D3.4: Ethical Analysis of Human Enhancement Technologies

[WP3 – Human Enhancement]

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Abstract

This report is prepared within the context of a European project called SIENNA (http://sienna-project.eu/), which was selected to fulfil the grant call SWAFS-18-2016.[1] The primary aims of this report were to:

- Identify HET products and applications, above and beyond those found in SIENNA D3.1: State-of-the-Art Review of Human Enhancement Technologies
- Identify potential present and future ethical issues
- Analyse those issues in a nuanced manner without moralising about them or attempting to resolve them

Therein, this report focusses on *mapping* the ethics of human enhancement. Analysis consists primarily of judging which topics deserve the most space with the limited time available to complete the report.

A secondary aim of this report has been to convey the results of SIENNA's "country studies" of the national academic and popular media debate on the ethical issues in human enhancement technologies in eleven countries, highlighting the similarities and differences about the academic and media debates between these countries. In comparison to the methods of ethical analysis, our analysis of the country study results has contributed fairly little to the overall identification and analysis of the ethical issues in this report. However, the country study results are expected to contribute more significantly to future SIENNA deliverables.[2]

Document history

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Information in this report that may influence other SIENNA tasks

Linked task	Points of relevance
Task 3.7	The proposal for an ethical framework for human enhancement will follow-up on the current report as the framework will be based on important issues identified in this task.

[1] https://ec.europa.eu/info/fundingtenders/opportunities/portal/screen/opportunities/topic-details/swafs-18-%202016

[2] See SIENNA D3.5: and SIENNA D3.6: for further data gathered in SIENNA on popular attitudes and opinions on human enhancement technologies.

Linked task	Points of relevance
Task 5.3	The code of responsible conduct for researchers relating to human enhancement will require consideration of the issues identified in this task.
Task 6.1	The report on adapting methods for ethical analysis of emerging technologies will require contemplation about the successes and challenges in the methodology used to complete this task.
Task 6.3	The step-by-step guidance from ethical analysis to ethical codes and operational guidelines task will require reflection about the successes and challenges in completing this task.

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Executive summary

What the reader should know about the general context behind the development of this report

This report is delivered in the context of a European Commission (EC) funded SWAFS[3] project called SIENNA, which began in October 2017 (http://www.sienna-project.eu). In the SWAFS-18-2016[4] call, that the SIENNA project has been developed to respond to, three areas of technologies have been defined: Human Genomics, AI/Robotics, and Human Enhancement.

This report is the fourth deliverable completed for SIENNA Work Package 3, which addresses the ELSI of Human Enhancement Technologies (HET). Specifically, this report fulfils the task described in the description of action of the project by the following:

> *"Task 3.4: Analysis of current and future ethical issues: This task will review existing ethical theories and approaches regarding human enhancement technologies. We will perform an ethical impact assessment of current and future ethical issues. We will use the review and assessment to identify major ethical issues and approaches to them regarding the technology in general, and regarding different domains and applications. The ethical impact assessment will engage stakeholders and experts, and is therefore connected to Tasks 3.5 and 3.6."*

The main author of this report (S.R. Jensen) is employed as a PhD candidate & academic researcher in the Faculty for Behavioural, Management and Social Sciences (BMS) Department of Philosophy at University of Twente (Enschede, Netherlands) with expertise in Bioethics and the Ethics of Human Enhancement in an International Context. Most additional contributors are PhD candidates/post-docs in BMS or Master's students in the Philosophy, Science, Technology & Society programme at the University of Twente (Enschede, Netherlands) working under the supervision of the lead author & work package leader S.K. Nagel (RWTH Aachen, Germany).

Both WP2 (ELSI Human Genomics) and WP4 (ELSI AI/Robotics) lead by H. Howard (UUppsala, SE) and P. Brey (UTwente, NL) respectively, have also produced reports with similar aims; however, given the different technology areas and related ethical aspects, the organisation of the reports may differ.

What are the aims and use of this report?

The primary aims of this report are to:

- Identify HET products and applications, above and beyond those found in SIENNA D3.1: State-of-the-Art Review of Human Enhancement Technologies
- Identify potential present and future ethical issues
- Analyse those issues in a nuanced manner without moralising about them or attempting to resolve them

[3] SWAFS = Science with and for Society
[4] https://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/swafs-18-2016.html

Therein, this report focusses on *mapping* the ethics of human enhancement. Analysis consists primarily of judging which topics deserve the most space with the limited time available to complete the report.

A secondary aim of this report is to convey the results of SIENNA's "country studies" of the national academic and popular media debate on the ethical issues in human enhancement technologies in eleven countries, highlighting the similarities and differences about the academic and media debates between these countries.

What is the content of this report?

This report is structured as follows: the first section includes introductory material to contextualise and explain the full content of the report. The second section includes a brief overview of the history of human enhancement and a short summary of where the field currently stands. The third section includes further details about the research methodology performed for this report. The fourth section includes the results of work from 11 SIENNA partners on ethics of human enhancement in countries of the partners' institutions, including a summary of the task and an analysis of the 11 studies received. Sections five, six and seven include the majority of findings of the SIENNA ethical analysis on human enhancement as follows: section five focusses on general ethical issues, section six focusses on issues specific to categories of HET, and section seven focusses on issues specific to application domains. Finally, section eight includes a brief conclusion about the results of the ethical analysis. Below, the contents of each section is explained more fully.

Section 1 introduces the aims of the report, the field of ethics of human enhancement, summarises previous SIENNA work in human enhancement, briefly states research questions and methodology and describes the scope and limitations of the report. The ethics of human enhancement is a subject that includes a larger amount of discussion on speculative products and techniques than the other SIENNA technology fields, thus requires contextualisation to properly situate the analysis at the heart of this report. Human enhancement (generally) can include many products and techniques with little or no ethically relevant debate (i.e., drinking coffee); thus, we adopt a definition of human enhancement technology to best capture the essence present in the majority of modern ethics literature on the subject. The primary research question motivating this ethical analysis is: What ethical issues related to and/or contingent upon HET ought to be discussed in the near future? Analysis about the moral valence of issues will follow in future SIENNA work, namely D3.7: Proposal for an ethical framework for human enhancement and D5.3: Central elements of a code of responsible conduct for researchers relating to human enhancement.

Section 2 describes (briefly) the history of the ethics of human enhancement and provides information about the modern scope of the field including common themes and ideas as well as a list of prominent organisations, centres and journals. Human enhancement can be traced back to antiquity, specifically ancient Greece, though primarily evolved as a consequence of Charles Darwin's experiments that brought to life the beginnings of genetic inquiry, which led to the development of eugenics. After the second World War, the field of bioethics developed largely as a response to atrocities conducted during the war. Recently, the pursuit of eugenics has returned with a more liberal flavour as 'neugenics,' which can be roughly understood as encompassing the majority of debate between bioconservatives (opponents of human enhancement) and post/transhumanists (advocates for human enhancement). Today, topics and problems that define the field foremost include the distinction between treatment and enhancement. Two further demarcations, distinguishing "normal" from "below" or "above" normal, and distinguishing "natural" from "artificial" or "unnatural" also exist in the debate. Additional

topics that are often discussed include, but are not limited to: authenticity and autonomy, human nature, justice and fairness, freedom and coercion, (im)perfection and accessibility.

Section 3 presents the SIENNA approach for ethical analysis of human enhancement technology and discusses its positioning in the current landscape of frameworks adressing ELSI of enhancement. The SIENNA approach can be considered as falling within or overlapping with ELSI approaches. The use of foresight and stakeholder input are certainly interesting but not necessarily novel (for ELSI studies). That said, the formal way in which the steps are described and should be perfomed tend to be more rigid or laboured as compared to the generally more open ELSI approaches. Furthermore, there remains a lot of debate on if and how empirical data could or should be used in normative frameworks. Within the current project, many limitations were encountered with the empirical approaches. In this section, we also discuss specific details about search terms, workshops, interviews and other elements of the methodology used to research for and write this report.

Section 4 presents the results of a study that we conducted of how ethical issues in human enhancement technologies have been debated in different countries, both in the EU and globally, and to identify differences and similarities. This section provides context from national perspectives for the ethical analysis that follows. Eleven countries were selected for our study, eight that are part of the EU (France, Germany, Poland, Sweden, The Netherlands, Greece, Spain, and the United Kingdom), and three other countries on different continents (China, South Africa, and Brazil). We performed two related studies: (1) a study of national academic ethical discussions of human enhancement, and (2) a study of national discussions of ethical, legal and social issues with human enhancement in media. These studies were carried out by partners in the SIENNA consortium with backgrounds in ethics and/or social science. This exploratory study provided a variety of ELSI perspectives, none of which were novel, but which gave an idea of the different preoccupations per country. The content of these reports is not easily summarised and is considered as a resource to be used as we go forward with task 3.7 addressing ethical framework in human enhancement technologies.

Section 5 contains the start of the actual ethical analysis, beginning with general ethical issues. The section is subdivided into sections on the aims of human enhancement, the fundamental technologies within the field and general implications and risks. The majority of issues discussed in sections 5-7 relate to technologies identified in SIENNA deliverable D3.1: State-of-the-Art Review of Human Enhancement or were identified based on interactions with experts in interviews and workshops as well as further research of the literature. In line with previous deliverables in SIENNA, the ELSI addressed are primarily demarcated into the six categories of human enhancement technologies identified in the aforementioned deliverable: cognitive, physical, affective & emotion, moral, cosmetic and longevity enhancement.

Aims and related issues discussed include:

- Enhancements to increase cognitive and physical performance
- Misuse of cognitive enhancement technologies
- Inequality within the general population
- The risk of a pharmacologic performance arms race
- Coercion
- The risk of cognitive & cosmetic enhancements changing norms related to fairness
- The risk of cognitive enhancement challenging prevailing ideas of what it means to be a person
- Cosmetic enhancement used to increase a user's self-appraisal
- The aim of offering safe, easily accessible HET options

- Medicalisation
- The risk of physical enhancement undermining the quest for authentic or traditional physical excellence
- Affective & emotion enhancement allowing individuals to take control of their experiential states via technology
- Affective & emotion enhancements leading to a loss of meaning in life
- Affective & emotion enhancements' impact on personal identity, authenticity and personality
- Moral enhancements improving moral decision-making
- Moral enhancements reducing immoral decision-making
- Longevity enhancements extending the length of the human life span
- Longevity enhancements creating environmental and generational burdens
- Longevity enhancements complicating concepts of identity

Fundamental techniques, methods and approaches discussed include:

- Machine/AI/computer-based augmentation
- Prosthetics
- 3D-Printing & tissue engineering
- Genetic interventions
- Nanotech-based interventions

Ethical issues with regard to general implications and risks include:

- Ownership of expensive HET
- Redefinition of 'human nature'
- Freedom to be 'imperfect'
- Accessibility in LMC areas & expansion of inequalities
- Dual-use & misuse
- Safety, security and liability
- Right to privacy
- General issues related to HET & Autonomy
- Weaponisation of enhancements

Section 6 includes a discussion of ethical issues stemming directly from products and techniques specific to the aforementioned six categorical subfields of human enhancement. The products and techniques include:

- PCE
- BCI & INI
- Neuro-stimulation / neuromodulatory techniques
- VR/AR
- Memory enhancement
- PED
- 3D bioprinting
- Bioweapons
- Wearables
- Chemical castration
- Criminal & correctional use of moral enhancement
- Sex enhancement

Section 7 includes a discussion of ethical issues stemming from specific application domains and population groups. The domains and groups include:

- Workplace
- Education
- Military
- Home & recreation
- Children & adolescents
- Students & educators
- Workers/management
- Consumers
- Elderly
- Poor & residents of LMCs

Section 8 consists of a short conclusion noting conceptual problems and a major thread found to dominate the ethical debates about HETs. The common characterisation of HETs presents the problem that, for example, a prosthetic limb may be spoken of as replacing a 'body part', so too might a pharmaceutical be described. Solving this problem may require a new language through which to discuss the ethics of such interventions. A dominant thread in ethical debates about HET has to do with the speculative content of inquiries: advocates and critics rely heavily on multi-factorial speculations about potential scenarios that may develop as a result of embracing HETs and many of these conditions are extremely difficult to predict with any certainty.

