat”, 5.4).

The evaluation of genetic possibilities is accordingly captured by the metaphor of the “**exploitation** of the human genome” (5.5).

The examples found in the corpus refer to space less in the sense of an area or vessel, but more as a temporal space. Spatial language is not found, but bounded-space, i.e. container language, appears as well as graspable objects such as treasures. In the texts analyzed, these non-spatial metaphors still evoke the idea of travel from a more primitive to a more developed state, from the epoch when we moved slowly and inconveniently through phylogenetic phases representing our evolutionary history, paralleled by our ontogeny through hazardous stages of life, to the future where reproductive and genetic technologies will move us forward much faster and safer. Thus on the one hand there is the ‘progressive’ break with a human epoch which did not widely employ new reproductive or genetic technologies, which is viewed as a “weirdly primitive epoch in which people only live 70 to 80 years to then die of horrible diseases” (Stock, 2000a, p. 192). On the other hand, humanity is seen to be “**leaving** its childhood **behind**” (4.11).

Metaphors from the field of vision such as “**prospects**” (6.1) into the “distant future” (Green, 1999, p. 65) are often used in the texts to express a futuristic exploitation of possibilities, of overcoming temporal or spatial distances. The sentence “if we **look** a hundred or a thousand years into the future – a mere instant in evolutionary terms – we are sure to have adopted functional cooperation with such appliances” (6.2) illustrates, in its grasp of time, just such an accomplishment. However, “we do [actually] not need to **look** that far ahead” (6.3).

This field of metaphors combines a notion of the sciences as a path through space with science as a means to overcome physical hindrances. To apply the techniques which science and technology offer will lead us towards a society in which nature is no longer dangerous but serves society. Nature will be under control and metaphors of handcraft signal that this is in fact an easy task, as we can see in the following subsection.

### 3.3 A firm grasp on the future: Reproductive technology means to manage nature

Although genetic material can only be handled by using chemical processes and the machines that have been created for these processes, the texts often refer to the genome as ‘within reach’ (‘zum Greifen nah’) and as apparently able to be shaped by human hands within this metaphoric field of MANAGING NATURE (7). Thus the opportunity of “taking a hand on the human genetic make-up are almost endless” (“**Eingriffsmöglichkeiten** ins menschliche Erbgut nahezu grenzenlos”, 7.3). The metaphor “**intervention**” (“Eingriff”, 7.4) is also frequently used to describe changes to genetic material, the “**germline**” (1.8) or the “hereditary estate”

(“Erbmasse”: Stock, 1998). Such “genetic **manipulation**” („Genmanipulation“, 7.5); germ line **manipulation** („Keimbahnmanipulation“, 7.6), “improvement **manipulation**” (“Verbesserungsmanipulation“, 7.7), or “**handling**” (7.8), which “**produce[s]** far-reaching changes in our biology” (“tief greifend“, 7.9), a “true **command** of the technique” (7.10) is as important as a “responsible **handling** of these new forces” (7.11).

Instead of procreation consisting of the “amalgamation of egg and sperm” (“Verschmelzung”: Katzorke, 2003, p. 149), which is like “a **lottery game** [...] for the **production** of offspring” (3.10, 7.12), soon “conception in the sense of **producing** a fertilized human egg cell” (7.13) could become the desirable norm; that is to say we could “**produce** children” (7.14) and “**design** the baby” (7.15) in the process. If the qualities of the child can be “**designed**” (7.16), then “**fitting** [...] the genomes” (7.17) of the two parents to one another can also be controlled, to conceive healthier and happier children. An industry offering these new reproductive and genetic technologies, including cloning, could bear the fictional acronym “IGET” (Hamer, 2002, p. 24). Instead of fertilizing an egg cell, one could carry out fertilization after “**activating** the egg cell” (7.18), i.e. through cloning, by which “genetic **copies** of humans can be generated” (7.19). The embryo is associated in some utopic fictional parts of articles with useful household appliances that make our lives easier. Also the embryo is associated with food, where we find it ‘normal’ to have a choice, provoking comments that “the genetic **equipment** of the future child is designed and ordered just like the kitchen for our new home” (7.20), or that we could in future choose our forms of reproduction as from a “**menu**” (7.21) in the “reproduction **restaurant**” (7.22). Being both direct and persuasive these last three metaphors are some of the rare deliberate metaphors in the analyzed corpus.

