Body descriptions in biohacking and their overlaps and origins: a Swedish case study

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| abstract

This article researches what body descriptions are present within Swedish biohacking, what roots they have, and what overlaps they create between biohacking and other philosophical, political, and scientific discourses. As biohacking has become an increasingly popular subcultural influence in contemporary culture, not least when it comes to individual responsibility for ones health, the aim of the article is to show what other discourses are imported into the health discourse via the use of body descriptions. The study focuses on the most well known and influential Swedish biohacker, and the analysis is based on her use of body descriptions when communicating to her followers. Her use of body descriptions leads to transhumanism where the biological body is seen as a computer, libertarianism where the body is a stage for health entrepreneurism, and synthetic biology where the biological body is placed within a post genomic culture.

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Introduction to biohacking

Biohacking is a contemporary buzzword, but it traces back to a *Washington Post* article written in 1988, in which journalist Michael Schrage described his observations of a subculture that consisted of people performing techno-biological experiments in their garages. In the article, Schrage reflected upon a future biotech culture in the following way:

> What happens, for example, if future generations begin to see life as something that's manipulable – just another computer program, but one in which the printout isn't on paper but in proteins? If children grow up believing that life is nothing more than organic chemistry? (Schrage, 1988).

Not only has the concept of biohacking survived and consolidated over the thirty-five years since the article was written, but the questions about what happens to a culture and society where biological life is comprehended as something possible to shape on a molecular level are also more relevant than ever. The ideal of an amalgamation of computer and biological body that Schrage observes in the biohacking community of the 80s has, to some extent since then, been realized through biotechnological advancements. And this

development has, just as he suggested, formed our conception about what biological life is and about our possibilities to shape it, interpret it, and create it. Biohacking has changed from being a subversive and secret subculture in the shady garage that Schrage refers to, into a normalized and frequently-used term in public discussions on how citizens should relate to (bio)medical science and take responsibility for their own health.

The biohacking community encapsulates many different subgroups with many different goals. One common denominator might be that biohackers are individuals or groups that make biological, biomedical, or biotechnical experiments in non-institutionalized settings, such as universities or medical companies. The movement started to grow substantially in the US around 2005 and then spread globally. But it was not until 2008 that biohacking became organized on the general society level, then under the name of DIYbio in Boston (Delfanti, 2013, p. 114). Different subgroups within the biohacking community are guided by different ideologies and aims, and the subcategories vanish and reappear, or morph at pace with biotechnological developments, innovations, and general access to those. There are many different hacks going on under the label of biohacking. In the more altruistic collective formations, experimenting in a DIY-biology setting, the goal could be to build cheap medical equipment to ship to poor countries. One example here is the French collaborative open science platform, Just One Giant Lab (JOGL), which, as the pandemic broke out, engaged to develop SARS-CoV-2 diagnostic tests that are safe, simple, sensitive, inexpensive and accessible (JOGL, 2021). In this case the hack is oriented towards the established political or bio capital market system. There are also groups that hack for fun and with artistic purposes, for example the European bioart collaborative, Biofriction, where participants in the artistic summer workshop of 2021 got to extract hormones from certain household products to see how they visually manifested when injected into mushroom mycel stained with dye (Biofriction, 2021). The goal of bioart is to make art pieces from biological material and/or through biological experimenting. The version of biohacking that has become universally dominant in recent years is one where the goal is to hack the individual body to optimize personal health – often with a clear focus on personal longevity. Here we find, for example, Danish Biohacker Community where longevity and optimal performance is in focus (Danish Biohacking Community, 2021). Scholars have argued that the US biohacking movement differs from its European counterpart, as the movement in the US is oriented toward market-driven entrepreneurship and personal enhancement to a greater extent than the European (Seyfried & Schmidt 2014, Keulartz & van den Belt, 2016). This might have been the case a decade ago, but many of the frugal DIY-biology initiatives of Europe (for example, the Danish Biologigaragen) have closed in the last couple of years and have been substituted by the individualist health entrepreneur model – in the case of Denmark, the aforementioned longevity and performance focused Danish Biohacking Community. The current individualist trend within biohacking, with the US entrepreneur and lifestyle guru Dave Asprey as a leading player, has also been the dominating variant of biohacking in Sweden over recent years. It is this variant of biohacking I will focus on in this article.

Purpose and aim

One important conviction that this project departs from is a belief that the way we speak about biological life determines how we live and value it (Nerlich & Hellsten, 2011). The tradition of comparing or explaining the human body by referring to it as a machine

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is very old, and in the computer age the comparison between a computer system and the workings of the human biological system on a molecular or genetic level has become standard (Kay, 2000). This study departs from a standpoint that the use of metaphors shapes our lives (Lakoff & Johnsson, 1981), and that technological body descriptions are non-neutral and instead loaded with meaning. Vaage (2018), for example, argues that the living machine metaphor, also in a historical sense, «builds upon a certain perception of life entailing an idea of radical human control of the living world» (p. 57). In this study I will focus on descriptions of the human biological body that biohackers are using as explanatory narratives as they advocate for biohacking, and what they really mean by tracing these descriptions to other discourses where they are also used.

Sweden is among the countries where interest in biohacking is strong. According to Google Trends, Sweden is among the five countries where the search term "biohacking" is used most frequently[1]. Swedish interest in biohacking is reflected through a widespread uncritical Swedish media coverage, where biohacking is described with science-fiction fascination as a cool trend and a future hopefulness (Petersén, 2019, pp. 22-23). The concept of biohacking has also recently spread into the broader public Swedish discussion on fitness and health. One of the most vivid examples of this is the well-known Swedish nutritionist, Fredrik Paulun, who has recently appropriated the label biohacking to his public health ideas on nutrition, which he has been advocating since the early 1990s (Paulun, 2020). Studies have shown that media has an impact on public attitudes and conceptualizations about biotechnology; for example, Nelkin & Lindee's (1995) studies on the cultural impact of gene research, largely through mass media. Ideland (2005) has investigated how gene research around the millennium, which culminated in the cloning of Dolly the sheep, influenced Swedish popular culture through mass media. Jidesjö (2012) has shown how popular scientific media has become an increasingly important source of knowledge for pupils in Sweden. The hypothesis from this is that, given biohacking's popularity and display through its own digital channels and mass media, the body descriptions spread from within biohacking onto a general public might contribute to shape the popular biological self-image, and conceptions of what human life is and could be. The aim of this analysis is first to see what descriptions of the human biological body exist within biohacking, and then to trace these descriptions to other political, philosophical, and scientific discourses with the aim to find out what ideas we really are accepting as part of the deal when we consume the ideas of biohacking. This study will not take into account the wider psychological or behavioral implications of these overlaps but aims to identify them for future studies.