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List of acronyms/abbreviations

Abbreviation	Explanation
3D	Three Dimensional
AAS	Anabolic, Androgenic Steroids
ADHD	Attention deficit hyperactivity disorder
AI	Artificial Intelligence
AR	Augmented reality
ATC	Assistive technologies for cognition
BCI	Brain computer interface
BMI	Brain machine interface
BMS	Behavioural, Management and Social Sciences
CAD	Computer-aided design
CRISPR/Cas-9 gene editing	Clustered Regularly Interspaced Short Palindromic Repeats/ CRISPR-associated protein 9
DARPA	Defense Advanced Research Projects Agency (USA)
DBS	Deep brain stimulation
DIY	Do-it-yourself
EC	European Commission
EEG	Electroencephalograph
ELSI	Ethical, legal, social issues
EPO	Erythropoietin
FDA	Food and Drug Administration (USA)
FGCS	Female genital cosmetic surgery
GPA	Grade point average
HBP	Human Brain Project
HET	Human enhancement technology
HIV	Human immunodeficiency viruses
INI	Implanted neural interface
IVF	In vitro fertilisation

Abbreviation	Explanation
IQ	Intelligence Quotient
IPED	Image & performance-enhancing drug
LMC	Low and middle-income
MDMA	3,4-methylenedioxy-N-methylamphetamine
MMT	Memory modification technology
NBIC	Nanotechnology, biotechnology, information technologies & cognitive science
NNI	National Nanotechnology Initiative (USA)
NPS	Non-medically prescribed stimulants
OCD	Obsessive–compulsive disorder
PCE	Pharmaceutical Cognitive Enhancement
PDAs	Personal digital assistants
PED	Physically/performance enhancing drugs/substances
PSTS	Philosophy, science, technology & society
PTSD	Post-traumatic stress disorder
RFID	Radio-frequency identification
R&D	Research and development
SIENNA	Stakeholder-Informed Ethics for New technologies with high socio-ecoNomic and human rights impAct
SSRIs	Selective serotonin reuptake inhibitors
SVP	Sexual violent predator
TCS	Transcranial B-mode sonography
TMS	Transcranial magnetic stimulation
tDCS	Transcranial direct-current stimulation
UK	United Kingdom
USA	United States of America
VR	Virtual reality
WADA	World Anti-Doping Agency
WP	Work package (as in: this report is part of SIENNA WP 3)

Table 1: List of acronyms/abbreviations

Glossary of terms

Term	Explanation
Additive manufacturing	A manufacturing method by which materials are used to build designs from simple arrangements into complex structures.
Accessibility	The quality of being easy to obtain or use.
Applied ethics	The philosophical examination, from a moral standpoint, of particular issues in private and public life that are matters of moral judgment.
(the) Artificial vs the Natural	A qualitative debate which contrasts objects that exist and emerge from nature with objects that are created by intelligent beings (i.e., humans).
Authenticity	The quality of being genuine.
Autonomy	The capacity of an agent to act in accordance with objective morality rather than under the influence of desires.
Bioconservative	A stance of hesitancy about technological development, especially if it is perceived to threaten a given social order; in HET literature, it is specifically a position fundamentally opposed to the research, development and use of HET.

Term	Explanation
Bioethics	A field of ethics that encompasses medical ethics, clinical ethics, research ethics, biomedical ethics and, increasingly, ethics of new and emerging technologies.
Biohacking	Refers to DIY biology, which is a biotechnological social movement in which individuals and small organizations study biology using the same methods as traditional research institutions, as well as people who alter their own bodies by implanting DIY cybernetic devices.
Biomaterials	Human cells combined with synthetic materials.
Biotechnology	The exploitation of biological processes for industrial and other purposes, especially the genetic manipulation of microorganisms for the production of antibiotics, hormones, etc.
Cognitive Science	The interdisciplinary scientific study of the mind and its processes.
CRISPR-Cas9	A site-specific gene editing technology, which is used to introduce precise modifications in genomes. It is the tool that has sparked this recent renewed work and ethical and legal debate into genetic modification. There are other tools that can also be used for gene editing.
Declaration of Helsinki	A set of ethical principles regarding human experimentation developed for the medical community by the World Medical Association, first signed in 1964 and last updated in 2013.
Dispersion	The breaking down of complicated designs and structures into abstractions of simpler subsystems and components.
Eugenics	Classically: a movement aimed at improving the genetic pool of the human race through reproductive control systems. Contrasted with “neugencs,” which is a modern movement (see below).
Fairness	Impartial and just treatment or behaviour without favouritism or discrimination.
Human enhancement / human enhancement technology	A modification aimed at improving human performance and brought about by science-based and/or technology-based interventions in or on the human body.
Human nature	The general psychological characteristics, feelings, and behavioural traits of humankind, regarded as shared by all humans.
Impact	A potential change – whether positive or negative, direct or indirect, in whole or in part – caused by or associated with the technological field under consideration.
Imperfection	The state of being faulty or incomplete.
Information Technology	The study or use of systems (especially computers and telecommunications) for storing, retrieving, and sending information.
Intervention	Any type of procedure, use of application or technique to achieve a result.
Justice	The quality of being just; righteousness, equitableness, or moral rightness: to uphold the justice of a cause.
Medicalisation	The progressive extension of the boundaries of mental health practice and psychopharmacology leading to judging more “normal” emotional and social problems as targets for medical treatment.

Term	Explanation
Meta-ethics	A branch of analytic philosophy that explores the status, foundations, and scope of moral values, properties, and words.
Nanotechnology	The branch of technology that deals with dimensions and tolerances of less than 100 nanometres, especially the manipulation of individual atoms and molecules.
Neugenics	A modern movement with a focus on the completion of the human genome project and the subsequent insights and near-future applications it has brought about and is mainly linked to genetic and reproductive technologies; thought of by proponents as a more liberal variant of classical eugenics (see above).
Non-therapeutic enhancement	Interventions with no therapeutic benefit that result in enhancement.
Nootropics	Drugs used to enhance memory or other cognitive functions.
Nuremberg Code	A set of research ethics principles for human experimentation created as a result of the Nuremberg trials at the end of the Second World War in 1947.
Off-label use	The use of pharmaceutical drugs (or, potentially, other enhancement products or techniques) for an unapproved indication or in an unapproved age group, dosage, or route of administration.
Pathological	Involving or caused by a physical or mental disease.
Perfection	The state or quality of being perfect.
Posthuman	A concept originating in the fields of science fiction, futurology, contemporary art, and philosophy that literally means a person or entity that exists in a state beyond being human.
Privacy	The right of an individual to keep his or her health information secret.
Restorative, preventative non-enhancing	Interventions (often medical) that result merely in a return to baseline health/performance standards.
Robotics	The branch of technology that deals with the design, construction, operation, and application of robots.
Science-based	Based on knowledge or a process developed from scientific research.
Technology-based	Based on the utilisation or integration with a technological artefact.
Technology transfer	Sharing of information about a technology, its manufacturing, and related skills between disciplines or economy sectors.
Therapeutic enhancement	Interventions that are often performed to return an individual's health/performance to their baseline but may also increase health/performance beyond the baseline.
Transhumanist	An international philosophical movement that advocates for the transformation of the human condition by developing and making widely available sophisticated technologies to greatly enhance human intellect and physiology.
Value	The regard that something is held to deserve; the importance, worth, or usefulness of something.

Table 2: Glossary of terms

1. Introduction

This report is prepared within the context of a European project called SIENNA (http://sienna-project.eu/), which was selected to fulfil the grant call SWAFS-18-2016.[5] The primary aims of this report were to:

- Identify HET products, techniques and applications
- Identify potential present and future ethical issues
- Analyse those issues in a nuanced manner without moralising about them or attempting to resolve them

Therein, this report focusses on *mapping* the ethics of human enhancement. Analysis consists primarily of judging which topics deserve the most space with the limited time available to complete the report.

A secondary aim of this report has been to convey the results of SIENNA's "country studies" of the national academic and popular media debate on the ethical issues in human enhancement technologies in eleven countries, highlighting the similarities and differences about the academic and media debates between these countries. In comparison to the methods of ethical analysis, our analysis of the country study results has contributed fairly little to the overall identification and analysis of the ethical issues in this report. However, the country study results are expected to contribute more significantly to future SIENNA deliverables.[6]

1.1 Introduction to the ethics of human enhancement

Our approach to human enhancement positions the subject as one worth discussing in itself, i.e. as a class of technology as opposed to a description of isolated pieces of technology. Thus, we view human enhancement as extending in some general ways beyond the constraints of the more specialised areas enhancement technologies often come from; that is, we see human enhancement as encompassing more than just, for example, techniques and applications that have emerged from neuroscience. In SIENNA, we define human enhancement (hereafter HET) as "a modification aimed at improving human performance and brought about by science-based and/or technology-based interventions in or on the human body."[7] Most existing HET comes from scientific fields such as neuroscience, pharmacology or engineering to name a few. Thus, HET is best thought of as a collection of varied technologies that can be grouped by their common goal of improving human performance and/or capability. The subject of HET has attracted widespread debate about the legitimacy of such pursuits given a range of societal constraints and concerns, which may be economic, legal, or social. Yet, one central area of interest to policy and scholars has been the ethical implications of HET, which is where this report has focused its attention in order to more adequately provide guidance for professionals working within the various sectors where there is evidence of an HET trajectory in existence.

[5] https://ec.europa.eu/info/fundingtenders/opportunities/portal/screen/opportunities/topic-details/swafs-18-%202016

[6] See SIENNA D3.5: and SIENNA D3.6: for further data gathered in SIENNA on popular attitudes and opinions on human enhancement technologies.

[7] SIENNA D3.1

The ethics of human enhancement may be distinguished by two critical forms of application. The first concerns discussion about established therapeutic, restorative interventions that may then find application in healthy individuals to make them "better than well"[8] (i.e. therapeutic enhancement). The second concerns applications already in existence that specifically aim to improve human performance in healthy individuals (i.e. non-therapeutic enhancement).[9] A previous SIENNA HET report focussed on identifying applications that are expected to be developed in the next twenty years. In this context, SIENNA has identified six categories of HET: physical, cognitive, behavioural & affective, cosmetic, moral and longevity. Depending on the category, the ethical debate may skew more toward either existing or speculative applications. In SIENNA, our general aim is to keep our focus on technology that is either already available or expected within the next 20 years. For this report on HET, we were required to make exceptions in many cases, particularly when ethical issues of certain speculative applications could have an extreme impact on society and/or values, as well as where ongoing ethical debate focusses on more speculative techniques and applications.

Much of the overall debate concerning the ethics of human enhancement comes from philosophers who specialise in neuroethics, biomedical ethics, ethics of technology and philosophers with other specialties. Sociologists, anthropologists and scientists, especially from the fields mentioned above, also contribute. Interest and activity in the field will often rise and fall alongside technological advances, with a recent example being the advent of CRISPR/Cas-9 gene editing.

1.2 Summary of previous work

The SIENNA project began in October 2017. Tasks that have led to the current report include the writing of the project's methodological handbook, a state-of-the-art review of the field of HET, five citizen panels, surveys in eleven countries and several workshops, all of which are briefly discussed below.

SIENNA D1.1: The consortium's methodological handbook was constructed with the help of all SIENNA partners, who at least provided commentary before the first version was approved. The handbook contains initial research on possible methods for SIENNA followed by explanation and justification of the approach adopted by the project. SIENNA partners are scheduled to review and update the handbook in the near future to reflect any changes or adaptations made in the course of work since the first version was completed in early 2018.

SIENNA D3.1: State-of-the-art-review of Human Enhancement Technology was completed in May 2018. This deliverable includes SIENNA's definition of HET, detailed descriptions of the six categories of HET identified by the project, many examples of existing and expected products and applications within those categories, and a socio-economic impact analysis. The majority of decisions on definitions and demarcations for human enhancement in this report come from work completed for the state-of-the-art review of the field. Throughout the document, we will point out any differentiations from D3.1 that has emerged from continued research.

[8] Kramer, Peter D., *Listening to Prozac*, Penguin Books, New York, 1997.
[9] Coenen, Christopher, et al, *Human Enhancement*, EU Parliament, STOA, May 2009. https://www.itas.kit.edu/downloads/etag_coua09a.pdf

Concurrent with research for this report, Kantar Public Division, in conjunction with SIENNA WP leaders, planned, conducted and analysed five citizen panels and surveys in eleven countries on the three technology fields SIENNA investigates. Two reports on human enhancement, one regarding the panels and one regarding the surveys, are expected to be submitted alongside this report.

SIENNA ran two workshops with experts that inform this report. The first was organised by Trilateral Research and held in London, England in January 2019, and the second was organised but Uppsala University and held in Uppsala, Sweden in June 2019. The London workshop was focussed on foresight and scientific developments in the field, and most guests were scientists in fields that include or are expected to be impacted by human enhancement. Data from the London workshop mainly helped with the identification of technologies to assess. The Uppsala workshop was focussed on ethics in the field, and most guests were ethicists with professional experience in the ethical debates in the field. Data from the Uppsala workshop mainly helped to expand upon the discussion of ethical issues, although the timing for this workshop came too close to the submission deadline for the report to successfully incorporate all findings.[10]

1.3 Research questions and methodology

The primary research question motivating this ethical analysis is: What ethical issues related to and/or contingent upon HET ought to be discussed in the near future? As such, this report largely consists of *mapping* the ethics of human enhancement. Analysis in this report consists primarily of judging which topics deserve the most space with the limited time available to complete the report. Analysis about the moral valence of issues will follow in future SIENNA work, namely D3.7: Proposal for an ethical framework for human enhancement and D5.3: Central elements of a code of responsible conduct for researchers relating to human enhancement. For a full description of research methodology used in this report please see section 3 below.