This way of “**producing** offspring” (7.23) would allow “**control** [over] the genetic **equipment**” (7.24). An embryo check in-vitro would lower the rate of malformation due to the “background risks, the parents bring with them” (Diedrich, 2003, p. 42). “Any hereditary disease” (Katzorke, 2003, p. 149), “grave genetic diseases for which we don’t have therapy and which end with an early death” (Rosenthal, 2001, p. 92) or phenomena such as morbus down (Djerassi, 2002, p. 76; also termed down-syndrome) could be prevented “by a routine pre-implantation embryo check” (Katzorke, 2003, p. 149), where parents can choose the embryo without the “sick version of the gene” (Rosenthal, 2001, p. 92) as “only one in five embryos is genetically intact” (Katzorke, 2003, p. 149). And if after a test – at the latest during the “**embryo check**” (7.25) – the “quality of the **product** didn’t satisfy the quality requirements” (7.26), one could “genetically correct handicaps” (Silver, 1998, p. 145) by means of ‘genetic therapies’. Cloning and gene therapy could prevent the transmission of “**risk genes**” (3.11), so that these “could finally be eliminated from the **family tree**” (ibid.: 65, 1.13). This doesn’t only

concern illnesses such as Huntington-Chorea or Tay-Sachs, but could also refer to “undesired ways of behavior” (Hamer, 2002, p. 26) as well as “all classical forms of psychosis” (Green, 1999, p. 28) or “schizophrenia” (ibid.). In those cases where illnesses go back to complicate interactions between genetic and environmental factors, at least the genetic predispositions for “syndromes such as manic depressions, obsessive-compulsive disorders and hyperactivity” (Hamer, 2002, p. 28) could be eliminated.

This “**manipulation** of human biology” (7.27) could, however, not only be used for ‘corrections’, but also for “genetic **improvements**” (7.28). If we wish to “**improve** genes” (7.29) we might as well “include genetic **controls**, which allow to **switch off** the genes” (7.30) when those new genes fail to satisfy the quality standards. It was also important to affirm that legalization in democratic high-tech countries would prevent “germline **manipulations** [...] **in the hands** of clichéd crazy scientists who want to create a new super-race” (7.31). Accordingly, “**manipulations** which not only affect our physiology, but also our emotional and spiritual world” (7.32) would ultimately “**recreate** our life completely” (7.33).

The analysis reproduced in this subsection has shown that the history of emancipation through science, wrapped in metaphors pertinent to the metaphoric field of the JOURNEY (4), enmeshed with COLONY (5) and VISION (6), constitutes the scaffold of the argumentation in favour of the combined use of reproductive and genetic technologies. In the following discussion, this scaffolding by the quoted scientists when they address the public will be further explored.

### 3.4 Discussion: The journey in history of science and technology

Is the JOURNEY (4) an exceptional metaphoric field in the recent life sciences communication to the public, and/or is it specific to discussions of reproduction and genetics? Historically, in earlier centuries, especially when the concepts to be communicated were publicly contested, JOURNEY (4) was a popular literary theme used for ‘public communication of science’. Furthermore, the texts reflect a contrast between allusions to enlightenment values, contained in scenarios which point out our obligations and responsibilities, and more pre-modern notions of a rational individual who has emancipated herself from (her own) nature through empirical insights into the workings of nature itself. In the early modern era the scientific project – liberalization through reason – was often described as a path through space. As Hobbes explained “[r]eason is the pace; increase of science the way; and the benefit of mankind the end” (Hobbes, 1886, p. 30). Descartes describes colleagues who in his eyes work with the wrong methodology as “travelers who leave the main path to take a shortcut, only to find themselves lost amongst briars and precipices” (Descartes, 1984, p. 401).