Approach

I have limited this study to just one case: Martina Johansson. Johansson is a publicly well-known Swedish biohacker, author and influencer; she communicates with a Swedish audience in the Swedish language and is not internationally focused. Her variant of biohacking belongs to the individualist entrepreneurial trend described above. In this study, I examine Johansson's role as an influencer among her many interested biohacking followers with help from Fleck's theory on esoteric and exoteric circles within "thought collectives" – his term for a discursive formation whose members interact

1. In 2021, Sweden was number three on the list as of 20 May and number five on 10 September.

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collectively towards the production or elaboration of knowledge using a shared framework of cultural customs and intellectual interaction (Fleck, 1997, Mirowski & Nik-Khan, 2017). The esoteric circle consists of specialist leaders, while the exoteric circle consists of following members, who are influenced by the thought style within the collective, but do not play a more active role in it. The biohacking movement can further be labeled as what Hepp has called "media-related pioneer communities", meaning groups of people who are constituted foremost by technical means of communication, and whose core of communality relates to media (Hepp, 2016). The esoteric circle and the exoteric circle of the biohacking community can clearly be seen in the online environment. Among the many biohacking communities on Facebook, some were started in the years around 2014 (such as Biohackers [GLOBAL] with 11,000 members) but many are new, specializing in fractions of biohackers – for example Biohacking women (800 members). The biohacking groups on Facebook are clearly directed towards the already believing members of the exoteric circle, and descriptions of the human biological body used for explanatory or recruiting purposes are therefore rarely seen there.

Johansson, who interacts with her audience mostly through the Internet, has become the most influential publicly directed biohacker in Sweden, and her blog *Next Level Biohacking* has around 187,000 weekly visitors as of 12 May 2021. Apart from her digital presence, she has also published more than 10 physical books within popular medicine since 2012 (Ghaffari, 2020, 09:30). She frequently participates in the media, has been lecturing on the Swedish national TV channel for public science (UR Play), and has an Instagram account with over 34,000 followers. Johansson appears in a lot of YouTube videos, both on her own channel "Martina A K Johansson" and as a guest in video pods and vlogs etc. Her education is in civil engineering, but in 2021 her self-studies within medicine earned her a PhD position at the Department of Health, Medicine and Caring Sciences, Linköping University, Sweden. Johansson is directed towards biohacking's exoteric and esoteric circle. On her homepage and blog she guides people who are hacking themselves and answers questions from them as an expert representing the esoteric circle. But her popular medicine books, general lectures, and appearances in pods are directed outwards, towards a general public ready to be drawn into the esoteric circle. It is also here, where she more clearly promotes her entrepreneur trademark as biohacker, that we find the descriptions of the human biological system, and the pedagogically thought-through rhetorical arguments for becoming a biohacker and that shape the individual biology. Her most recent book, co-authored with a biohacker friend, was released in autumn 2021, and is visually and structurally designed as a high school level schoolbook, with question boxes at the end of each chapter (Johansson & Hansson, 2021). Her published books, her participation in pods, and her webpage have been of most value to the analysis which foremost aims to investigate what is communicated to the (yet) non-biohacking public.

In this study, I have chosen to use the word *discourse* to describe the different cultural contexts that appear throughout this investigation. This study is not a formal discourse analysis, and discourse is understood in its loosest form, as «a particular way of talking about and understanding the world (or an aspect of the world)» (Winther, Jørgensen & Phillips, 2002, p. 1). Qualitative content analysis has been used both to analyze the statements in Johansson's physically published books, the spoken statements on vlogs or in pods, and the written content on Johansson's blog and Instagram. Meaning units, i.e. «words, sentences or paragraphs containing aspects related to each other through their content and context» (Lundman & Graneheim, 2004), have been sought

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for when identifying descriptions of the human biological body and statements about our possibilities to shape and control it using biohacking methods. To include different types of narrative elements, I have chosen to use the word *descriptions* as a label for what I have sought for in the data. The descriptions found in Johansson's work carry political, philosophical and scientific traces in them. In the analysis, I first identify the descriptions found, and then in three sections explore what overlaps with other political, philosophical, and scientific discourses that descriptions have. In the parts of the analysis where I discuss the, at times, overlapping political, scientific, and philosophical discourses that share narratives of the human body with Johansson's biohacking, I depart from Johansson's statements and extend them by adding previous research, and my own prior knowledge and experience in an interpretational process of knowledge construction rather than knowledge discovering (Stake, 1995, p. 99). This implies that it is, of course, possible to find several other discourses that overlap with Johansson's vast amounts of statements made in different contexts. For example, there is an interesting current of holistic new age ideology, and one of psychology, which will not be dealt with here, but will be left for other future investigations.

Previous research and theoretical framework

Research on biohacking has mostly been concentrated within the sociological realm, exploring the subversive agenda of the subcultural organizations against bio capitalism (i.e. Delfanti, 2013), with the juridic issues concerning biosecurity (Zettler et. al., 2019), or with the relation between amateurs and experts (Kelty, 2010). The above-mentioned studies have mostly explored the DIY biology scene as collectives or formations with a more or less common agenda. Research on the more transhumanist-tinged version of biohacking, which dominate private lifestyle cultures, and which is the subject of this study, have a closer affinity to research on the quantified self-movement. The significant interest from researchers in quantified self has manifested itself in much research from sociological and biopolitical aspects (e.g. Ajana, 2017), which will be referred to in my analysis of biohacking's neoliberal elements. Other studies have focused on how wearable technology and self-tracking forms people's behavior in everyday settings (e.g. Lupton, 2016, Fors et al., 2021). In this study, I examine the rhetoric used by advocators of biohacking, and not the impact on the participating audience. Furthermore, quantified self and biohacking are not interchangeable terms. Quantified self is an important part of biohacking as an experimental method tool, called QS-hacking, but only accounts for technologically dependent hacking. That which Johansson calls «the subjective hacking», and which she renders the most important, instead relies on a more holistic self-observation approach where, for example, looking in the mirror or scanning the mind for feelings and moods is essential (Johansson, 2019). Except for one short study on how the computer metaphor has been extended to age intervention within biohacking (Ellison, 2020), body descriptions have to my knowledge not been studied, either with regard to the practice of life logging or to biohacking.