1.4 Scope and limitations

For this report, our aim is to accurately map what the current literature discusses as important and urgent ethical issues in the field of HET. Research began in July 2018 and continued through August 2019.[11]

To ensure we have identified urgent and important issues and to identify new ethical issues and emerging technologies in the field, we conducted interviews and organised workshops with experts in ethics and scientists in fields related to HET. Even so, by the time this report is published there is a strong chance that new issues will be discussed that we did not have the opportunity or insight to include below. Despite this limitation, the field of HET is a field that is *emerging*, meaning many applications are anticipated (i.e., unavailable at present) and are thus likely to bring issues impossible

[10] We plan to carry the results from the Uppsala workshop and utilize them further in our next major reports: D3.7: Proposal for an ethical framework for human enhancement and D5.3: Central elements of a code of responsible conduct for researchers relating to human enhancement.
[11] The majority of research was completed by May 2019, although some additional research was carried out following new insights gained from the previously-mentioned Uppsala workshop that occurred in June 2019.

to identify before they become available. In other words, it can be expected that any extensive report on HET will include similar gaps.

Two important notes regarding the scope of our work need to be made. First, in order to provide the most useful input for the development of practical recommendations in later SIENNA reports, it has been deemed helpful to set a soft limit on the inclusion of potential developments in HET that may only occur over larger time scales. In the analysis of ethical issues relating to potential future developments in HET, we therefore aimed to restrict ourselves to discussing developments that are reasonably possible within twenty years from now. We consider a time horizon of twenty years to be neither a point in time too far into the future (making the analysis too speculative), nor one that is too close to the present (decreasing the anticipatory value of the analysis). However, since many HET applications that are well discussed in the ethics literature are applications that are promised and lack clear paths to realisation we have decided to include discussion about ethical issues we deem important (primarily based on the scale of potential impacts) that are not likely to be realised in less than twenty years.

Second, this report intends to provide the groundwork for further SIENNA work on the moral valence of the issues that have been identified and analysed. As such, it provides no moral conclusions regarding the goodness or rightness of particular actions, persons, things and events, and the rightness or wrongness of possible courses of action in relation to the ethical issues that have been identified. In the upcoming SIENNA report D3.7, reasoned moral conclusions will be provided for the issues analysed here to arrive at an ethical framework for practitioners working within the field of HET.

1.5 Structure of the report

This report is structured as follows: the first section includes introductory material to contextualise and explain the full content of the report. The second section includes a brief overview of the history of human enhancement and a short summary of where the field currently stands. The third section includes further details about the research methodology performed for this report. The fourth section includes the results of work from 11 SIENNA partners on ethics of human enhancement in countries of the partners' institutions, including a summary of the task and an analysis of the 11 studies received. Sections five, six and seven include the majority of findings of the SIENNA ethical analysis on human enhancement as follows: section five focusses on general ethical issues, section six focusses on issues specific to categories of HET, and section seven focusses on issues specific to application domains. Finally, section eight includes a brief conclusion about the results of the ethical analysis.

2. Historical context and review of the modern field of ethics of human enhancement

2.1 History

This section gives an overview of the history of the ethics of human enhancement. Today's debates about the ethics of human enhancement stem from arguments about past efforts of human enhancement. Hence, in order to understand the modern state of the debate better, it is important to investigate the historical arguments about the ethics of human enhancement. In this section, we will focus on three specific historical debates: 1) eugenics, 2) bioethics and 3) new eugenics, which is also referred to as neugenics.

It is difficult to pinpoint an exact time when the goal for enhancing humans and the debates surrounding it began. Bostrom mentions that the human desire for improving human nature and the human species can be traced back to ancient Greece.[12] Many Greek myths speak of *hubris,* largely in relation to human beings wanting to extend their own capabilities. It wasn't until the 18th and 19th century that the clear thought of enhancing humans through technology arose.[13] This thinking was fuelled by Darwin's *Origin of Species* in 1859, where he lays down his theory of natural selection.[14] Darwin's cousin Francis Galton added the notion of improving human genetics by encouraging positive characteristics and discouraging negative ones to Darwin's theory of natural selection. Galton was the first to coin the term eugenics by distinguishing between positive and negative eugenics.[15]

During the period from 1880 through 1945, eugenics was widely applied and supported on a global scale. The pursuit of eugenics in this time can be perceived as an offspring of Darwinism,[16] which was a movement aimed at improving the genetic pool of the human race through reproductive control systems.[17] Many countries adopted the movement through state-sponsored eugenics programs. Reproductive control systems were especially applied in the United States, where individuals were forcibly, and in cases even unknowingly, sterilized.[18] Yet, eugenics is most known for its relation to the Nazi eugenics programs that led to mass murder.[19]

Both Juengst & Moseley and Bostrom claim that the human experiments conducted by the Nazis in the name of scientific improvement is the starting point of (medical) ethics. They indicate that due to its dark history, eugenics had put both the cultural authority of science and the social values science implies and perpetuates into question. It simultaneously created a fear of the worsening of these oppressive types of human enhancement.[20] Miah[21] and Bostrom[22] both remark that the adoption of the Nuremberg code in 1947 and the Declaration of Helsinki in 1964 were two ways in which stricter regulations about the appliance of medical experimentation were established and made stark black & white guidelines about what is and is not permissible, though it is crucial to note that the emphases of such forms of governance were focused on the minimisation of harm, rather than some notion of there being important limits to human capacities that should be respected.

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[12] Bostrom, Nick, "A History of Transhumanist Thought," *Journal of Evolution and Technology* Vol. 14, No. 1, 2005, pp. 1–30.
[13] Ibid, p. 3.
[14] Wikler, Daniel, "Can We Learn from Eugenics?," *Journal of Medical Ethics* Vol. 25, No. 2, January 1999, pp. 183–194.
[15] Ibid, p. 183.
[16] Vizcarrondo, Felipe E., "Human Enhancement: The New Eugenics," *The Linacre Quarterly* Vol. 81, No. 3, 2014, pp. 239–243.
[17] Juengst, Eric, and Daniel Moseley, "Human Enhancement," *Stanford Encyclopedia of Philosophy*, Stanford University, May 15, 2019. https://plato.stanford.edu/archives/sum2019/entries/enhancement.
[18] Bostrom, op. cit., 2005, p. 6.
[19] Wikler, op. cit., 1999, p. 183.
[20] Juengst & Moseley, op. cit., 2019.
[21] Miah, Andy, "A Critical History of Posthumanism," *Medical Enhancement and Posthumanity The International Library of Ethics, Law and Technology*, 2007, pp. 71–94.
[22] Bostrom, op. cit., 2005, p. 17.

These two historical events (that is, the Nuremberg code and the Declaration of Helsinki) marked the return of applied ethics in medical ethics. Applied ethics had faded into the background in the early and mid-20th century and had been replaced by linguistic or meta-ethical problems.[23] However, applied ethics was found to be necessary again because of new medical interventions that sparked new ethical dilemmas. Applied ethics in medicine especially expanded around the 1970s. The reason for this was the strong technical developments in the fields of reproductive technology and genetics.[24] Besides these two emerging fields, applied ethics in medicine was also encouraged by the rise of transhumanist organizations, which came to prominence especially at the end of the 20th century. These organizations had a variety of ambitions and interests, which ranged from life extension to space colonization, the pursuits of which involved embracing the idea that evolution required human, technological intervention, to allow humans to progress more quickly.[25] Indeed, transhumanism was discussed also as the next stage in humanity's evolution, characterised by the point at which human intellect had found ways to intervene within such processes using biotechnology. Ethics therefore had to broaden.[26]

This new, expanded field of applied ethics became known as bioethics.[27,28] While bioethics has always been intimately connected to medical ethics, clinical ethics, research ethics and biomedical ethics,[29] it is also distinguished by its focus on matters specific to transhumanist concern, where discussions focus on speculative ethical issues presented by emerging technologies. The new dilemmas and difficulties which arose due to the abovementioned technical developments during the 1970s needed to be addressed in a serious, systematic way to which bioethics could present solutions. Bioethics was there to help human beings regulate the use and appliance of new enhancement technologies (alongside developments and innovations in treatment) in rational and careful ways and this included such matters as IVF, assisted suicide, and sports medicine, to name just a few ways of interest.[30]

Alongside these theoretical investigations into bioethics, a new community of professional bioethicists was also emerging, which involved training doctors, students, hospital staff and politicians about the possible dilemmas and dangers that can arise in biomedicine.[31] Bostrom sums up the ways in which people working or involved in the field were trained as "absolving doctors of moral dilemmas, training medical students to behave, enabling hospital boards to trumpet their commitment to the highest ethical standards of care, providing sound bites for the mass media, and allowing politicians to cover their behinds by delegating controversial issues to ethics committees."[32] The field of bioethics was, in short, professionalised and, along with this, came a growing framework for providing ethical legitimacy

[23] Ibid, p. 17.
[24] Ibid, p. 17.
[25] Ibid, p. 14.
[26] Ibid, p. 14.
[27] Koch, Tom. *Thieves of Virtue: When Bioethics Stole Medicine*. Boston: MIT Press, 2012.
[28] Bostrom, op. cit., 2005, p. 17.
[29] Hedgecoe, Adam M., "Critical Bioethics: Beyond the Social Science Critique of Applied Ethics," *Bioethics* Vol. 18, No. 2, 2004, pp. 120–143.
[30] Pickersgill, Martyn, and Linda Hogle, "Enhancement, Ethics and Society: towards an Empirical Research Agenda for the Medical Humanities and Social Sciences," *Medical Humanities* Vol. 41, No. 2, October 2015, pp. 136–142.
[31] Elliott, Carl, *A Philosophical Disease*, Routledge, London, 1999.
[32] Bostrom, op. cit., 2005, p. 17.

to HETs, notable examples of which include cosmetic surgery, neuromodulation and some psychopharmaceutical cognitive enhancement drugs.

Since 2000, the enhancement debates can be summarised as focussing largely on a new eugenics, i.e. the focus on the completion of the human genome project and the subsequent insights and near-future applications it has brought about. In theory, the new eugenics, or neugenics, is a more liberal variant of the old eugenics and is mainly linked to genetic and reproductive technologies.[33] Unlike old eugenics, in which states forcibly treated citizens who often did not even know what was done to them, the new eugenics leaves the choice of enhancement up to the individual. There is, therefore, no (or, at most, limited, in terms of regulation) state involvement. This means that enhancement is no longer compulsory but a free, individual choice. The absence of this state-based coercion is often used to distinguish morally between the bad, old eugenics, and the good, neugenics, though the application of this distinction warrants further inquiry.

Indeed, neugenics is known for having strong proponents and opponents. According to the former group, neugenics is based on good science and individual consent instead of state consent.[34] It stems from the desire to improve oneself as well as future generations, each of which cohere with a certain notion of a virtuous life. As previously specified, this desire can be traced back to Ancient Greece and is present within a wider range of virtuous behaviours, such as seeking to educate oneself or to lead a healthy life.

To exemplify the turn in the field, consider Selgelid[35] and Wikler[36] who are both in favour of the neugenics because they believe that eugenics is in itself not a bad thing. What was wrong about the old eugenics movement was the way it was applied but not its goal of wanting to improve humankind. Proponents of neugenics, sometimes dubbed the new eugenicists, sum up old eugenics as unscientific, coercive and concerned with improving the human race.[37] The goal of neugenics is to create better opportunities for children by eliminating undesirable traits and individual enhancement. It is not concerned with improving the human race in itself, even if this may be a by-product of such freedom.

Alternatively, Koch opposes neugenics, arguing that current enhancement pursuits resemble the American variant of eugenics.[38] He therefore believes that the similarities between current practices and past practices should be studied carefully if we want to establish an informed ethics of enhancement. Both primarily focus on improving humankind by removing bad traits and promoting good traits, which was literally the goal of the old eugenics movements.