One of the earliest and noted forerunners in the dawn of modern science is Francis Bacon, who in archetypical ways used JOURNEY (4), COLONY (5) and VISION (6) to campaign for science and a scientific methodology as such. It is with this political philosopher engaged in the study of nature at the beginning of the 17th century in particular, that the technological utopia and the euphoria regarding the projects of colonization are used metaphorically when discussing scientific and political innovations.

Bacon's perspective on the project of natural science differs in its epistemological approach from that of other enlightenment researchers. According to those others, nature, when experienced in a physical, empirical way, can only be known within the limits of perception and reflection, as indicates the English empiricism of Locke (1979) or Hume (2000). Otherwise the idea was implied that the reflecting intellect and nature are inseparable from one another (as with Spinoza, 1986). For Bacon, instead, 'real' knowledge should be possible like a mirror to the world, if only humans could rid themselves of their mistaken consciousness, namely their prejudices (Bacon, 2000).<sup>6</sup> As Bloch claimed "[t]his mistaken consciousness has never again been discussed with the same detail or passion in bourgeois philosophy" (Bloch, 1977, p. 254; translation B.v.W.).

The means of illustrating the human being captivated in nature's arbitrariness, putting humans in DANGER (3), contrasted with the dawning liberation through genetic technology in the metaphoric use described above, show similarities to Bacon's announcement and propagation of a new era of research into nature with the empirical sciences. These commonalities are mainly marked through metaphors of the JOURNEY (4) or concretely the PATH (4.4, 4.7) to scientific innovation and its recognition and application by society. Bacon, like other utopian authors of his time inspired by Columbus' discovery of the 'New World', aimed to discover an 'intellectual world', an analogy reflected in the metaphoric field of the COLONY (5). This would allow the natural sciences to offer humans the same material salvation as the Kingdom of God at the end of all times (Tarnas, 2001, p. 242).

Bacon draws this analogy between the discovery of the colony and achievements of especially (bio-)medical sciences in paradigmatic fashion in two books: The title page of the first edition of Bacon's explanations on this new form of sciences, the *Novum Organum* of 1620, bears a frontispiece showing a ship sailing between the Pillars of Hercules (Gibraltar & Hefnerich, 2001, p. 152). If the path into this new intellectual world is both difficult and isolating, the journey ultimately

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6. If nature was imperceptible, this was due to "the way which is now in use. They [authors who assume nature to be imperceptible] thereupon proceed to destroy the authority of sense and intellect; but we devise and provide assistance to them" (Bacon, 2000, p. XXXVIII, 40).

promises the discovery of a kingdom of paradisiacal democratic conditions, since this world will be governed by scientists of an open and unprejudiced mind.

Another one of Bacon's works, *Nova Atlantis* of 1627 (Bacon, 1993, p. 111, 118), describes such an ideal society living on an isolated island off the coast of America. The narrator and a group of men from Europe on a ship reach this island. The journey had been hard, but the group is finally welcomed on the island. The democratic and at the same time Christian island state, Bensalem, is governed by natural scientists (the Society of Salomon's House, Bacon, 1993). The scientific innovations of the Society of Salomon's House care for the physical intactness of everyone living on the Island of Nova Atlantis (Bensalem): various foods are in abundance, while the Society studies and produces medicinal fruits and substances, not only breeds but also *creates* formerly unknown animals, and generates life-prolonging products (Bacon, 1993, pp. 129–131). This society achieved freedom for itself from the grip of nature and thus to MANAGE NATURE (7).