From its start, this study has been guided by some important theoretical principles, which I shall describe here. First, the study relies on a belief that the language we use to describe objects form our way of interacting with them (Lakoff & Johnson, 1980, McLean & Syed, 2015). This is also true for the metaphors used to popularize scientific theories on the biological human body (Hellsten & Nerlich, 2011). Second, all discourses, includ-

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ing science (Latour, 1993, Kay, 2000, Jasanoff, 2004), are co-constructs with society and culture, and can be studied as embedded among other cultural practices. Descriptions float from one cultural practice to another, constructing overlapping master narratives, i.e. culturally shared stories that affect both individual identity formations and cultures (McLean & Syed, 2015).

Third, the use of descriptions for the body in biohacking can be understood as an effect of an emerging contemporary science-culture co-shaping process. The long history of explanations of the human body by references to prevailing technological paradigms throughout history is well known. The contemporary explanation where the body is placed into the computing and data paradigm, one in which the biohacking discourse has emerged, has lasted for a considerable time and is seemingly ubiquitous. Already in the 1950s certain metaphors – foremost *code* and *information* – spread from computer science to a range of academic disciplines. The great cultural valence of the two concepts made them into chameleon-words that permeated several discourses, where they carried different hopes and notions (Kay, 2000, Meirowitz & Nik-Khan, 2017, Buckland, 2012). The code and information descriptions became the backbone in biology science dealing with the gene, both within the "doing" of research as well as in the public communication of the findings. The Human Genome Project, which was initiated in 1990, meant a massive cultural impact of gene research during the 90s, which culminated in 2004 when the project resulted in the presentation of a composite sequence of the human DNA (HRG) (Nelkin & Lindee, 1995, Kay, 2000, Day, 2001).

Since then, contemporary culture has moved far away from the interest in a common human DNA-sequence. Even if biologic explanations to human behavior is as strong as ever, contemporary culture is a post-genomic one where more individual approaches to the knowledge about genes dominate. Rose (2007) describes a general cultural biological shift of the last fifteen years in which the way to speak about life has most often been to refer to it at a molecular level, and where the public tend to increasingly understand themselves as biological creatures with the ability to engineer, control, and shape their own vital parameters (Rose, 2007). Harvey (2009) has described a health entrepreneur interest following this cultural shift. Here, biohackers belonging to the individualist current are found asking: How can I as an individual use all this bio(medical) knowledge to personally benefit from it as much as possible? The individual, often amateur, approach to (bio)medical science also links biohacking to a post-truth epistemology, where previous society-wide authoritative truth-tellers are seen as less representative for the masses (Harsin, 2018).

As a consequence, evidence of conversion of qualitative aspects of life into quantified data, or datafication, is today seen in almost every aspect of life (Ruckenstein & Dow Schüll, 2017), as well as an explanatory paradigm for social behaviour (Cukier & Mayer-Schoenberger 2013, Van Djick, 2014). Opportunities to register individual body data through digital wearables corroborates the practices to this datafication. Harari has described our culture as one of "dataism", a paradigm in which human beings are described as algorithmically processed data flows and where «the value of any phenomenon or entity is determined by its contribution to data processing» (Harari, 2016, p. 373). Dataism thus reinforces the core belief in biohacking: that the biological body is a system of data that can be measured. Thus, I conclude that biohacking is not an unexpected phenomenon in contemporary culture but seems instead to follow quite naturally from many other changes of culture and society that have co-shaped with science and technology described in literature.

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Johansson's biohacking and the descriptions she uses

Johansson's blog and Instagram posts consist of videos, images and texts where she shares the results of various experiments which she is conducting on herself. After a long and frustrated period of not getting help for any of her many medical issues, she started to do research and experiment in order to «fix herself» (Ghaffari, 2020, 01:02:35). The list of what she has fixed or "reprogrammed" is long, and contains for example: social phobia, anxiety, OCD, nervosity, mental focus, self-confidence, feeling of self, depression, extreme stage fear, IBD, IBS, chronic inflammation, general health, hair growth, nail growth, metabolism, strength, fitness, agility, dependencies, sleep quality, and pollen allergy (Johansson, n.d.). She instructs her audience on how she eats, exercises, thinks, sleeps etcetera in a way that is optimal for her chemical bodily system at a molecular level. She contextualizes these self-experiments in a mix of theories and findings, both from academic research and holistic and pseudo-scientific areas. Her interest in the functions of her biological body embraces many different angles, and on her social media channels posts on topics such as power thinking, brain waves while meditating, heart frequency, hormone optimization, ketogenic diet, blood sugar, anxiety, sleep, exercise, and instructions for how the public should read research articles, are blended together. She describes her approach in the following way:

> I usually say that it is about having a certain point of view, a very dynamic point of view on one's own ability to change and get better. I consider my body a programmable, biological computer and find it very exciting to explore the limits of my human potential. This means that I try to improve my inner biology with the help of various "hacks", i.e. tricks that include everything from thought patterns to diet, supplements, routines, special forms of exercise or protocols (Johansson, n.d.).[2]

In her lectures, posts and books Johansson repeatedly describes the biological body as a «human machine» (Ghaffari, 2020, 01:18), and as a biologic programmable computer where all the chemical building blocks that it comprises can be optimized (Johansson, n.d., Biohacking – en grundkurs 2018, 01:45). Her experimentation on this inner chemistry-optimization is very much focused on diet, where nutritional components, in her model, act as another set of building blocks that are infused on the programmable system to optimize its power to reach its fullest potential. She is using her experiments in a proactive sense to prevent aging and illness, «as a reinsurance for the future» (Ghaffari, 2020, 30:33), but also to engage in a thrilling "exploration" of her "human limits» (Johansson, n.d.). In this exploration, she most often utilizes a large amount of different digital technological measuring devices such as finger rings that measure sleep, heart rate variability monitors, or a combined blood glucose and ketone meter. Johansson uses technological measurements as a part of her life logging but is not limited to technological gadgets. There is a clear holistic and spiritual side of her version of biohacking with, for example, meditation, healing and power thinking as important elements. She believes technology alone is not enough to gain true self-knowledge (Johansson, 2019).