An important link Koch makes is the one between neugenics and the current debates between transhumanists and bioconservatists.[39] Transhumanists embrace the extension of current therapeutic practices in healthcare for the goals of human enhancement, whereas bioconservatists contest the

[33] Vizcarrondo, op. cit., 2014, pp. 239-243.
[34] Ibid, p. 240.
[35] Selgelid, Michael J., "Moderate Eugenics and Human Enhancement," *Medicine, Health Care and Philosophy* Vol. 17, No. 1, January 2013, pp. 3–12.
[36] Wikler, op. cit., 1999, p. 3.
[37] Vizcarrondo, op. cit., 2014, p. 240.
[38] Koch, op. cit., 2010.
[39] Ibid. p. 11.

legitimacy of this shift. Koch therefore sees supporters of transhumanism as enhancement enthusiasts who are logically committed to the same eugenics as the old eugenicists, even if the process by which consent takes place is different. To sum up, according to Koch transhumanists are the ones who put neugenics into practice: "Enhancement enthusiasts like to wrap their eugenics in the bold promise of species betterment, of the advance of humankind in general."[40] Furthermore, Koch states that current bioethicists seem to simply join transhumanists in their goals of enhancement. For that reason, Koch states that there is a need for a new bioethics. This ethics should be more humanist, responsible, and defensible. Yet, the peculiarity of these debates is that transhumanist also regard their reasoning to be humanist, responsible, and defensible and so there exists something of an impasse between these views, which speaks mostly to a contested sense of what informed consent entails.

Although a full history of the ethics of human enhancement could span many more pages, this section has sought to contextualise important developments in the field. It has outlined how the societal case on behalf of HETs may be located within an interpretation of Darwinian evolution that encompasses human interventions as components of natural selection, exemplified by the eugenics movement. In this sense, humanity's cognitive evolution that leads to a situation where technological disruptions to nature are treated as consistent with – or better than – evolutionary processes absent of such interventions. The folly of such ideas was made manifest in the exploitation and abuse that accompanied such aspirations and the post-war Nuremberg code and Helsinki Declaration consolidated the global consensus on such inadequacies. They marked the start of a new type of enhancement ethics whereby informed consent became the guiding moral principle for legitimate scientific and medical interventions. The many technological developments in the 1970s have led to bioethics. Over the last two decades, the enhancement debate has largely revolved around neugenics, which Koch has linked to the old eugenics movement and transhumanism. According to Koch, a new form of ethics is therefore required to deal with these current ideas on enhancement.

2.2 Review of the field

As stated in the introduction, the ethics of human enhancement is best considered as a collection of technologies, namely *emerging* technologies. Thus, accurately attributing the state of the 'field' is likely to provoke disagreement with other experts, especially those who may subscribe to a different definition of the term "human enhancement." Despite this, we shall attempt to identify in this section the currently discussed subfields, schools, topics and problems that define the field, along with a brief listing of major organisations, journals and centres for ethical study of human enhancement.

Subfields include the six categories previously identified by SIENNA—that is: 1) cognitive enhancement, 2) physical enhancement, 3) emotional & affective enhancement, 4) moral enhancement, 5) cosmetic enhancement and 6) longevity enhancement. However, it is not always the case that philosophers or ethicists will subscribe to the exact definitions we give in SIENNA D3.1 for these categories. For example, sometimes cosmetic enhancement applications will be discussed as physical enhancements instead because both categories deal with modifications to the physical properties/attributes of the human body. Yet, the justification for such interventions may be on the basis of some notion of mental well-being, rather than some claimed physical value that has improved.

[40] Ibid, p11.

Additionally, “nootropics,” “smart-drugs” and “life-style drugs” may be discussed alongside what we categorise as cognitive enhancement, despite these impacting physical properties.

Furthermore, in SIENNA HET we have decided not to aggressively pursue investigation about ethical issues related to so-called “natural” enhancements such as drinking caffeinated beverages like coffee, meditating, studying or participating in the performing arts. This is an important subfield that we have excluded from consideration to maintain our focus on the broader *emerging* and *technology* sides of the field (the SIENNA definition of HET further precludes us from engaging with this subfield) and especially those that involve some form of professional – typically medical or scientific – administration. In our ethical analysis below, we will sometimes reference this subfield where other authors have made analogies or otherwise used examples that highlight ethical issues which fit the SIENNA definition of HET. In addition, it should be noted that often the most effective use of HET as we define it requires practicing one or more “natural” enhancement techniques; for example, using human growth hormone on short people should always be done alongside a healthy diet. Although we have chosen not to fully explore this combinatory potential, it is important to be aware of its potential impact as in some cases it makes HET applications much less valuable in isolation.

Schools in the debate include transhumanists and posthumanists as extreme proponents of HET, and bioconservatives as extreme opponents of HET, though it is important to note there is much variance within these categories. The dichotomy between these groups is further discussed in SIENNA D3.1. Additionally, one could describe another school in the field as that of *practitioners* of human enhancement, i.e. those who self-experiment (most often today with cognitive enhancements) or help others to utilize HET.

Topics and problems that define the field foremost include the distinction between treatment and enhancement. This distinction is also discussed at length in SIENNA D3.1, as well as by many authors who have contributed to the debate over the last several decades. Two further demarcations, distinguishing “normal” from “below” or “above” normal, and distinguishing “natural” from “artificial” or “unnatural” also exist in the debate and are described further in SIENNA D3.1. Additional topics that are often discussed include, but are not limited to: authenticity and autonomy, human nature, justice and fairness, freedom and coercion, (im)perfection and accessibility.

Major organisations, centres and journals include (but are not limited to) the following:

- Organisations
    - Institute for Ethics and Emerging Technologies
    - Humanity+
- Centres
    - The Hastings Center
    - The Future of Humanity Institute
    - The Oxford Uehiro Centre for Practical Ethics
    - The Center for Bioethics & Human Dignity
    - IEEE
- Journals
    - American Journal of Bioethics
    - Bioethics
    - BioSocieties
    - BMC Medical Ethics
    - Body & Society
    - Cambridge Quarterly of Healthcare Ethics

- Frontiers in Human Neuroscience
- Human Behavior and Emerging Technologies
- Int. J of Technoethics
- Institutional Review Board Ethics
- Journal of the American Philosophical Association
- Journal of Bioethical Inquiry
- Journal of Evolution and Technology
- Journal of Law, Medicine, and Ethics
- Journal of Medical Ethics
- Journal of Medicine and Philosophy
- Journal of Posthuman Studies
- Kennedy Institute of Ethics Journal
- Memory Studies
- Nanoethics
- Nature Biotechnology
- Nature Human Behaviour
- Neurology
- Neuroethics
- Neuropharmacology
- Neuroscience
- New Scientist
- Regenerative Medicine
- Science and Engineering Ethics
- Technologies
- Theoretical Medicine and Bioethics
- Zygon

3. Ethical analysis of human enhancement: method and approach

3.1 SIENNA methodology

Previously, SIENNA researchers developed a methodological approach for ethical analysis in the project that can be found in SIENNA D1.1: The consortium's methodological handbook.[41] The SIENNA methodology consists of a six step process: 1) Specification of subject, aim and scope of analysis, 2) Description of subject of analysis, 3) Identification of stakeholders and (potential) impacts, 4) Identification and specification of ethical issues, 5) Analysis and evaluation of ethical issues and 6) Recommendations and options for ethical decision-making. In writing the previous SIENNA human enhancement report, SIENNA D3.1: State of the art review of human enhancement technology, we followed steps 1-3.

[41] Rodrigues, Rowena, et. al., *D1.1: The consortium's methodological handbook*, WP1, 2018, Public deliverable report from the SIENNA project.

For the current report, we followed the methodology for **step 4 and part of step 5** (analysis, but not evaluation), and include the text from the handbook on these steps below.

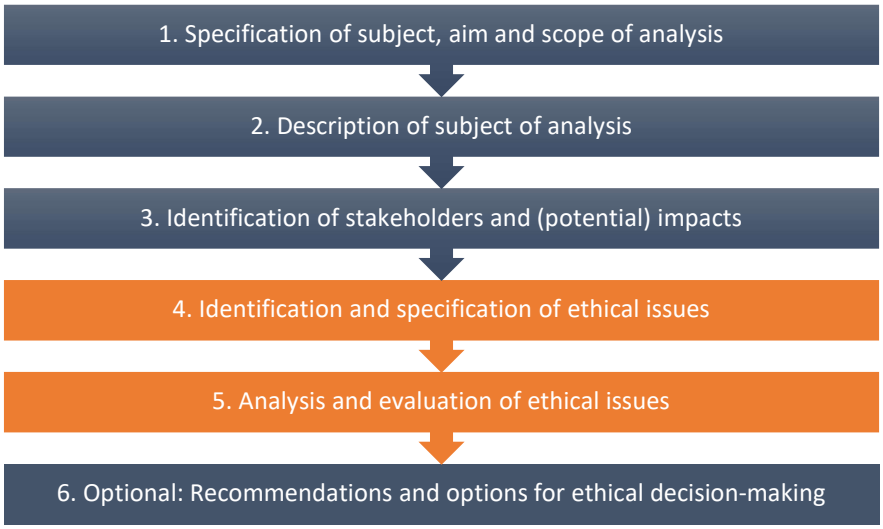

Figure 1: Overview of the SIENNA approach to ethical analysis.

Identification and specification of potential ethical issues (SIENNA handbook step 4)
In this step, we identify and describe all the ethical issues relevant to the subject (in this report: HET) including those that pertain to the (potential) impacts uncovered in step 3. Specifically, we identify issues, principles and values that may be affected or challenged by a given technology, partly based on its applications and impacts that were described in the earlier steps. Some identification and specification of ethical issues may already have been performed in the forgoing steps.[42] As in steps 2 and 3, analysis will take place at the technology, artefact and application levels.[43] Possible outcomes are, for example, the observation that there is the potential for bias in machine learning or a risk that increased knowledge of the human genome invites discrimination (technology level), the identification of risks to privacy from the use of social robots or of dual use of neurostimulators (artefact level), and issues of autonomy and informed consent in the genetic enhancement of children and moral responsibility in the use of killer robots on the battlefield (application level).

Methods for the identification and specification present and potential future ethical issues at the three levels of analysis have included: (1) literature review of prior ethics studies in the fields of AI and robotics, (2) stakeholder and expert consultation through workshops and interviews, and (3) the use list of questions about the technologies that could help identify ethical issues (which are sometimes presented as "checklists"[44]), e.g., by cross-referencing them with the results of our D4.1 report on the state of the art of AI and robotics technology.

[42] To the extent the ethical issues have not all been comprehensively identified and specified in steps 1, 2 and 3, they will be identified and specified in step 4.
[43] Brey, Philip, "Anticipatory Ethics for Emerging Technologies," *Nanoethics*, Vol. 6, 2012, pp. 1–13.
[44] Several ethical checklists are available. Brey, op.cit, 2012 contains a comprehensive checklist for ethical issues in technology, and the SATORI CEN "pre-standard" for ethics assessment also specifies a large number of ethical issues in relation to the medicine, information technology and engineering fields. See: SATORI, "CEN

Analysis and evaluation of ethical issues (SIENNA handbook step 5)

In step 5, we further analyse and evaluate the ethical issues that were identified in step 4 including those raised by stakeholders. This involves, first of all, steps to further clarify, provide details about nuances, and contextualise the ethical issues that were identified, without necessarily arriving at strong moral judgments or solutions. This will involve some or all of the following: identifying different moral values that apply to the issue and potential conflicts between these values, identifying roles, rights and interests of stakeholders, identifying reasons or arguments for and against certain moral judgments, and the pros and cons of particular ways of addressing value conflicts. To perform such analysis, we use instruments for ethical analysis from the field of ethics (i.e., ethical concepts, theories, frameworks and/or arguments).

The aims of ethical analysis may consist of establishing a better understanding of the ethical issues pertaining to a case and the possible ways of resolving them, but it may also include *ethical evaluation*, which involves making and defending moral judgments regarding the goodness or rightness of particular actions, persons, things and events, and the "rightness" or "wrongness" of possible courses of action in relation to the ethical issue. For example, regarding procedures of moral enhancement, a considered moral judgment may conclude that it would be unethical to perform these procedures for persons incapable of demonstrating informed consent.[45] These moral judgments may be based on previous analysis, previously accepted ethical theories, principles and guidelines, and input from stakeholders**. Note that SIENNA Tasks 2.4, 3.4 and 4.4 ("Analysis of current and future ethical issues") will focus on "neutral" ethical analysis and will avoid moral judgments on key ethical issues.** In Tasks 2.7, 3.7 and 4.7 ("Proposal for an ethical framework"), to some extent, considered moral judgments will be made for the three technology fields in order to arrive at ethical frameworks.

In this step, we explore various existing and novel approaches for including stakeholder input (views, experiences, etc.) within the ethical analysis, balancing the professional ethical expertise with stakeholder experiences and insights. It can perhaps already be said at this point that stakeholders could make contributions by: (1) identifying and articulating ethical issues that may have been overlooked by ethicists, and commenting on such articulations by ethicists; (2) arriving at moral judgments, jointly or collectively, and commenting on such judgments by ethicists; (3) proposing decisions and solutions in response to ethical issues, and responding to such proposals made by ethicists; and (4) proposing ethical decision-making guidelines, and commenting on such proposals by ethicists.