Within this allegory of Nova Atlantis, another shorter allegory is contained – the discovery of the bible as instruction for the PATH (4.4, 4.7) to knowledge on the one hand and the result of the search for knowledge on the other. The narrative depicts the origin of Bensalem (Nova Atlantis) as occurring one night when the people of the island saw a shining cross over the sea and took their boats out. When none of the boats could approach the cross, only the wise man of the island was 'unbound' (Bacon, 1993, p. 112) after he had said a prayer to God about his aims in the laws of nature. Once the wise man reached the cross, it turned into a chest containing the Old and the New Testament as well as a letter of the apostle Bartholomew who explained that he had trusted these works to the floods (*ibid.*).<sup>7</sup>

This allegory, like the scenarios introduced above, all suggest that nature itself (also in the form of evolution) provides us with the means and thus the duty to take evolution into our own hands. For Bacon, the rewarding exploration of nature through the sciences (see COLONY, 5) is the PATH (2.2, 2.7) to the knowledge of God, led by God Himself, turning the scientist into a priest. This corresponds with Bacon's deistic background, believing that whilst God created the world, He no longer interferes in it, leaving humans to their own devices (Tarnas, 2001, p. 342). This concept treats God as equal with nature. The perception of nature, the 'victory' over nature by following its laws to improve the well-being of humans, is thus a continuation of God's work, which is inscribed into natural laws (Helferich, 2001, p. 155). Since in this concept God is viewed as the initiator, who can now only be found in nature itself, it can be used in evolutionary biology without

7. The author of "The selfish gene", Richard Dawkins, describes the inherited genetic material as a "family bible" in another of his works (Dawkins, 1995, p. 39).

reference to any God.<sup>8</sup> Nature now stands separately, allowing humans to seek knowledge and to procreate for their own well-being.

The book and TEXT metaphors (2) mentioned above present similarly religious associations that are discussed further below. The logic of the analyzed texts follows this picture: for the next step is to decide to combine genetic and reproductive technologies and to realize the benefits of human intervention into evolution, which are represented mainly by metaphors of handcraft. We may interpret Bacon's allegoric oeuvre as a mere strategical pamphlet to make society and the church more comfortable with the sciences. Nevertheless, beyond this function, considering Bacon's Christian background, we may as well assume that the allegory of the JOURNEY (4) and COLONY (5), enmeshed with VISION (6) and MANAGING NATURE (7) is for Bacon his ethical guiding principle. This ambiguity between educative manipulation and generative guiding principle is an ambivalence in the use of metaphors as well as in the interpretation of their function, which Bacon's JOURNEY metaphors share with their use today, as I will discuss in more detail below.

As already shown we can discern conventional metaphors of general use in biology, such as those from the fields of FRUIT (1) and TEXT (2), from others which are specific to what we could call scientific fiction aimed at the broader public. Implicitly the authors enthusiastically follow the Baconian journey allegory and thereby carry forward a near spiritual, morally laden, subtext arguing in favour of the combination of genetic and reproductive technologies. In fact, the metaphors used to arrive at an appealing and convincing narrative observed in the analyzed texts date back to Bacon's times: the human is confronted at the crossroads (4.1, 4.2, 4.3) of evolution with a far reaching decision to make: to follow the better path to put human evolution in the hands of humans applying laboratory techniques or to follow the traditional path of DIY reproduction. This challenge can however, if humankind makes the right decision, lead to a rewarding future (4, 5, 6, 7).

Obviously, the function of the JOURNEY (4) metaphor in the above-analyzed texts is not pedagogical, in that this metaphor is not applied to the technology itself in order to understand the exact working of an otherwise abstract and sensually difficult to perceive phenomenon (Jäkel, 2002). Instead, the metaphoric field of the JOURNEY (4) portrays the use of technology as an emancipatory process of humankind, thereby promoting the use of the technology, and along the way fulfils the textual function of keeping the text together, serving as a storyline. Through its specific history the metaphoric field of the JOURNEY (4), and concretely all the metaphors related to the PATH to tread on (4.1, 4.4, 4.6, 4.7, 4.8),