2. All translations of Johansson's quotes, originally expressed in Swedish, are my own.

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Transhumanism and the body computer

Even if Johansson has a holistic outlook on biohacking, the possible expansion of human limits that she expresses that she seeks, and her arguments on optimizing her own individual biochemistry in order to avoid illness, reach longevity and postpone aging, place her in the section of biohacking that overlaps with transhumanism. Central to this overlap is her description of the human biological body as a machine. Transhumanism is an old concept dating back to the 1950s, when the British biologist Julian Huxley coined the term. The core idea of transhumanism, in short, is to merge the human body with technology in order for mankind to benefit from technological development as much as possible. Transhumanists see technologically enhanced man as the next necessary step in the evolutionary ladder, and often the expressed future goal of mankind includes mind uploading. The human biological body's separation from nature and technology is viewed as a false construction (Petersén, 2019, p. 63), and the human body is believed to be a biological restriction – a ‹meat sack' – which prevents humans from overcoming biological aging and death, which are seen as forms of curable illnesses (Roden, 2015). Johansson often mentions the difference between biological and chronological age, and is convinced that controlling the first through biological therapies will soon be the norm: «When will humans become biologically immortal? I can tell you that we are pretty close now! Probably this will happen within the next ten years, not for everyone, but for some individuals» (Johansson, 2021a). In Johansson's biohacking, the body is not a meat sack which is eventually to be eliminated, but instead a laboratory site that can be tweaked to molecular perfection.

This idea of transhumanism was, in the 1990s and early 2000s, often either ridiculed as a marginalized sci-fi sect, or as a dangerous movement that promoted ideas that could lead to a genetic divide between enhanced and non-enhanced humans (e.g. Sandel, 2007). The ideology was, in a famous article by Fukuyama, identified as a threat to future democracy and human equality (Fukuyama, 2004). Around 2010, the status of transhumanism started to change, and in the last decade it has been taken increasingly more seriously in prominent, bioethical, peer-reviewed journals (e.g. Thompson, 2017). This change is probably partly due to the formal establishment of transhumanism through organizations such as the WTA (World Transhumanist Association) in 1998. But the change, moreover, mirrors (bio)technological development over the past thirty years, lately including synthetic biology and the Crispr gene editing technology, which has made the transhumanist ideal to (co-)create and enhance human bodies appear more feasible. Also the reduced prices and public market for biomedical technical gadgets that serve as extensions of our bodies and minds has supported a normalization of transhumanist ideas. The gradual acceptance of transhumanism is undoubtedly also due to contemporary dataism and the cultural shift whereby biological bodies are normally seen as systems of data flow.

The converging of services and gadgets made possible by biotechnological development, contemporary dataism, and the rhetoric of the major tech companies, frequently driven by technolibertarian reasoning, often make it difficult to see where the borders of transhumanism today are drawn. The word transhumanism seldom appears today in relation to transhumanist reasoning. Biohacking, being a much newer concept with less moral baggage, is one of the headlines that has lately substituted the debated concept of transhumanism. In Sweden, the transhumanist movement has been exceptionally

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strong since the 1990s. Sweden was the first country with a national transhumanist organization (1993), and it was also a Swede (Nick Bostrom) who founded the international transhumanist organization in 1998. Transhumanism has thus long been strong in Sweden, but when biohacking formed on the Swedish scene in 2015, transhumanism became marketed under the cloak of the more socially accepted and culturally trendy label of biohacking (Petersén, 2019). Since 2016, European biohackers have organized an annual event called Summit, and in 2018 Stockholm hosted it. The focus on transhumanist interests is clearly reflected in the list of presentations in this summit, which had the theme Optimal Recovery and Peak Performance (Biohacker Summit, 2018).

We can see, then, that Johansson's biohacking clearly overlaps with transhumanism but differs in the way that it is open to molecular biological, non-technological methods of optimization. Johansson mentions that she is extremely interested in transhumanism but thinks that transhumanists focus too much on technology (Ghaffari, 2020, 33:30). In Johansson's biohacking, not all hacks are initially dependent on technology; a biohack could just as well be a hack of rising hormone levels that has its onset in a cold ice bath, or of consuming 90% dietary marrow – concepts initially far removed from technological devices, although the reading of results in changes of the inner chemistry is then often interpreted through technology. However, even if there is a difference between Johansson's biohacking and transhumanism in terms of reliance on and appreciation of technology, the two discourses share the descriptions of the human biological body as a hackable system that functions as a machine. Transhumanism needs this description to assure people that a bodily merge with technology is a natural step in evolution since the body really already *is* a technology. Johansson needs the description to explain the functions of the bodily system in order to convince new and existing members of the community that every individual has the possibility to program their own biological system by intervening in its genetically pre-programmed automacy.

Synthetic biology and post genomic culture

The descriptions found in Johansson's rhetoric, i.e. the biological body as: 1. a human machine; 2. a programmable computer system; and 3. a system of building blocks that can be optimized, can all be found within synthetic biology. The influence from synthetic biology onto DIY-biology is well researched (e.g. Meyer & Vergnaud, 2020), but for the more individualist trace of biohacking that Johansson represents there are also important overlaps. Synthetic biology is a field of science that involves redesigning organisms for useful purposes by engineering them to have new abilities (NHGRI, 2019). The appropriation of synthetic biology descriptions by biohacking can be interpreted as a process of *social alchemy* (Bourdieu, 1986), where biohacking has imported metaphors used by the recognized and stable science of synthetic biology, to scientifically legitimize its own field in the eyes of the public. Furthermore, the fact that synthetic biology is often advocated as the hopeful solution to many of the socio-technical global problems we are facing and will face in the future – a buzzword rhetoric that is used both by academics, companies selling biotechnological products, and politicians alike (Balmer, Bulpin & Molyneux-Hodgson, 2016) – makes it a beneficial scientific context to import rhetoric from.