3.2 Specifics: literature review, foresight, interviews

Workshop Agreement: Ethics assessment for research and innovation - Part 2: Ethical impact assessment framework, CWA 17145-2, June 2017. http://satoriproject.eu/media/CWA17145-23d2017.pdf

[45] Note that it is difficult to avoid making some (implicit) moral judgments in ethical analysis, but even so, ethical analysis can then still be neutral on key ethical issues, being those that concern key value conflicts.

Beyond the approach discussed above, the method of research for this report consisted of a limited (scoping)[46] literature review, two workshops on (1) foresight of human enhancement and (2) ethics of human enhancement, and seven informal interviews for input with scientists in fields associated with HET.

Our literature review utilised standard academic literature search methods, such as via inputting search terms in databases for publishers of scholarly journals or other repositories of articles. Databases used include: University of Twente Library FindUT (which searches further databases including Springer, Taylor & Francis Group, Wiley-Blackwell and many important journals), SCOPUS and Google Scholar. Snowballing methods were also used, i.e. referring to the citations in one paper to find additional relevant articles. Finally, recommendations from interview subjects and workshop guests led the authors of this report to a small, but important, selection of additional sources.

Examples of main search terms used in literature review for this report[47]	
List 1: Primary terms	**List 2: Secondary (in conjunction w/ one or more primary and/or secondary search term)**
(Human) enhancement	Physical
Ethics	Cognitive and/or Neural
ELSI (Ethical Legal or Social)	Affective and/or emotional and/or behavioural
Treatment vs enhancement	Moral
Anthropological	Cosmetic and/or superficial
Debate	Longevity and/or life-extension
Philosophy (of)	Lifestyle drugs
	Biohacking
	Bioweapons
	Performance
	Nootropics and/or smart-drugs
	Beyond therapy/normal/species-typical
	Neuromodulation, tCDS, TCS, BCI, INI
	Cyborg

Table 3: Examples of search terms used in literature review for this report

The workshop on foresight of human enhancement took place over 1.5 workdays in January 2019 in London, England. Fifteen guests were invited with expertise primarily in scientific disciplines related to human enhancement, i.e. neuroscience & biochemistry. The workshop format consisted of intense discussions between guests in assigned groups of 3-5 experts each along with 1-2 SIENNA members to moderate and take notes. The workshop on ethics of human enhancement followed a similar format to the foresight workshop, running over 1.5 workdays in June 2019 in Uppsala, Sweden. Fifteen guests were invited, most of whom were experts in one or more subjects of ethics and had published on one

[46] Scoping reviews are meant to give a preliminary assessment of the literature without going in-depth (from SIENNA D1.1: The consortium's methodological handbook).

[47] An exhaustive list of all search terms cannot be provided as full search term lists were not fully catalogued between all contributors. The table provided captures all key terms + strings used by the lead contributor in the noted databases, and many articles used by other contributors came from the direction of the lead contributor.

or more domains of human enhancement issues. Participant lists for both workshops can be found in Annex 2 at the end of this report.

SIENNA researchers also conducted seven informal interviews on foresight and ethics of human enhancement. Most of these interviews were with scientific experts at institutions in the Netherlands or Germany. Five interviews were conducted face-to-face, while two had to be conducted via the Skype videoconferencing platform due to scheduling issues.

4. The ethical debate of human enhancement in different countries

Introduction and Methodology

SIENNA partners conducted limited studies of academic literature and media articles on the topic of ethics of human enhancement in their institution's country for this report. We received studies from our partners in eleven countries: Brazil, China, France, Germany, Greece, the Netherlands, Poland, South Africa, Spain, Sweden and the United Kingdom.

For the country study task, partners followed a methodological strategy produced in concert between the leads of the three primary WP tasks on AI & robotics, human genomics and human enhancement. The reporting structure differed in a few small respects. For human enhancement, partners were asked to review media including newspaper and (online) magazine articles with the expectation that few items would fit the criteria. Media analysis guidelines were slightly more limited for AI & robotics, and significantly more limited for human genomics. Another difference between SIENNA research areas was the timeframe of articles: for enhancement, partners were asked to limit their search to articles published since 1998 and, if time allowed, to run two searches: one with articles published between 1998-2010, and another with articles published between 2011-present. Search terms were also specific to the technology area. For human enhancement, some variation (dependent on national language in the country) of Ethics + country + (human) enhancement was suggested, with partners allowed to expand search terms where appropriate.[48] The inclusion criteria for academic articles requested publications to discuss human enhancement, some ELSI and were specific to the country of the study.

During the study period, several partners reported difficulty with identifying articles specific to their country, with some partners struggling to find more than five articles that fit the original search criteria from over 100 results. An amendment to the instructions was distributed for the HET country study task late in the research period that allowed partners to expand the inclusion criteria for articles that were written for an international audience but demonstrated insights about the local debate. For example, under the original inclusion criteria an article published by a Spanish academic in an international journal on the topic of ethical questions for cosmetic surgery would likely be rejected. Under the new criteria, if the SIENNA partner found that this article included insightful material (such as examples or data from Spanish populations) about the local debate, then it should be used.

[48] For a broader example of search terms used in this task, please see Table 3 in this report.

The following research questions were used for the academic literature review in each study:

i. What were the ELSI that were addressed in the academic literature specific to your country?
ii. Can you contextualise these ELSI in the larger cultural, financial, religious, political or societal context of your country?
iii. Can you glimpse a trend based on years (2018-2013; 2012-2008 etc.)?
iv. Are there themes that are surprising to find? Surprising not to find
v. Did you find a preponderance on one issue and nothing on many others? Can you explain why this is?

For the media report, partners were asked to answer the following questions about media published in the popular literature for their country:

i. What is the focus of the articles?
ii. What kind of enhancement is discussed? Is it only one category in detail or a wider range of subjects with less detail?
iii. Is ELSI included? If so, what ELSI?

The analysis in the following subsection cannot be considered a true "comparative analysis" of the reporting documents, primarily due to time constraints for the authors of this report limiting our capacity to follow the rigorous standards required for such an analysis. Instead, we begin by including below the primary findings from the 11 studies completed by SIENNA partners, with the text in the tables that follow heavily adapted, if not directly borrowed, from the partners' written reports.

4.1 Summary & analysis of 11 country reports

Academic debate on ethical issues in human enhancement

Country	Summarised findings
Brazil	Brazilian researchers are primarily focused on a wider, more internationally-oriented debate as opposed to a local one. Only 22% of articles found in the search addressed the situation within the country. Furthermore, it seems Brazilian researchers in general not written heavily on topics of ELSI in human enhancement. Regarding what can be found, topics primarily focus on the use of biomedical/pharmaceutical methods of cognitive enhancement. One article was found on physical enhancement and the method of machine-based augmentation for the military. Since so few results were found, it is difficult to draw conclusions about trends except to say cognitive enhancement seems most favoured. This may be explained by social, economic, and cultural factors. Brazil is a large, extremely unequal country; as a result, it is also highly competitive. Students and workers suffer a lot of pressure. It is thus expected that the debate on human enhancement will develop with a focus on the cognitive side, for it is the category of human enhancement that offers significant advantages in competing environments. A possible explanation for the lack of academic literature on physical enhancement is that the academic discourse in Brazil is replicating what goes on abroad. Perhaps the little attention given to physical and other categories of human enhancement is not a peculiarity of the Brazilian academic discourse.
China	The state of ELSI of HET in China is well developed. In particular, Chinese experts and scholars tend to focus on cognitive enhancement, emotional enhancement and moral enhancement. For cognitive enhancement technology, experts and scholars elaborate on the implementation of this technology and how it can achieve the effect of cognitive enhancement; for example, whether it is through drugs or nerve stimulation. They pay special attention to the ethical issues caused by cognitive enhancement technology,

Country	Summarised findings
	mainly including health and safety issues, technology risks, side effects, addiction, justice and equality issues, and issues of self and autonomy. For emotional enhancement, issues discussed in the Chinese literature include personal identity, personality split, emotional mutation, the effect of emotional enhancement on emotion itself and autonomy. For moral enhancement, Chinese scholars discuss the definition of the technology, the realization of enhanced technical support, autonomy and dignity, health and safety, justice and equality, addiction and autonomy. They also find solutions from the innovation of the subject, the use of the subject of technology, social environment, technology supervision and other aspects. There are not themes that are surprising to find nor interesting gaps compared to international debates. Additional articles mentioned privacy, safety, health, justice, equity, autonomy and responsibility, maybe because they are the issues people generally concern about in recent human enhancement applications.
France	The debate in France tends to focus moreso on theoretical concerns with roots in French philosophical tradition. Often, contributions on robotics and genomics overlap with HET and discuss some of the aspects at stake in a broader manner. The French discussion about human enhancement and what it means rests on a famous assumption made by Georges Canguilhem, according to which the distinction between normal and pathological is not objective or natural, but rather normative.[49] From this presupposition we can find four main conceptual galaxies enriched by different integrations, nuances and overlaps which share some common traits. First, we find the so-called transhumanist, literally an intellectual and cultural movement affirming the possibility and desirability to enhance the human condition through new technologies.[50] Far from being instrumental, transhumanists believe enhancement can lead human-beings towards an increased state of power and freedom.[51] The second group is often named bio-conservatives or anti-enhancement. This constellation believes that, for instance, medicine should not go beyond its therapeutic function of healing a dysfunction, and think of enhancing the organism. Although the reasons for sticking to our given nature can be theological,[52] warning from the dangers of playing God,[53] or political,[54] pointing at human rights, the common core of the arguments is the necessity to respect nature and human-beings as part of the natural environment themselves. The third framework, including those thinkers called bioethicists, finds its strongest circle in the anglophone world. These authors have in common a general optimism about enhancement for the development of individual and consequently social aspects. They propose to shift from a content-based approach to a management-based one, so to judge

[49] Le Dévédec, N, and F Guis, "L'Humain Augmenté, Un Enjeu Social," *SociologieS [En Ligne]*, November 19, 2013.
[50] Ibid.
[51] Giesen, Klaus-Gerd, "Le Transhumanisme Comme Idéologie Dominante De La Quatrième Révolution Industrielle," *Journal International De Bioéthique Et Déthique Des Sciences* Vol. 29, No. 3, 2018, p. 189-203.
[52] Saintôt, Bruno, "Quelle Éthique Théologique De La Procréation Et De La Filiation Pour Les Débats Actuels ?," *Revue Déthique Et De Théologie Morale* Vol. 297, No. 5, 2017, pp. 75–88.
[53] Larchet, Jean-Claude, "La Divinisation Comme Projet Et Modèle Chrétien Du Perfectionnement Et De l'Augmentation De l'Homme," *Revue Déthique Et De Théologie Morale*Vol. 286, No. 4, 2015, pp. 181–197.
[54] Le Dévédec & Guis, op. cit., 2013.

Country	Summarised findings
	single cases according to procedural frameworks. Adopting a more nuanced utilitarian and managerial posture, they recognize the positive role of enhancement, and they just want to limit the risks connected to it. The fourth group stems from French philosophical and epistemological tradition, who prefer questioning not only the specific technologies or their role for individuals, but also the conceptual and political framework driving the enhancement process. As pointed out by Le Dévédec and Guis, enhancement technologies are not neutral but they are inscribed into a society which they contribute to shape.[55] In this fourth constellation shifting the focus on a meta level, we can identify two main paradigms that are sometimes part of the same analysis and sometimes distinguished. On the one hand, we can find the features of an anti-capitalist and anti-neoliberal analysis. On the other hand, we find suspicion about human enhancement on the basis of well-established French theoretical devices like bio-politics, discipline and medicalization of society. When these two variations overlap we can observe the emergence of concepts like social engineering, techno-fetishism and techno-latry.[56]
Germany	The search for academic articles that discuss ethical, legal and social issues (ELSI) of Human Enhancement Technologies (HET) was quite successful. However, it is challenging or even not possible to define any HET related ELSI that are specifically German, or rather more specific for the German debate compared to other countries. Therefore, we can only describe some trends. Ethical principles and values like fairness, justice, wellbeing, autonomy and self-determination are in focus of the debate. The ELSI discussed most often in the German academic debate on HET can be clustered in the following categories: • difficult distinctions between therapy and enhancement and/or health and disease; • risks issues (This includes direct risks but also unforeseeable risks in the future for individuum's. Often discussed in this context is irreversibility, risks for third parties and risks for the society as a whole); • justice and fairness issues (who has access to HET and who not?); • autonomy and self-determination issues; • issues concerning the patient-medical doctors relationship; • issues concerning anthropological terms (what is natural or rather normal and what is not?). Special for the German debate might be the references to the Nazi-era and their eugenics-programme. That can be the reason why there is a lot of scepticism and carefulness in the German HET debate. In many publications the authors argue for strict rules to prevent misuse of HET technologies.
Greece	Academic literature in Greece does not seem to have elaborated in any real way on human enhancement and ethical or other issues. The weight is on legal/ethical/social issues of aesthetic/cosmetic surgery, which is a theme we see in the articles. We also have a couple of articles on doping and sports. This result is not surprising as cosmetic surgery is rather standard in Greece today, and doping has been an issue of interest for quite some time.