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8. The changes in the concept of God as an omniscient, "Leviathan" outside of nature in early natural philosophy into a force working between, and meanwhile even within, molecules such as the Laplace or the Maxwell Demon is described by Evelyn Fox in *Refiguring Life*, Keller (1995).

additionally carries a religious undertone (Bacon, 1993; Jäkel, 2002) relating to the Old Testament. The result is a clear moral imperative: LEADING A MORAL LIFE IS MAKING A JOURNEY ON GOD'S WAY" (Jäkel, 2002, p. 25): As a general literary theme we find the source-path-goal scheme in many cultures, independent of religion (Lakoff & Johnson, 1980, pp. 88ff.). In the religious context however, it has this specific moral connotation (Charteris-Black, 2004, p. 208).

Already the exodus of the people of Israel out of Egypt contains an allegory of human emancipation: a mental progress from polytheism to the one God of Israel (Assmann, 1998). More often however, according to Jäkel, over half of the cases of the journey metaphor in the Old Testament "are concerned with worldly wisdom" (Jäkel, 2002, p. 25), located in the two books of Psalms and Proverbs.

The concept of nature as TEXT (2), again, is based on a long tradition of the metaphoric use of the 'Book of Nature'. This can be seen in Schrödinger's *What is Life?* as well as in Francis Bacon's utopian work *Nova Atlantis*. The writing metaphor for DNA was first introduced as a theory constitutive resource in reciprocal exchanges among scientists, allowing experimental classifications until it finally achieved ontological status (Brandt, 2004, pp. 257ff.; see also Chargaff, 1970) and became a conventional metaphor for which no other term was available. As Schrödinger stated: "the great revelation of quantum theory was that features of discreteness were discovered in the *Book of Nature*, in a context in which anything other than continuity seemed to be absurd according to the views held up until that time" (Schrödinger, 1992, p. 48; emphasis B.v.W.).

Blumenberg describes this very consistency as one of the qualities of the Book of Nature. There is the idea that nature was "a whole from a single cast" (Blumenberg, 1983, p. 18; translation B.v.W.), limited, and thus easy to MANAGE NATURE (7), and in itself contained and containing a "temptation to totality" (ibid.; translation B.v.W.). The Book of Nature metaphor also points to a paradox: "Nature was a book, but one written in hieroglyphs, in ciphers, in mathematical formulas – the paradox of a book which refuses to be read" (ibid.; translation B.v.W.). Nature is thus not simply self-evident, but only able to be experienced through man-made rules, which will, by definition, also become natural laws.

As with Francis Bacon the laws of nature themselves have been viewed since the end of the Renaissance as the will of God. In these readings, the Book of God (i.e. the Bible) and the Book of Nature are synonymous (Curtius, 1948). The media texts from my corpus, which I analyzed above, often present the point of view that cloning or preparing human DNA for different processes are acts of evolution or of nature when 'We' become creators (7, especially 7.14–7.17,

7.19–7.30, 7.32–7.33).<sup>9</sup> ‘Our’ actions are thus legitimate through being a continuation of God’s work.

Meanwhile, the scenarios of new genetic and reproductive technologies form a dialectical relationship with the scenarios of liberation and determinism. These latter scenarios envisage that technologies should be made available, because they liberate us from the limitations of (our own) nature (DANGER, 3, versus MANAGING FUTURE, 7). These scenarios can only be understood through the framework of some ‘dogmatic gene’, a deterministic concept which inevitably leads to a dreadful disease if neither society nor reproductive biology or genetics can offer a solution (see subsection 3.3).

In a similar sense, the TEXT metaphor in genetics (2.1, 2.2, 2.3, 2.5), used to explain, for example, the predisposition to diseases in our children, is linked to the ‘inscriptions’ in our genetic material. Note, however, that ‘literacy’ (2.4) can prevent such problems in the reproductive process, if we only change the ‘text’.