With the focus on genes, and the media discourse surrounding them during the last few decades, there followed a normalized and widespread idea of so called "genet-

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ic essentialism", that is, an understanding of the outcome of human lives as dependent and determined by gene configurations (Nelkin & Lindee, 1995, p. 149). Dar-Nimrod and Haine (2011) argue that the influence from media concerning this specific scientific argument must be seen as profoundly distinct from the impact of other kinds of scientific arguments because of its immense cultural power. They further argue that genetic essentialism influences peoples' behavior and the way they chose to live their lives (Dar-Nimrod & Haine, 2011). Within synthetic biology, the metaphor to describe the biological body as a programmable computer system which it is possible to (re)build on a molecular level, is essential, both when it comes to synthetic biology education literature and research articles from within the subject (Hellsten & Nerlich, 2011, Boldt, 2018, Braun, Fernau & Dabrock, 2018, Taylor and Dewsbury, 2018). Mirroring the critique against genetic essentialism, several studies suggest that the use of engineering metaphors to explain complex biological systems found within synthetic biology are reductionist and that they therefore might have consequences for the moral view of what life is, as they might foster teleological thinking in students and the public (Piggliucci & Boudry, 2013, Boldt, 2018, Braun et al., 2018). On the other hand, articles written from within synthetic biology have also been found to carry a performative element where the engineering metaphors inform individuals that they are in charge of their own destiny (Bensaud Vincent, 2013).

> This view of the human biological body as a pre-programmed genetic system which can be re-programmed if we intervene in its cause-and-effect logic and take control of it is also the model we find in Johansson's biohacking. As long as we know our data, we can decide the outcome. She writes: "[...] my belief is that you do not have to be a victim of your own genes, an inhibitory personality or a bad upbringing. Everything can be fixed!" (Johansson, n.d.).

In Johansson's statements, the bodily system is repeatedly described in a simple mechanistic way: as input and output, or as a system functioning in line with a simple cause-and-effect logic. Johansson emphasizes that her training as a civil engineer facilitates a certain unique "systematic way of thinking about biological problems" when she is doing research within medicine (Johansson, 2021b). However, importantly, her biohacking offers a way out of this determinist genetic essentialism, and she clearly challenges determinism by taking control of her individual biological situation. Both synthetic biology and Johansson's biohacking belong to the post-genomic discourse. As the HRG was completed in 2004, the focus shifted into different post-genomic fields with more individual applications of the new genetic knowledge giving rise to new discourses, for example, synthetic biology. As Zwart (2016) notes, post-genomics has both led to a de-personalization as the mystery of human biology became data sets, and a parallel re-personalization and self-centeredness as new possibilities to map the individual genome enabled individuals to become health entrepreneurs[3]. Johansson can be placed in the group of re-personalization entrepreneurs.

The idea that the determinism in our biology will only enslave us as long as we do not take control of it and find exactly what is optimal for our system – and that this is entirely up to ourselves – comes through in several of the quotes found in Johansson's books.

3. Zwart builds here on Harvey's theory on health entrepreneurship following the biologism of the 21st century (Harvey, 2009).

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> Cause and effect is true also for the human body, and it is the choice you make every day that will decide if you are sick or healthy, or if you are unsatisfied or satisfied with your life situation. Despite whether you choose to use the information or not, the same set of rules apply: You are the one who steers, so steer right and feel good! (Johansson, 2014, p. 191).

Not only is a sense of control shining through as utterly important in this rhetoric, but so also is the concept of individual freedom and doubts concerning generalized objective truth, which I shall deal with in more depth in the next section. Even if the bodily system is based on laws of mechanistic cause and effect, both of these can be controlled as long as we take the time to first monitor them in order to make the right interventions. The pre-programmed software (genetic determinism) could then be hacked, but to do that you also have to hack the established medical research system, and the market. All of the established structures that Johansson's model challenges us to analyze and understand present an overwhelming challenge to most of us – not least with regard to the amount of time this would take. This is also how her entrepreneur or influencer model works; she sells us her hacking of various established orders surrounding personal health, for example by sharing her experiments, recommending technological gadgets and nutritional supplements that she has tested, and providing us with crash courses on how to critically read research articles found on the Internet. However, she avoids taking responsibility for individual outcomes by acknowledging that every body system is unique, and no hack is really generalizable to anyone else.

The libertarianist health entrepreneur (and transhumanism revisited)

Johansson describes the human body as a machine and a system, which it is possible to optimize, but one that is totally individual, and which does not fit into a medical research system where results have been generalized from large collected data samples. From this approach follows a skepticism towards institutional healthcare and research, and a renegotiation of where the medical expertise should really lie. Johansson declares:

> No doctor can know everything about all diseases, but every human being can become an expert of his or her own body. It's important to know that it is you who must know most about yourself, both in order to keep yourself as healthy as possible in general, but also to get access to the right healthcare when needed (Johansson, 2014, p. 22).

Johansson also has tutorials on how to read and interpret scientific articles for a grassroots audience, since she believes everyone should know how low the level of validity and objectivity in (bio)medical scientific research really is. In several videos and blog posts she expresses strong criticism towards institutionalized research as she wants to show how often it is financed by companies in a way that effects the research quality. In the post «Call the bluff step by step: this is how you read scientific articles!» she argues that much scientific research within medicine is financed by medical companies who want to sell products (Johansson, 2017). The debate on corporate interests in biomedical research and what McHenry (2008) calls a «crisis of credibility» has roared for several decades. But even if source criticism is more important than ever in the digital information flow, the way Johansson presents "the bluff" suggests that intentional deception is widespread and normal within science. In this way, Johansson inscribes her biohacking

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approach into a post-truth discourse where elite driven «truth markets» are believed to be structured around «strategic deception» (Harsin, 2018).

The critical perspective against both medical experts and the state healthcare system can further be related to previous research on datafication of health as a form of neoliberal subjectification. This research emphasizes how new wearable technology devices used to measure vital parameters make possible the withdrawal of the welfare state from citizens' lives, turning healthcare into self-care (Ruckenstein & Dow Schüll, 2017). Lupton identifies self-tracking devices as fitting well into the neoliberal paradigm where self-responsibility, market economy, and competition are leading driving forces (Lupton, 2016, p. 47). Johansson declares herself a libertarianist (Ghaffari, 2020, 01:40:06), and even if she is not dependent on technological devices for her biohacking, her rhetoric around how to take control of the individual system of the body shows affinity with the description of how individuals, through self-tracking gadgets, tend to make their lives and bodies into neoliberal projects, or "mini-corporations" that are in need of «constant self-development, improvement and investment» (Ajana, 2017, n.p.).