[55] Le Dévédec & Guis, op. cit., 2013.
[56] Derian, Maxime, "Interview : « L'homme Augmenté Existe Déjà ! », Le Monde 19/06/2017," *Anthropologie Des Interfaces Homme/Machine*, 2017. https://anthropo-ihm.hypotheses.org/677.

Country	Summarised findings
	There seems to be no research on the impact of human enhancement drugs upon people, apart from doping, which could mean that this is not an issue in the Greek society today.
Netherlands	Although not an academic article in the strictest sense, the report of *Schuijff & Munnichs*[57] is the only report which addresses HE in the context of the situation within the Netherlands in the form of investigating public opinion of human enhancement. It seems that the debate on human enhancement in the Netherlands is mainly conducted within a national policy framework, over an academic setting. The topics which were discussed in the found literature are, in order of amount of times addressed: cognitive (11); affective (6); moral (6); longevity (4); physical (3); and cosmetic (1).These are all discussed in conceptual investigations, except for the report of *Schuijff & Munnichs* which focus on policy guidance. There seems to be an explicit preference in the literature in regard to cognitive enhancement, through medical interventions such as pharmaceutical stimulants and neuro-stimulation. Concerning the ethical side of the debate, the articles mainly focus on the autonomy of the individual and the authenticity of human life. Absent seem to be articles discussing HET in the context of prosthetics and tissue engineering, while cosmetic enhancement is only discussed once. These results can be explained in the context of the Netherlands, if we suppose Dutch "sobriety," i.e. the tendency to value direct communication, is a cultural phenomenon. There seems to be a lot of focus on the enhancement of the mind, while less so on the enhancement of the body. Autonomy of the individual and human authenticity are also cultural values which are held in high regard in the Netherlands. Due to human authenticity being held in high regard, there is little culture revolving around matters such as cosmetic enhancement. One of the main findings of this investigation is that academia within the Netherlands seem to have very little interest in discussing HET within the context of the country. This is not surprising, as it is general academic culture in the Netherlands to predominantly publish academic articles in the Netherlands. As such, the focus of the academic debate is more often focussed on an international level than on the national one. This might have to do with the size of the country (there are just fewer universities than more populous developed nations), but also with the fact that the (higher educated) populace is strongly internationally orientated in general (the Netherlands has one of the relative largest populations of non-native English speakers in the world). What is surprising is that there is very little debate on the relation between HET and politics, or HET and human rights. The found literature seems to be very practically orientated (not surprising), while the legal and ethical dimensions seem to have a backseat spot.
Poland	As far as terminology is concerned, authors of the analysed texts tend to equate the notion of "human enhancement" with "transhumanism". It seems that the concept of "enhancement" is understood as entailing a positive assessment of the phenomenon. The themes of "human enhancement" and "transhumanism" have entered the Polish scientific landscape quite recently. It appears that most texts have been written after 2010.

[57] Schuijff, Mirjam, and Geert Munnichs, *Goed, Beter, Betwist: Publieksonderzoek Naar Mensverbetering [Good, Better, Disputed Public Research into Human Improvement]*, Rathenau Instituut, Den Haag, 2012.

Country	Summarised findings
	Many of the texts are of very general nature. With some exceptions, most of the analysed texts do not focus on specific enhancement categories or enhancement methods, nor are they limited to a particular life stage or area of use, but rather approach the entire field as a whole. Authors tend to discuss a wide variety of topics. Some popular examples (e.g. the case of Oscar Pistorius) are provided as illustrations. There is a strong presence of the Catholic and more generally Christian (social) thought in the analysed scholarship. It is symptomatic that two recent anthologies on enhancement have been published by Catholic institutions. Those texts are written from a clear ideological standpoint, which is shown for example by the fact that strong moral standpoints are mentioned in passing and treated as undisputable (e.g. "abortion is murder" or "selection of embryos is ethically unacceptable"). The relation between transhumanism and faith or religion is of interest to Polish authors. Some of them suggest that the rise of transhumanism has the process of secularization at its source. There are very few texts that explicitly refer to the Polish context, i.e. are specific to Poland. Some scholars mention the problem of translating the notion of "enhancement" into Polish and the fact that some terms are confused, e.g. "transhumanism" is used as an equivalent of "posthumanism". Others refer to Polish authors whose work is considered relevant. They do not however juxtapose the Polish thought against the ideas presented by academics from other countries. The analysis showed that the academic scholarship on HE in Poland is at a very initial stage. The lack of terminological clarity and the fact that academics are still discussing the question of translating the basic terms shows that this is still a novel area. This novelty has been underscored by some authors. The preponderance of texts of general nature, of introductory character speaks in favour of this claim.
South Africa	Only one paper was found in the search that really contributes an African philosophical account to discussions about enhancement which is the contribution by A.K. Fayemi.[58] In their work, Fayemi asks a key question which is "How do we best understand an African view of personhood in a transhumanist context?" The argument is that because an African/Yoruba understanding of personhood is fundamentally relational in character (and personhood is not a static characteristic but rather a lifelong process), any biological or technical enhancements that could improve a human being's actions (and particularly their moral actions and behaviour towards others) would be likely to increase their personhood (with 'greater' personhood meaning greater moral status relative to others). Critically, an enhanced person would likely only attain greater moral status (or: greater personhood) vis-à-vis others if the enhancements and actions resulting from the enhancements contribute to the "moral good of communal well-being."[59] Fayemi calls for articulation of "Afrofuturism" which will involve "critical African imaginations of a posthuman future taking cognizance of African history, culture, religion and philosophy."[60]

[58] Fayemi, Ademola Kazeem, "Personhood in a Transhumanist Context: An African Perspective," *Filosofia Theoretica: Journal of African Philosophy, Culture and Religions* Vol. 7, No. 1, May 2018, pp. 53–78.
[59] Ibid, p. 61.
[60] Ibid, p. 71.

Country	Summarised findings
	Schauffer[61] proposes that the real distinction between AI and humans is the latter's ability for non-dual thought, as evidenced in the worldviews of non-Western societies. Schauffer proposes that whereas Western logic is dualistic in nature (yes/no, in/out, either here or there), non-Western and African worldviews sustain a more cyclical worldview (which he describes as 'something can be both in this category and not in this category at the same time'). It seems that as for Fayemi, there is an interesting perspective here that could (should!) be explored in relation to thinking about the ethics of enhancement, yet it is unfortunate that Schauffer himself does not reason through how his observation would change the acceptability or ethics of enhancement. Overall, the picture that emerges from this analysis is that there is a fairly liberal attitude to enhancement in the broadest sense in South Africa. All the sources – including those from a theologian and an African philosopher – suggest that enhancement would be permissible in the South African context. Two main concerns stand out, namely those around social justice and around safety. Of these, social justice concerns are most prominent and would prescribe that a) as a minimum, human enhancement is not developed and governed in ways that increase inequality but b) that ideally, human enhancement should be targeted to specially promote equality and social justice. Not much is said of the second concern, safety, other than observing that it is very important that scientifically sound and ethical trials should be undertaken to establish the long-term safety of enhancements, taking into account specific vulnerabilities of prospective participants that could influence their decisions to participate in research (specific mention is made of the elderly and the poor).
Spain	The vast majority of academic publications in Spain on ELSI with reference to HET are about ethical issues, and almost all articles found in the search are signed by authors with philosophical training. This is surprising because it is unusual for philosophers, much less Spaniards, among whom applied philosophy has little tradition, to set aside their interests for an investigation that is usually more historical and speculative, in order to analyse controversies related to contemporary science and, in particular, with applications that have not yet been produced. Regarding the ethical framework of the publications analysed, there is a plurality of theories. There are works carried out both from a continental perspective, Nietzschean and Anglo-Saxon. However, the works inspired by this last tradition appear to be dominant, although from very different approaches, such as utilitarianism, liberalism, social analysis of science or some combined proposals. This is also surprising in Spain, given that it has long been the case philosophy of continental origin, especially German, is dominant. This reflects an important change in Spanish philosophy, reflected in, among other things, the emergence of a greater interest in the analytical study of social controversies about science, and in particular, on the new biotechnologies applicable to human enhancement. Bioconservative authors are criticized by virtue of their appeal to a non-existent human essence against which human enhancement projects would attack[62]; of being based on an

[61] Schauffer, Dennis, "We Know What We Are, but Not What We May Be," *The Journal for Transdisciplinary Research in Southern Africa* Vol. 2, No. 2, November 2006.
[62] Diéguez, Antonio, "Reflexiones Sobre Las Tecnologías De Mejoramiento Genético Al Hilo Del Pensamiento De Ortega y Gasset ," *Scio* Vol. 10, 2014, pp. 59–80.

Country	Summarised findings
	outdated and arbitrary naturalism[63,64]; and of its confusion between the intention of who enhances (to dominate nature) and the consequences of the enhancement (the beneficial effects for human beings).[65] To support an intermediate position between bioconservatives and transhumanists Dieguez[66] turns to José Ortega y Gasset, the Spanish philosopher best known internationally. For Ortega y Gasset, the human being is a being in constant evolution, who lacks essence and who needs the technique to create himself. For that reason, the bioconservatives are mistaken when looking for a human essence against which the projects of human enhancement would attack. However, transhumanists are also wrong for wanting to go beyond human beings. Instead of putting technology at the service of human freedom, what they achieve is to frustrate the free destiny of humans. Despite recognizing the obvious differences between new possibilities of enhancement, some Spanish philosophers have pointed out some interesting warnings about them. Thus, Dieguez[67] insists on the need to distance ourselves conceptually from some assumptions of traditional eugenics.[68] Lema Añón[69] adds that liberal eugenics is not a panacea. He argues that the free choice for enhancement could in many cases be questionable because although they were objectively a clear benefit to the individual, they can be morally objectionable by virtue of what they would mean for others. The ethical arguments offered in favour of human enhancement tend to be consequentialist. Thus, Campos[70] defends from a strict utilitarianism a paternal obligation to use genetic advances to morally enhance children. There are also proposals in this debate from a minimal and conditional consequentialism. From the particularistic perspective mentioned before, Lara[71] analyses four possible scenarios of possible application of neurotechnologies for the enhancement of moral motivation: the strengthening of the will, the reduction of aggressiveness, the increase of empathy and the increase of the sense of justice. Enhancement does not entail secondary effects that are detrimental to the health of the enhanced ones. However, the author concludes that the realization of such enhancements should be postponed as long as it is not possible to modulate them in such a way that one can be sure of not exceeding certain thresholds from which their effects would clearly cease to be valuable.

[63] Diéguez, Antonio, "La Biología Sintética y El Imperativo De Mejoramiento," *Isegoría*, No. 55, 2016.
[64] Campos, Olga, "La Mejora Del Carácter Moral En La Evaluación De Las Técnicas De Mejora Biológica," *Inicio* Vol. 3, 2010, pp. 45–59.
[65] Ibid.
[66] Diéguez, op. cit., 2014.
[67] Diéguez, op. cit., 2016.
[68] The dualism between inferior and superior beings and the belief that the world's problems will be solved by modifying the biology of the people.
[69] Lema Añón, Carlos, "Intervenciones biomédicas de mejora, mejoras objetivas y mejoras discriminatorias: ¿De la eugenesia al darwinismo social? [Human Enhancement, Objective Enhancement and Discriminatory Enhancement: From Eugenics to Social Darwinism?]," *Anales De La Cátedra Francisco Suárez* Vol. 49, 2015, pp. 367–393.
[70] Campos, op. cit., 2010.
[71] Lara, Francisco, "Ethical Requisites for Neuroenhancement of Moral Motivation," *Ramon Llull Journal of Applied Ethics* Vol. 8, No. 8, 2017, pp. 159–181.