The main epistemological advantage of the TEXT metaphor (2) lies in the fact that it both represents flexibility (interchangeability of letters) and continuity (inheritability). The ‘dogmatic’ interpretation of the TEXT metaphor, instead, only emphasizes the aspect of continuity. Humans are thus fatefully chained to their genes, which determine their lives. However, humankind is seen as being on a JOURNEY (4), which will, if the right PATH is chosen, lead to their final liberation. The powerful reference to the metaphor of space (Brown, 1998, 2003) as something which needs to be crossed and transcended (4, especially 4.3, 4.7, 4.11), and which is tightly linked to time metaphorically understood as space (see especially 4.4–4.7), alludes to the *spatial turn* of the end of the 1990s, when not only time but space came into the focus of socio-cultural analysis. The metaphoric domain of text and book refers both to eternity and stability as well as to universalization and expansion (Anderson, 2005). The expanding space is simultaneously ‘internalized’ because genetic material is perceived as a temporal molecule which needs to be ‘exploited’, changed, stored, or saved (see COLONY, 5, especially 5.3–5.5).

Similar to the metaphoric field of the COLONY (5) reported here, Nerlich, Dingwall and Clarke (2002) found in discourse on genetic innovation in the United States, the reference to US American pioneer settlers, transgressing space risking their lives, always being faithful in God. The authors showed that this amalgamation of ‘pioneer science’, Christian belief and American History was constructed during the time of the Human Genome Project (at the end of the

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9. See e.g. Stock (1998): “We begin to change the building plans of creation, even our own. [...] The truth is [...], that we already hold the power in our hands.” Stock (2000b): “Because our cultural evolution now gives us the power to change our biology” (Stock, 1998, p. 125; translation B.v.W.).

1990s) in an interaction between politics, biomedicine and media. This occurred especially in the speeches on genomics of U.S. President at the time, Bill Clinton, in which “an inspirational tone and a counter-theology” combined (ibid.: 453). Clinton’s speeches were evidently intended to counteract the threat that pro-life religious citizens perceived in the Human Genome Project.

Such religious undertones are rather alien to the German scientists’ public portrayal of technological advancements in genomics and the reproductive sciences. The well-informed and often critical German public would be more likely to accept a less glossy, prophetic, and pioneer-related discourse. This was true when the so-called new reproductive technologies were reported in earlier years.

However, the JOURNEY metaphor (4) might still be successful in this foreign context. Recall that metaphors are frequently found in fiction (cf. Jakobson & Halle, 1956; Lodge, 1977; Semino & Steen, 2008). And I argued above that the popularized texts describing reproductive technologies that we are dealing with here have many of the characteristics of fiction. Metaphor used in fiction, contrasted with its use in science writing, is rather broad and opens up imaginative space, just as do metaphors in lyrics. When metaphors such as JOURNEY support broader narratives, they enliven the texts, making them more provocative and capable of triggering public discussion of relevant medical topics that have important political implications. They may appeal to the (religious) explorer in the readership.

As said earlier, a metaphoric phrase can function interpersonally and be understood as an interactive ‘event’, where “the speaker adopts for himself a particular speech role, and in doing so assigns to the listener a complementary role which he wishes him to adopt in his turn” (Halliday, 1994, p. 68). This, in Goatly’s terms means “acting on others” (Goatly, 1997, p. 302) who (in these texts) are meant to be taken on that journey into a better human future, enabling them to view the issues at stake from a new perspective, sharing with the scientists the excitement about our future possibilities.

Although this suggests a deliberate use of metaphors following the specific aim to tell a convincing story, there are several doubts about such deliberate use: First, most authors will be unaware of the metaphoric status of the terms they use (apart from “**menu**”, 7.21, in the “reproduction **restaurant**”, 7.22). Second, when we speak of ‘acting on others’, the question that has already been raised in the introduction is who the actor in the cases presented here is. Is it the Anglo-Saxon scientist in most cases, with his specific interests? Or is it the German journalists and editors involved in each article and interview, who translate the text and choose specific terms over others – again with different interests in mind? A third doubt arises from our not knowing if educators are choosing the metaphors according to what seems best pedagogically, or if scientists are choosing them based on their firm

conviction: the JOURNEY to the betterment of society may indeed be the guiding principle of scientists' work, just as Bacon may have seen it over four centuries ago.