New, and more publicly disseminated, biomedical technology has, together with new public management politics, made possible a biopolitical development that has shaped the health system in recent decades. In research, self-tracking is often seen as a «key illustration of a neoliberal attitude towards the self and its governance» (Ajana, 2017). People who engage in self-tracking express a great deal of hope tied to the potential of technological self-tracking devices to raise general medical health levels, and their potential to help people to become more empowered and proactive in relation to so-called lifestyle diseases by breaking unhealthy habits (Topol, 2012). Alas, the information retrieved through self-tracking devices is most often not enough for patients to make lifestyle changes or decisions about health but needs the context of «support, coaching, or advice» (Nafus & Neff, 2017, p. 142). Johansson seeks to provide her readers with support, coaching or advice as she interacts with her followers on her homepage and the blog through chats, live videos, and open questioning opportunities through live Instagram chats. One of her missions is to guide her audience to insights on how we are all capable of steering the systems of our own bodies in a very precise way and she considers this to be the «beginning of something fantastic!» (Johansson, 2014, p. 17). Thus, her device «To measure is to know!» (Johansson, 2014, p. 21) shows only parts of a chain through which the human mini projects are realized. At length it reads out as: measurement – information – knowledge – power – quality of life:

> With more information about the hormones of the body and their functions you suddenly get the power over your own well-being, your body, and your health. With understanding also comes the possibility to act, because we can never change something we don't know anything about. [...] it is possible to use this knowledge to increase one's quality of life (Johansson, 2014, p. 14).

The entrepreneurship in which Johansson examines her «body as a field biologist (fältbiolog) and dare to experiment towards optimal health» (Johansson, 2014, p. 22), as well as her optimism towards the possibilities of empowerment for the individual who engages in these activities, shows great affinity with extropianism, a branch of transhumanism launched by Max More in the late 80s. As with the transhumanists described

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at beginning of this analysis, extropians believe humans will one day achieve eternal life through science and technology. The optimistic outlook on technology leads them to contribute to the development by conducting private research on themselves (More, 2003). In the *Extropy principles* from 2003, More writes:

> Extropy means affirming continual ethical, intellectual, and physical self-improvement, through critical and creative thinking, perpetual learning, personal responsibility, proactivity, and experimentation. Using technology – in the widest sense to seek physiological and neurological augmentation along with emotional and psychological refinement (More, 2003).

More's approach resembles Johansson's more holistic outlook on biohacking as it also incorporates mental refinement as part of the improvement project. Just as in Johansson's statements, there is a strong libertarianist current in More's writings, which vividly appears in his idea of Morphological freedom, closely related to the quote above. Morphological freedom is the civil right of an individual to modify – or resist modification on – their bodies. This idea of self-ownership disengaged from any public health program follows the libertarianist principles of individual liberty, which rests on a belief that no individual should be subject to «interference by other agents in her doing as she sees fit with her own person and legitimate holdings» (Mack, 2018, p. 1). As libertarianists distrust government and the state and think that no one should need to ask society's permission to shape individual lives (Brennan, 2012, p. 1), it follows that libertarianist human body entrepreneur projects should be left alone, non-regulated by anyone. It also follows that the individual subject itself should lead the project, and not rely on any institutionalized medical research or structures of expertise.

Another perspective that links Johansson's biohacking, libertarianism and More's extropianism is the attitude towards risk. More describes the extropianist mindset when faced with challenges as follows:

> Where others see difficulties, practical optimists see challenges. Where others give up, we move forward. Where others say enough is enough, we say let's try again with a fresh approach. Practical optimists espouse personal, social, and technological evolution into ever better forms. Rather than shrinking from future shock, practical optimists continue to advance the wave of evolutionary progress (More, 2003).

Fuller (2014) considers this attitude as fundamental to the transhumanist world view. At this point the discourses of libertarianism and transhumanism almost eclipse. In transhumanist discourse, risk is treated as an opportunity rather than a threat, and there is a beliefwhere humanity should take those opportunities and deal with the consequences later (Fuller, 2014, Virtual Futures Stage, 2019, 12:25, 16:43). This relentless optimism, says Fuller, is permeated by a rhetoric also used by entrepreneurs in the libertarian free market (Virtual Futures Stage, 2019, 15:10).

Similarly, Johansson's expressed optimism surrounding the possibilities of experimenting and taking charge of the individual body system is strong. For example, she lets us know that 80-90% of all mental and physiological problems are «entirely curable» (Johansson, n.d.) if we only know about and act upon them. However, this optimism also obviously comes with a great individual responsibility to make the right choices in exactly everything we do – from dietary intake to thoughts we think – and if we do wrong, we might lose the opportunity to become happy, healthy, and a better version of our-

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selves on every level. For a person with, for example, health anxiety (around 6-8% is an estimated general population prevalence according to recent studies (Axelsson, 2018, p. 7), or for a person with performance addiction, this might feel like an imperative that it is impossible to be flexible to, leading to much stress.

Furthermore, the individual risk taking ideal implies that everyone should bear the burden of consequences themselves, and that some will be better at bearing it than others (Virtual Futures Stage, 2019, 15:34). There are affinities between this and what Ajana (2017) refers to as «the neoliberal health and productivity imperative of our present time» (n.p.). This imperative is, just like Johansson's biohacking, not especially interested in being either coercive or inclusive, but is instead directed to individual entrepreneurs who are ready to invest in optimizing their individual body parameters. Johansson's statements repeatedly expresses that only if you are willing to take control of your life and health you will succeed. If you fail, then you have to improve your methods. In this context, it is also important to mention that the entrepreneurship of the optimized body is totally dependent upon access to, sometimes very expensive, private measuring technology. In a radio interview, Johansson talks about her newly purchased sleep measuring finger ring, which cost her 5,000 SEK, and she herself – with a laugh – declares: «It is expensive to biohack!» (Ghaffari, 2020, 29:26). The amount of time and money needed for the health entrepreneur project advocated for by Johansson effectively rule out groups of society that have neither the economic means nor the opportunities to dedicate themselves and their time to control their bodies and be good entrepreneurs.