Country	Summarised findings
Sweden	The search appeared to show that the debate around HET in Sweden is not yet taken down to a local dimension, but rather part of a global discussion. Such enhancement technologies have medical applications and may be used to treat many diseases and disabilities. Additionally, in the coming decades, they could allow us to boost both our physical and mental abilities. Three papers debate whether mood and cognitive enhancement should be publicly funded. Fröding & Juth argue that based on the principle of need, cognitive enhancement is in some cases compatible with public funding.[72] They do point out that the line between treatment and enhancement is somewhat blurred. Brülde asks if mood enhancement is indeed a legitimate goal in medicine. He argues that there are cases where mood enhancement might be acceptable, even in a publicly funded health care system.[73] Bergström asks GPs and the general public whether society should pay for enhancing memory in healthy people.[74] They found that a minority of the general public support altruistic reasons for enhancing mood and memory in healthy individuals. Malmqvist[75] discussed enhancement through genetic testing in reproduction. He argues that it would be wrong not to use these techniques once they are proved safe and that we should welcome enhancement for the same reasons as we welcome treatment. Several articles mentioned that the use of human enhancement would be beneficial to society at large. Franssen and Malmqvist[76] argue that it might benefit society in reducing age related diseases. Fröding[77] and Jebari[78] point out that human enhancement will be needed in tomorrow's society. Future sensory enhancement technologies may increase our possibility to imagine and anticipate some of the risks that we have failed to conceive, i.e. via techniques like echolocation and electroreception, and may contribute to different ways of relating and interfacing with the world.[79] Important questions about what it means to be human were also raised. Romanov[80] interviewed Swedish priests about their view on Human enhancement. Even though the respondents have a bioconservative point of view, a lot of the participants argued that

[72] Fröding, Barbro, and Niklas Juth, "Cognitive Enhancement and the Principle of Need," *Neuroethics* Vol. 8, No. 3, 2015, pp. 231–242.
[73] Brülde, Bengt, "Is Mood Enhancement a Legitimate Goal of Medicine?," Essay, *Enhancing Human Capacities* , Wiley-Blackwell, Chichester, 2011, pp. 218–229.
[74] Bergström, Lena Strand, and Niels Lynöe, "Enhancing Concentration, Mood and Memory in Healthy Individuals: An Empirical Study of Attitudes among General Practitioners and the General Population," *Scandinavian Journal of Public Health* Vol. 36, No. 5, 2008, pp. 532–537.
[75] Malmqvist, E., "Reproductive Choice, Enhancement, and the Moral Continuum Argument," *Journal of Medicine and Philosophy* Vol. 39, No. 1, 2013, pp. 41–54.
[76] Franssen , Trijsje, and Erik Malmqvist, "Heracles or Icarus: Mythological References in the Enhancement Debate," *Future-Human.life*, 2017.
[77] Fröding, Barbro, "Virtue Ethics and Human Enhancement," *SpringerBriefs in Ethics*, 2013.
[78] Jebari, Karim, "Sensory Enhancement," *Handbook of Neuroethics*, 2014, pp. 827–838.
[79] Ibid.
[80] Romanov, Artur. Gränsen mellan människa och maskin sett ut ett kristent perspektiv. En kvalitativ studie om prästers syn på den mänskliga naturen i relation till cybernetiska organismer. [Priest' View on the human Nature in Relation to Cyborgs]. Stockholm University, Stockholm. 2018.

Country	Summarised findings
	human nature is changeable, and that human enhancement is acceptable as long as free will and the biological brain remain intact. Counterarguments are voiced in that enhancement may undermine our privacy and autonomy. Enhancement may also exacerbate and cement social inequalities. Franssen & Malmqvist[81] state that the drive to self-enhancement can threaten to undermine humility in the face of human imperfection and solidarity with the least fortunate.
United Kingdom	Only few articles met the selection criteria. The main challenge was to find ethical analysis specifically focused on the UK context. This is most likely due to the nature of ethics to which national boundaries apply to only a limited extent. An additional issue that we faced in this search on ethical analysis on human enhancement in the UK relates to the fact that the some of the leading experts who dominate the international ethical debate are actually located in the UK. These include authors such as Nick Bostrom, Julian Savulescu and Guy Kahane. Some references from these authors were mentioned in the reporting tables in order to provide some broader context to the ethical debate specifically focused on the UK. However, these were not analysed as they fell outside the scope of this search. The majority of academic articles that fitted the selection criteria focus on the use of drugs for enhancement purposes. This might be due to the fact that drug consumption can indeed be assessed at the national level, primarily due to questions of access (whether through legal or illegal channels). The enhancement objectives are primarily physical, cosmetic and cognitive. Another specificity that emerges from this search is the focus of the articles on students (who might use drugs for cognitive enhancement in the context of their studies) and on young males (mainly driven by physical and cosmetic enhancement in the private context).

Table 4: Summarised findings per country on the country-specific academic debate on ethical issues in human enhancement.

Media debate on ethical issues in human enhancement

Country	Summarised findings
Brazil	One important aspect that distinguishes the relevant "articles" is their emphasis on the adult life stage. Also, all relevant "articles" cover the category of cognitive enhancement in the areas of work/professional and education. A similarity between the academic media articles and the academic articles per se is their effort to relate the discussion of the ELSI of human enhancement to the international debate – only 2 out of 6 media articles that met the criteria makes a direct effort to relate the ethical discussion to the Brazilian context. And perhaps it might be relevant to note that these 2 media articles are authored by Marcelo de Araújo, who participates and underwrites the Brazilian country study.
China	Chinese media articles on HET suggest authors are eager to learn more about HET and popularize relevant knowledge for the public. The Chinese public is not very familiar with HET. Therefore, in many reports, the Chinese media will first introduce the specific concept of human enhancement technology, and distinguish enhancement from treatment. The main contents reported in most Chinese newspapers include: the public's attitude towards HET, analysis of the reasons for this attitude, the impact of HET on social life, health and safety issues brought by enhancement technology, justice and equality issues, autonomy and dignity issues, addiction issues and so on. Some newspapers also discuss the ethical boundaries of when to consider human enhancement and when not to use it.

[81] Franssen & Malmqvist, op. cit., 2017.

Country	Summarised findings
	At present, Chinese media mainly focus on cognitive enhancement and genetic enhancement. Drugs are the main method for cognitive enhancement, i.e. "smart drugs." People tend to focus on the enhancing effects, ignoring side effects and addictions. The emphasis on "smart drugs" was originally developed for children with ADHD, and non-clinical use is strictly prohibited. China's health administration has put them on the list of class I psychotropic drugs, which are strictly prescribed. In the face of heavy academic pressure on children, Chinese media suggest that children's health and safety should be ensured, and children's study and life should be arranged in a scientific and reasonable way, paying attention to the combination of work and rest. Regarding genetic enhancement, the recent gene editing controversy of He Jiankui's experiment has aroused attention from all walks of life. Some experts believe that genetic modification in healthy people is gene enhancement. Chinese media have discussed a series of ethical issues in gene enhancement technology, such as autonomy, responsibility, natural evolution, privacy, justice, equality, intergenerational and health. They are trying to keep an eye on the development of gene enhancement and hope to legislate on it as soon as possible.
France	*A separate analysis of the popular media debate was not delivered.*
Germany	As we outlined already for the German academic debate, also for the German media debate we can only identify some trends. It is not easy to say if the media debate on ELSI of HET in Germany is different compared to other countries. Of course, the media debate is influenced very much by current events, like new research findings, new laws or new affairs. We want to describe some of the trends: • German media debate on ELSI related to doping in sports. This topic is discussed every now and then, mostly triggered by sports events and connected to this new doping cases. The ethical principles discussed in the sports and doping context are fairness, justice and autonomy. • German media debate on ELSI related to gene editing. Since the Chinese scientist He Jiankui published his research about genetically modifying embryos to make them immune against HIV in November 2018, gene editing is a big topic in the German media debate. In focus are unforeseeable long-term effects of gene editing, questions of fairness and equality and the impact on the society as a whole. Phrases like "playing god" are often used. • German media debate on ELSI related to the use of lifestyle drugs. Cognitive HET or using lifestyle drugs is in the media now and then. Especially the use of enhancing drugs in the working life is discussed a lot, but also the use of neuro-enhancing drugs in school or university. • German media debate on ELSI related to enhancing children. Questions discussed here are e.g. What needs to be treated? What counts as illness and what not? How can parents decide what is the best for their children or rather can parents decide in the best interest for their children? Ethical principles discussed are autonomy, self- determination and no-harm.
Greece	There is no media understanding, so far, that a set of medical procedures, practices and use of substances etc is tied together as human enhancement in Greece. Issues related to HET are dealt with separately, with only one exception. Articles were found dealing with doping in sports and cosmetic surgery, with a common focus on the dangers of such practices for children/minors.
Netherlands	*A separate analysis of the popular media debate was not delivered.*

Country	Summarised findings
Poland	The media analysis is based on a search of Gazeta Wyborcza daily, the most popular daily in Poland that is not a tabloid.[82] As far as enhancement category is concerned, the following types of enhancement have been discussed: cosmetic, physical, affective, cognitive, neuro-enhancement and longevity including immortality, as well as genetic enhancement. The theme of longevity seems to draw particular attention. That being said, some popular examples of physical enhancement, e.g. the case of Pistiorius, are brought up oftentimes. Different methods of enhancement were mentioned, among others: surgeries, drugs (anti-depressants, Ritalin®, steroids, growth hormones). The authors do not, however, compare or problematize different categories or methods of enhancement. They do not focus on similarities and differences between them, but treat them collectively with little detail. As far as specific ELSI are concerned, the authors referred to questions of access and inequality, as well as values such as authenticity and self-fulfilment. The authors of the analysed texts seem to have mixed feelings about enhancement and the societal changes it may bring about. Some authors are anxious about the effects of enhancement. They voice a fear that only the rich will be able to afford benefits of enhancement, which will lead to furthering the gaps between the reach and the poor. Other authors are dubious about the value of progress and highlight that progress does not always mean improvement.
South Africa	Overall, there is very little discourse about any form of enhancement in South African media. The two articles were found that paint a picture of a transhumanist world ([83,84]) seem to somehow ridicule this prospect and the reality that these developments are now upon us. Especially Ball[85] pointedly describes transhumanists' 'infantile fantasies' to have their heads frozen. Otherwise, the articles sketch/reiterate some of the fundamental concerns around enhancement, including questions about safety, equality, fairness and so forth. Nothing really new or interesting came from this analysis.
Spain	In the Spanish newspapers, human enhancement does not appear as a clearly delimited and consolidated theme. When referring to human enhancement this field is presented as a discourse at the service of the broader objective of overcoming the human species.[86] In that sense we can say that a conceptual confusion between human enhancement and transhumanism predominates. Nor is there a differentiation of types of human enhancement and, much less, a comparison between such types. It is true that there are two types of enhancement that have received greater attention in Spanish media such as longevity and the increase of certain physical capacities related to health (immunological in particular) through genetic editing. But this interest responds to particular social concerns such as, on the one hand,

[82] k, m, "„Fakt' Na Czele Sprzedaży Kioskowej w Lutym, „DGP' i „Parkiet' Na Plusie," *Wirtualnemedia*, April 13, 2019. https://www.wirtualnemedia.pl/artykul/fakt-na-czele-sprzedazy-kioskowej-w-lutym-dgp-i-parkiet-na-plusie.
[83] Bunting, Madeleine, "Be All You Can Be," *Weekly Mail and Guardian*, Cape Town, February 9, 2006, sec. 10.
[84] Ball, Philip, "Religious Riddle of Nanotechnology," *Weekly Mail and Guardian*, Cape Town, January 26, 2012, sec. 16.
[85] Ibid.
[86] Cortina, Albert, and Miquel-Àngel Serra, "Retos De Un Futuro Posthumano," *EL PAÍS*, January 2, 2016. https://elpais.com/tecnologia/2015/12/29/actualidad/1451389449_117291.html.

Country	Summarised findings
	the desire to combat the evils of aging[87,88] and, on the other, the controversy arising from the genetic modification of embryos in China by the team of He Jiankui[89,90]. The point is that when these two topics are discussed, they are not usually analysed as manifestations of the broader issue of human enhancement. An exception to the above is when interviews are published with philosophers who, coming mainly from Oxford, come to our country to attend conferences on this subject. Only in these cases journalists explicitly refer, in response to statements made by the philosophers interviewed, to the subject of human enhancement.[91] When journalists are ethically positioned regarding the possibilities of using new technologies for human enhancement (even if they do not conceptualize it as such) they do so, in general terms, from a great concern about the possible negative effects of that use. In particular, they worry that the individual will be superseded by the machine and that we will end up in a more unequal society.[92,93] There is also, in the wake of the Chinese case, a strong concern for the uncontrolled use of techniques that may affect the health and endanger the human species.[94,95] There is an author who is also concerned that this Chinese case has begun to seriously question the firm distinction so far between therapy and enhancement.[96] In the specific case of technology for longevity, newspapers expose a predominantly pessimistic attitude, among Spanish scientists, to achieve immortality, but at the same time a strong involvement of these in international studies to significantly increase life expectancy.[97,98] Regarding the attitude that is demandable respect to all these technological possibilities, the belief prevails that we have a strong responsibility to respond to the challenges we

[87] Abril, Guillermo, "Reportaje: ¿Vamos a Vivir 140 Años?," *EL PAÍS*, September 16, 2017. https://elpais.com/elpais/2017/09/17/eps/1505599510_150559.html.
[88] Izquierdo, José María, "Entrevista: Carlos Martínez Alonso, Científico: 'Lograremos Ser Inmortales,'" *EL PAÍS*, May 24, 2016. https://elpais.com/elpais/2016/05/25/eps/1464127228_146412.html.
[89] Sampedro, Javier, "Análisis: Los Chinos Se Saltan Dos Pasos," *EL PAÍS*, November 26, 2018. https://elpais.com/elpais/2018/11/26/ciencia/1543235368_883802.html.
[90] Castro, Nuria Ramírez de, "«Nos Arriesgamos a Tener Un Turismo De Mejoramiento Humano»," *Abc*, ABC.es, November 27, 2018. https://www.abc.es/sociedad/abci-arriesgamos-tener-turismo-mejoramiento-humano-201811270336_noticia.html.
[91] Jorge, J. de "«Claro Que Debemos Jugar a Ser Dios»," *Abc*, ABC.es, June 5, 2019. https://www.abc.es/ciencia/abci-julian-savulescu-bioeticista-claro-debemos-jugar-dios-201906030223_noticia.html.
[92] Cortina & Serra, op. cit., 2016.
[93] Izquierdo, op. cit., 2016.
[94] Sampedro, op. cit., 2018.
[95] Ramirez de Castro, op. cit., 2018.
[96] Sampedro, op. cit., 2018.
[97] Abril, op. cit., 2017.
[98] Izquierdo, op. cit., 2016.