## Literature corpus of the analysis of metaphors

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## Appendix. List of metaphors

### (1) FRUIT

- 1.1 "chances of **implantation** of a selected embryo": Diedrich 2003: 42
- 1.2 "**implanting** the fruit": Reich 2000: 206
- 1.3 "**implanting** into the uterus": Wilmut 1997: 220
- 1.4 "**fruit** water" (amniotic fluid): Katzorke 2003: 149, Djerassi 2000: 212
- 1.5 "**planting forth**" ("Fortpflanzung", meaning reproduction or generation: Hughes 2000, Katzorke 2003: 149, Reich 2000: 204, 206, Silver 1998: 145, Stock 1998, Stock 2000a: 192)
- 1.6 "impregnation" ("**Befruchtung**"): Antinori 2001: 208, Baker 1999: 163, Diedrich 2003: 42, etc.)
- 1.7 "hyper-intelligent **offspring**" ("Sprössling"): Hughes 2000
- 1.8 "**germline**": Hughes 2000, Silver 2000: 146, Stock 2000a: 190, 191, 192; Stock 2000b: 123, 125
- 1.9 "family **trees**": Green 1999: 65
- 1.10 "To **stem** from": Solter 2002: 23
- 1.11 "**stem** cells": Rosenthal 2001: 92, Solter 2002: 23
- 1.12 "**cultivating** stem cells": Solter 2002: 23
- 1.13 "**family tree**": Green 1999

### (2) TEXT AND WRITING

- 2.1 "**write error**" ("Schreibfehler"): Hughes 2000
- 2.2 "**letters**" (of "genetic material"): ibid.
- 2.3 "**deciphering** the human genome": Rosenthal 2001: 84
- 2.4 "**syntax and grammar** are yet largely unknown": ibid.
- 2.5 "ten thousand RNA-**transcripts**": Rosenthal 2001: 85

### (3) DANGEROUS ARBITRARINESS

- 3.1 "**playing** the genomic **dice**": Reich 2000: 206
- 3.2 "**playing** the lottery": ibid.

- 3.3 “**randomness** of nature”: Silver 2000: 147
- 3.4 “**nightmare**”: Hughes 2000
- 3.5 “a **thunderstorm** of the nerves” (“Nervengewitter”): Reich 2000: 204
- 3.6 “procreation managed by **casting** the genomic **dice**”: Reich 2000: 206
- 3.7 “**playing the lottery**”: *ibid.*
- 3.8 “**throwing the genomic dice**”: *ibid.*
- 3.9 “**dice playing** nature”: Djerassi 1999: 51
- 3.10 “a **lottery game** [...] for the production of offspring”: Reich 2000: 206
- 3.11 “**risk genes**”: Green 1999: 64

(4) JOURNEY

- 4.1 “parting of the **ways**”: Stock 2000a: 190
- 4.2 “**turning point**”: Silver 1998: 144
- 4.3 “marking a **crossover**” (“Übergang markieren”): Reich 2000: 206
- 4.4 “**path** of life”: Silver 2000: 147
- 4.5 “life **track**” (“Lebenslauf”): Hamer 2002: 24
- 4.6 “a small **step**”: Silver 2000: 146
- 4.7 “**path** into the future”: Silver 1998: 145
- 4.8 “**tread** into unknown waters”: Stock 2000a: 191
- 4.9 “to measure this **journey**” (“diese Reise durchmessen”): Reich 2000: 206
- 4.10 “inaccessible **destination**”: Green 1999: 64
- 4.11 “**leaving its childhood behind**”: Stock 2000a: 192