Conclusion

The growing interest in biohacking and personal health in Sweden, the many uncritical media entries on the topic, and the known influence on public attitudes and conceptualizations about biotechnology from public cultural discourse makes it important to take a closer look at the content of the ideas expressed from within the biohacking discourse. The aim of this analysis has been to see what descriptions were present within Johansson's version of biohacking, and examine what other ideas and ideologies followers accept as part of the deal when they consume her ideas of biohacking. The descriptions found can be classified into three elements as follows: a) a human machine, b) a programmable computer system, and c) a system of building blocks that can be optimized. The analysis traced these descriptions to transhumanism, the libertarianist and neoliberal healthcare discourse, and postgenomic science.

In summary, the analysis has shown that biohacking expressed through Johansson overlaps with transhumanist discourse as they both describe the human biological body as a machine but with different meanings. It also overlaps with post-genomic biology science, as both share an imperative of taking charge of one's own destiny through intervening in one's individual biological system on a molecular level. An overlap with libertarianist ideology was also found concerning Johansson's ideas about medical research and healthcare as non-generalizable, and personal health as an individual neoliberal entrepreneur project. The latter also raised the question of a post-truth approach to expertise. Given these overlaps the impact of transhumanism, post-genomic biology, and libertarianism on biohacking should be considered part of the biohacking discourse in a future where this model might influence healthcare, and the public's biological self-understanding.

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References

Ajana, B. (2017). Digital health and the biopolitics of the Quantified Self, *Digital Health*, *3*, 1-18.

Axelsson, E. (2018). *Severe health anxiety: novel approaches to diagnosis and psychological treatment*, Karolinska Institutet.

Balmer, S.A., Bulpin, K. & Molyneux-Hodgson, S. (2016). *Synthetic Biology. A Sociology of Changing Practices*, Palgrave MacMillan.

Bensaude Vincent, B. (2013). Between the possible and the actual: Philosophical perspectives on the design of synthetic organisms, *Futures*, *48*, 23-31.

Biofriction (2021). *Biofriction summer program*. https://biofriction.org/biofriction/biofriction-summer-program-diary/ (accessed: 16/11/2021).

Biohacker Summit 2018 (2018). *Theme: Optimal Recovery and Peak Performance*. https://new.biohackersummit.com/2018-stockholm-recording (accessed: 10/09/2021).

Biohacking – en grundkurs (2018). UR Play, Kunskapskanalen. https://urplay.se/program/208820-ur-samtiden-gather-2018-biohacking-en-grundkurs (accessed: 10/09/2021).

Boldt, J. (2018). Machine metaphors and ethics in synthetic biology. *Life Sciences. Society and Policy*, *14*(6), n.p.

Boudry, M. & Pigliucci, M. (2013). The mismeasure of machine: Synthetic biology and the trouble with engineering metaphors. *Studies in History and Philosophy of Biological and Biomedical Sciences*, *44*, 660-668.

Bourdieu, P. (1986). The forms of capital. In J. Richardson (Ed.) *Handbook of Theory and Research for the Sociology of Education* (pp. 241-258). Greenwood.

Braun, M., Fernau, S.& Dabrock, P. (2018). Images of synthetic life: Mapping the use and function of metaphors in the public discourse on synthetic biology. *PLoS ONE*, *13*(6), np.

Brennan, J. (2012). *Libertarianism: what everyone needs to know*, Oxford University Press.

Buckland, M. (2012). What kind of science can information science be? *Journal of the American society for information science and technology*, *63*(1), 1-7.

Cukier, K. & Mayer-Schoenberger, V. (2013). The Rise of Big Data: How It's Changing the Way We Think About the World. *Foreign Affairs*, *92*(3), 28-40.

Danish Biohacker Community (2021). https://www.facebook.com/DanishBiohackerCommunity (accessed: 16/11/2021).

Day, R.E. (2001). *The Modern Invention of Information. Discourse, History, and Power*. Southern Illinois University Press.

Dar-Nimrod, I. & Heine, S.J. (2011). Genetic Essentialism: On the Deceptive Determinism of DNA. *Psychological Bulletin*, *137*(5), 800-818.

Delfanti, A. (2013). *Biohackers: the politics of open science*. Pluto Press.

Ellison, K.L. (2020). Upgraded to Obsolescence: Age Intervention in the Era of Biohacking. *Engaging Science, Technology, and Society*, *6*, 39-44.

Fleck, L. (1997) [1935]. *Uppkomsten och utvecklingen av ett vetenskapligt faktum. Inledning till läran om tankestil och tankekollektiv*. Symposion.

Fors, V., Pink, S., Berg, M., O'Dell, T. (2021). *Imagining Personal Data: Experiences of Self-Tracking*. Routledge.

Fukuyama, F. (2004). Transhumanism. *Foreign Policy*, *144*, 42-43.

Fuller, S. & Lipinska, V. (2014). *The proactionary imperative: a foundation for transhumanism*. Palgrave Macmillan.

DOI 10.36158/97888929573671

Ghaffari, T. (2020). *Loungepodden #77 – Martina Johansson, Biohacker and Forskare: Sveriges största blogg om biohacking*. [Podcast], 27 February 2020 (16 May 2021). https://saleslounge.podbean.com/e/77-martina-johansson-biohacker-forskare-sveriges-storsta-blogg-om-biohacking.

Harari, Y.N. (2016). *Homo Deus: A Brief History of Tomorrow*. Harvill Secker.

Harsin, J. (2018). Post-truth and critical communication, *Oxford Research Encyclopedia of Communication*. Oxford University Press.

Harvey, A. (2009). From Genetic Risk to Post-Genomic Uncertainties: Nutrigenomics and the Birth of the 'Genetic Entrepreneur'. *New Genetics and Society*, *28*(2), 119-137.

Hellsten, I. & Nerlich, B. (2011). Synthetic biology: building the language for a new science brick by metaphorical brick. *New Genetics and Society*, *30*(4), 375-397.

Hepp, A. (2016). Pioneer communities: collective actors in deep mediatization. *Media Culture and Society*, *38*(6), 918-933.

Ideland, M. (2002). *Dagens gennyheter. Hur massmedier berättar om genetik och genteknik*. Nordic Academic Press.

Jasanoff, S. (2004). Ordering knowledge, ordering society. In S. Jasanoff (Ed.), *States of knowledge: The co-production of science and the social order* (pp. 13-45). Routledge.

Jidesjö, A. (2012). *En problematisering av ungdomars intresse för naturvetenskap och teknik i skola och samhälle – Innehåll, medierna och utbildningens funktion*. Department of Social and Welfare Studies, Linköping University.