(5) COLONY

- 5.1 “**pioneer people**”: Silver 1998: 145
- 5.2 “disputable **pioneer activity**”: Green 1999: 62
- 5.3 “scientists struck a **gold vein**”: Hamer 2002: 26
- 5.4 “**pioneer activity**” (“Pioniertat”): Green 1999: 62
- 5.5 “**exploitation** of the human genome”: Rosenthal 2001: 85

(6) VISION

- 6.1 “glamorous **prospects**”: Silver 2000: 146, Green 1999: 65
- 6.2 “if we **look** a hundred or a thousand years into the future – a mere instant in evolutionary terms – we are sure to have adopted functional cooperation with such appliances”: Stock 2000b: 125
- 6.3 “we do [actually] not need to **look** that far ahead”: Stock 2000b: 123

(7) MANAGING NATURE

- 7.1 “having a **firm grasp on**”, directly translated as “to take a hand in” (“Eingreifen”): Hamer 2002: 26; Silver 2000: 146, 147; Stock 1998; Stock 2000a: 190, 192 etc.
- 7.2 “to **control** the genetic equipment”: Silver 1998: 144
- 7.3 “taking a **hand on** the human genetic make-up are almost limitless” (“Eingriffsmöglichkeiten ins menschliche Erbgut nahezu grenzenlos”: Silver 2000: 147
- 7.4 “**intervention**” (“Eingriff”): Silver 2000: 147, Stock 1998, Stock 2000a: 190, 192; Stock 2000b: 123
- 7.5 “genetic **manipulation**” (“Genmanipulation”): Silver 1998: 142, 145; Stock 2000c: 125)
- 7.6 “germ line **manipulation**” (“Keimbahnmanipulation”): Silver 2000: 147; Stock 2000a: 191
- 7.7 “improvement **manipulation**” (“Verbesserungsmanipulation”): Silver 2000: 147

- 7.8 “**handling**”: Stock 1998, Stock 2000b: 125
- 7.9 “**produce**[s] far-reaching changes in our biology” (“tief greifend”): Stock 2000b: 125
- 7.10 “true **command** of the technique”: Solter 2002: 23
- 7.11 “responsible **handling** of these new forces”: Stock 1998
- 7.12 “a lottery game [...] for the **production** of offspring”: Reich 2000: 206
- 7.13 “conception in the sense of **producing** a fertilized human egg cell”: Reich 2000: 205
- 7.14 “**produce** children”: Green 1999: 63
- 7.15 “**design** the baby”: Hamer 2002: 24
- 7.16 “**designed**”: Reich 2000, 206
- 7.17 “**fitting** [...] the genomes”: *ibid.*
- 7.18 “**activating** the egg cell”: Solter 2002: 23
- 7.19 “genetic **copies** of humans can be generated”: Wilmut 1997: 220
- 7.20 “the genetic **equipment** of the future child is **designed** and **ordered** just like the kitchen for our new home”: Reich 2000: 206
- 7.21 “**menu**”: Baker 1999: 163
- 7.22 “reproduction **restaurant**” (*ibid.*)
- 7.23 “**producing** offspring”: Silver 1998: 145
- 7.24 “**control** [over] the genetic **equipment**”: Silver 1998: 124
- 7.25 “embryo **check**”: Katzorke 2003: 149
- 7.26 “quality of the **product** didn’t satisfy the quality requirements”: Reich 2000: 204
- 7.27 “**manipulation** of human biology”: Silver 2000: 147
- 7.28 “genetic **improvements**”: Silver 2000: 147
- 7.29 “**improve** genes”: Stock 2000b: 124
- 7.30 “include genetic **controls**, which allow to **switch off** the genes”: *ibid.*
- 7.31 “germline **manipulations** [...] **in the hands** of clichéd crazy scientists who want to create a new super-race”: Stock 2000a: 190
- 7.32 “**manipulations** which not only affect our physiology, but also our emotional and spiritual world”: Stock 2000b: 125
- 7.33 “**recreate** our life completely”: *ibid.*