JOGL (2021). https://app.jogl.io (accessed: 16/11/2021).

Johansson, M. (n.d.). *Biohacking*. https://martinajohansson.se/biohacking/ (accessed: 10/09/2021).

Johansson, M. (2014). *Hormonbibeln:Hormonoptimering för den moderna människan*. Pagina.

Johansson, M. (2017). Syna bluffen steg för steg: såhär läser du vetenskapliga artiklar! 16 March. https://martinajohansson.se/syna-bluffen-steg-steg-vetenskapliga-artiklar/ (accessed: 10/09/2021).

Johansson, M. (2019). Quantified Self och biometri. December 3. https://martinajohansson.se/?s=quantified+self (accessed: 10/09/2021).

Johansson, M. (2021a). Anti-aging och biologisk odödlighet. 13 May. *https://martinajohansson.se/anti-aging-och-biologisk-ododlighet/* (accessed: 8/09/2021).

Johansson, M. (2021b). *Genomsnittslivsstil och antihacking*. 28 July 2021. https://martinajohansson.se/genomsnittslivsstil-och-antihacking/ (accessed: 9/09/2021).

Johansson, M. & Hansson, M. (2021). *Handbok i biohacking: Lär dig förstå din kropp och nå din fulla potential*. Tukan Förlag.

Kay, L.E. (2000). *Who wrote the book of life? A history of the genetic code*. Stanford University Press.

Kelty, C.M. (2010). Outlaw, hackers, Victorian amateurs: Diagnosing public participation in the life sciences today. *Journal of Science Communication*, JCOM 9(1), 1-8.

Keulartz, J. & van den Belt, H. (2016). DIY-Bio – Economic, epistemological and ethical implications and ambivalences. *Life Sciences, Society and Policy*, *12*(7), 1-19.

Lakoff, G. & Johnson, M. (1980). *Metaphors we live by*. The University of Chicago Press.

Latour, B. (1993). Ethnography of high-tech: About the Aramis case. In P. Lemonnier (Ed.), *Technological choices: Transformation in material culture since the Neolithic* (pp. 372-398). Routledge.

DOI 10.36158/97888929573671

Lundman, B. & Graneheim, U.H. (2004). Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today*, *24*(2), 105-112.

Lupton, D. (2016). *The quantified self: A sociology of self-tracking*. Polity.

McLean, K.C. & Syed, M. (2015). Personal, Master, and Alternative Narratives: An Integrative Framework for Understanding Identity Development in Context. *Human Development*, *58*, 318-349.

Mack, E. (2018). *Libertarianism*. Polity.

Meyer, M. & Vergnaud, F. (2020). The rise of biohacking: Tracing the emergence and evolution of DIY biology through online discussion. *Technological Forecasting and Social Change 160*(2).

Mirowski, P. & Nik-Khan, E.M. (2017). *The knowledge we have lost in information: The history of information in modern economics*. Oxford University Press.

More, M. (3003). *The Principles of Extropy 3.1*. https://web.archive.org/web/20131015142449/http://extropy.org/principles.htm (accessed: 10/09/2021).

Nafus, D. & Neff, G. (2016). *Self-tracking*. MIT Press.

NHGRI (2021). *Synthetic Biology*. https://www.genome.gov/about-genomics/policy-issues/Synthetic-Biology (accessed: 10/09/2021).

Nelkin, D. & Lindee, S.M. (Eds.) (1995). *The DNA mystique. The gene as cultural icon*. Freeman and Company.

Paulun, F. (2019). *Biohack:Ät rätt för just din kropp*. Harper Life.

Petersén, M. (2019). *The Swedish Microchipping Phenomenon*. Emerald Publishing.

Roden, D. (2015). *Posthuman life. Philosophy at the edge of the human*. Routledge.

Rose, N. (2007). *The politics of life itself. Biomedicine, power, and subjectivity in the twenty-first century*. Princeton University Press.

Ruckenstein, M. & Dow Schüll, N. (2017). The Datafication of Health. *Annual Review of Anthropology*, *46*, 261-78.

Sandel, M.J. (2007). *The Case against Perfection: Ethics in the Age of Genetic Engineering*. Belknap Press of Harvard University Press.

Seyfried, G., Pei, L. & Schmidt, M. (2014). European do-it-yourself (DIY) Biology: Beyond the hope, hype and horror, *Bioessays*, *36*(6), 548-551.

Schrage, M. (1988). Playing God in your basement, *Washington Post*, January 31. https://www.washingtonpost.com/archive/opinions/1988/01/31/playing-god-in-your-basement/618f174d-fc11-47b3-a8db-fae1b8340c67/ (accessed: 20/05/2021).

Stake, R.E. (1995). *The art of case study research*. Sage.

Taylor, C. & Dewsbury, B.M. (2018). On the Problem and Promise of Metaphor Use in Science and Science Communication. *Journal of Microbiology and Biology Education*. *19*(1): n.p.

Thompson, J. (2017). Transhumanism: How Far Is Too Far? *The New Bioethics. A Multidisciplinary Journal of Biotechnology and the Body*, *23*(2), 165-182.

Topol, E.J. (2012). *The creative destruction of medicine: How the digital revolution will create better health care*. Basic Books.

Vaage, N. (2020). Living Machines: Metaphors we live by. *Nanoethics*, *14*, 57-70.

Van Dijck, J. (2014). Datafication, dataism and dataveillance: Big data between scientific paradigm and ideology, *Surveillance and Society*, *12*, 197-208.

Virtual Futures Stage (2019). *Transhuman Politics – James Hughes w/ Prof. Steve Fuller*. 8 July 2019. https://www.youtube.com/watch?v=-zObSYrDBzY (accessed: 10/09/2021).

DOI 10.36158/97888929573671

Winther Jorgensen, M. & Phillips, L. (2002). *Discourse analysis as theory and method*. Sage Publications.

Zettler, P.J., Guerrini, C.J., Sherkow, J.S. (2019) Regulating genetic biohacking. *Science*. *5*, 365(6448).34-36. DOI: 10.1126/science.aax3248.

Zwart, H.A.E. (2016). The obliteration of life: Depersonalization and disembodiment in the terabyte era. *New Genetics and Society, 35*(1), 69-89.

DOI 10.36158/97888929573671