Country	Summarised findings
	face and to do so from a social, democratic and interdisciplinary debate[99,100]. Sometimes the concepts of dignity and equality are invoked as theoretical references to think about these current challenges.[101]
Sweden	One article discusses the European "Human Brain Project".[102] Researchers from Karolinska Institute are participating in the project. HBP was launched by the European Commission's Future and Emerging Technologies (FET) scheme in October 2013. In the article Anders Sandberg, a researcher in the field of Human enhancement at the Future of Humanity Institute at Oxford claims that "the future is already here". Sandberg points out that the line between treatment and enhancement is blurred. To give amputees a prothesis they can control with their mind is desirable, but to boost the mind capacity of people is not prioritised. Medical research is meant to improve the life quality of the people that need care, not to help already healthy people. Sandberg reckons that by 2050 we will have the capacity to simulate a human brain, a technical progress that will give a boost to both healthcare and science and technology. It will also advance society and the economy. Ingar Brink at Lund University points out that it does not mean that a simulated brain will have an identity, like a human being. A major concern and probably most important ELSI is that these techniques used to enhance cognitive capabilities might mitigate social inequalities. There are valid concerns that cognitive enhancement will benefit only the wealthy, thus exacerbating current inequalities.
United Kingdom	We only obtained a few media analysis articles from the search conducted: six articles fitted the selection criteria. The limited number of results obtained is most likely due to the fact that the human enhancement field is still a relatively new one and media studies on a scientific field can only come a few years after the establishment of the new field. The search reveals media analyses on human enhancement are primarily concerned with issues related to neuro-stimulation and the use of the wakefulness-promoting drug modafinil. Ethics-related issues are present in these articles: if ethics is not one of their areas of focus, it is at least referred to. However, as one of the articles studied notes, ELSI are less present in the media coverage of human enhancement than it is in the media coverage of genetics and genomics.[103] As noted above, this might be explained by the fact that human enhancement is still a relatively new field compared to genetics and genomics, and that ELSI of the latter field is widely developed, while this is not yet the case for the former. Furthermore, a particular concern that can be noted from these studies relates to the medicalisation (or pharmaceuticalisation) of specific sectors of human existence, in

[99] Cortina & Serra, op. cit., 2016.
[100] Izquierdo, op. cit., 2016.
[101] Cortina & Serra, op. cit., 2016.
[102] Jurjaks, Arvid, "Hjärna En Kopia," *Fokus*, February 14, 2013. https://www.fokus.se/2013/02/hjarna-en-kopia/.
[103] Racine, Eric, Sarah Waldman, Nicole Palmour, David Risse, and Judy Illes, "'Currents of Hope': Neurostimulation Techniques in U.S. and U.K. Print Media," *Cambridge Quarterly of Healthcare Ethics* Vol. 16, No. 03, September 2007.

Country	Summarised findings
	particular sleep and alertness.[104,105] This focus reflects to some extent the results obtained by the search on ethical analysis articles for which a concentration on drugs could also be observed.

Table 5: Summarised findings per country on the country-specific popular media debate on ethical issues in human enhancement.

4.2 General discussion

Upon preparing the instructions for the country studies task for ethical analysis of human enhancement, we hoped the results would lead to the identification of new ethical issues not found in the broader literature. Unfortunately, few unique insights about ethical issues were gleaned. The task has managed, however, to demonstrate how sporadic the study of HET is at present around the world. In the following analysis, we highlight similarities and differences and attempt to offer a preliminary explanation about the general nature of the results.

The one similarity that stood out across the studies was a focus on cognitive enhancement. Not all countries discussed the category in the same way, nor seemed to follow the same definition, but nearly every study showed that academics in all eleven countries are investigating ELSI related in some way to cognitive enhancement. Few other similarities stood out among the studies. Additional popular areas of inquiry were physical enhancement and cosmetic enhancement, whereas few studies showed an emphasis on moral enhancement (with Germany and Netherlands as exceptions), longevity enhancement or affective & emotional enhancement (with Sweden as a lone exception). Our best guess to explain the disparity between emphases among the eleven countries is that HET, in many respects, is hard to classify as a field in its own right, such that even the base definition of "human enhancement" remains one of the primary topics in the debate.

We noticed many differences in foci among the eleven countries, in both the academic and media searches. From our partners' work, we observe that some countries (Poland, Brazil, South Africa) appear to have almost no relevant work in ELSI of HET, while others (China, Germany, Sweden, UK) appear to have more work being done on the subject, although in the case of the UK and Netherlands very few articles were found that discuss issues relevant to the country instead of adding to international debates. The media searches revealed somewhat similar results, with especially few articles being found in Greece and South Africa, and far more being found in Germany and China.

The results from South Africa, although limited, revealed perhaps the most enlightening insight from the task. The work by authors A. K. Fayemi and D. Schauffer show how traditional African philosophy utilises a much different understanding of personhood and non-dualistic thinking. Although our partners found little material in which these ideas pushed the envelope, the discovery suggests there may be a fruitful gap, i.e. a promising target for future research, in the literature about how non-Western philosophy/philosophers may approach HET in different ways.

[104] Coveney, Catherine M., Brigitte Nerlich, and Paul Martin, "Modafinil in the Media: Metaphors, Medicalisation and the Body," *Social Science & Medicine* Vol. 68, No. 3, 2009, pp. 487–495.
[105] Williams, Simon J., Clive Seale, Sharon Boden, Pam Lowe, and Deborah Lynn Steinberg, "Waking up to Sleepiness: Modafinil, the Media and the Pharmaceuticalisation of Everyday/Night Life," *Sociology of Health & Illness* Vol. 30, No. 6, 2008, pp. 839–855.

Our partners in France and Spain showed us that long-held philosophical traditions in these countries were rarely used in favour of a more 'analytic' or 'applied' approach when discussing HET. Whether this is because the international debate skews more toward applied/analytical approaches or because the topic requires tools better found in this approach may be worth pursuing in further research.

We include the following comparative table noting the number of relevant articles analysed in each country to help understand the results. "Search" is the number of articles found (i.e. that met the search criteria discussed in section 4.1 above), "Analysed" is the number of articles carefully analysed for the study. Subsequent columns document how many of the articles that were analysed discuss each category of enhancement. Asterisk (*) denotes a full reporting table was not delivered.

Country	Search	Analysed	Phys.	Cog.	Aff.&Bhvr.	Moral	Cosm.	Long.
Part 1 (Academic)								
Brazil	27	5	1	4	0	0	0	0
China	22	7	0	5	1	1	0	0
France*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Germany	22	13	7	11	4	7	4	4
Greece	13	4	2	2	0	0	4	2
The Netherlands	28	15	5	10	6	6	1	4
Poland	12	9	3	2	0	0	2	1
South Africa	19	14	4	4	0	0	1	2
Spain	49	11	6	8	5	4	3	3
Sweden	15	11	9	8	7	3	5	3
The United Kingdom	21	6	4	2	1	0	0	0
Part 2 (Media)								
Brazil	10	7	4	6	0	1	0	0
China	6	4	2	4	0	0	0	0
France*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Germany	17	11	6	3	1	1	1	5
Greece	27	10	10	3	0	0	2	0
The Netherlands*	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Poland	20	5	2	2	2	0	2	4
South Africa	8	8	2	6	1	1	2	1
Spain	21	5	2	1	1	0	0	3
Sweden	1	1	1	1	1	1	1	1
The United Kingdom	9	6	0	6	0	0	0	0

Table 6: Number of articles found in search and analysed for the country study task with breakdown per enhancement category

5. Ethical analysis: general ethical issues

Below, we include the majority of SIENNA's ethical analysis of human enhancement divided into three sections: general ethical issues (this section), issues specific to human enhancement products and techniques (section 6), and ethical issues specific to application domains (section 7). Section 5 is further divided into subsections on issues with regard to the *aims* of human enhancement (5.1), the

fundamental technologies within the field (5.2), and *general implications* (5.3). The division between these sections is loosely based upon Brey's three level approach to ethical analysis: the technology level, the product level and the application level.[106] The primary means & methodology of the ethical analysis are included above in Section 3.

5.1 Ethical issues with regard to the aims of human enhancement

The following subsection is divided by aims found in the six subcategories of HET identified and discussed in SIENNA D3.1. Roughly, the first three subcategories (cognitive, cosmetic and physical) are presented as representative of *present* general aims of HET, whereas the latter subcategories (affective & emotional, moral and longevity) are presented as representative of *future* general aims of HET, although some future aims also apply to the former subcategories. Each category includes an updated definition based on that provided previously in SIENNA D3.1.

Cognitive enhancement

Cognition can be defined as the neurological processes that organisms employ to organise information from the acquisition of information through perception (i.e. the selecting and representing of information through attention and understanding) to using these processes to guide behaviour through reasoning and coordination of motor outputs. [107] The term 'cognitive enhancement' originates from attempts to treat disease-associated cognitive impairments, such as dementia and schizophrenia, by using various strategies to boost an individual's cognitive functions.[108] Today, the term and associated techniques are used not just for individuals with cognitive deficits, which would fall on the 'treatment' side of the treatment/enhancement distinction, but instead for healthy individuals who wish to improve their cognitive functioning beyond initial capability.

Cognitive enhancements are interventions that improve cognitive abilities. Potential targets for cognitive enhancement are *intelligence, clarity* and *creativity*. Intelligence enhancements improve capabilities associated with intellectual abilities, such as critical thinking, reasoning, memory[109] or comprehension of ideas. Clarity enhancements are primarily related to focus but can also apply to enhancements that increase abilities associated with maintaining rigour during cognitive tasks. Creativity enhancements improve inventiveness, artistic ability, design-related tasks, or, more broadly, the ability to think of new ideas or concepts.

Cognitive enhancements can be attractive means of meeting the demands for greater performance in educational settings and workplace settings, thus one of their primary aims is to **increase cognitive**

[106] Brey, op. cit., 2012.
[107] Bostrom, Nick, and Anders Sandberg, "Cognitive Enhancement: Methods, Ethics, Regulatory Challenges," *Science and Engineering Ethics* Vol. 15, No. 3, 2009, pp. 311–341.
[108] Ferrari, Arianna, Christopher Coenen, and Armin Grunwald, "Visions and Ethics in Current Discourse on Human Enhancement," *NanoEthics* Vol. 6, No. 3, 2012, pp. 215–229.
[109] We remain agnostic about whether memory and intelligence necessarily amount to the same kind of ability; for our purposes, we have associated memory with intelligence in this HET category as a matter of practicality. It may be that memory enhancements deserve their own subcategory within cognitive enhancements if memory is not linked to intelligence.

performance.[110] Cognitive enhancement can be achieved through methods including the use of caffeine[111] as well as prescription stimulants such as modafinil, methylphenidate and amphetamine derivatives.[112] As the former method does not engage any form of regulated, ethical practice to administer, we will not consider it in our analysis. Some of the effects of stimulants include increased arousal, improved attention and increased motivation, along with improving aspects of learning and memory. Illicit stimulants include amphetamines, cocaine and ecstasy (3,4-methylenedioxy-N-methylamphetamine, colloquially referred to as MDMA).[113] Nutritional supplements are sold as cognitive enhancers as well, producing a billion-dollar industry in the United States, even though the effectiveness of such supplements is not conclusive.[114]

Similar to the wider debate of where to draw the line between enhancement and therapy, it is also difficult to draw a comparable line in the more specific case of cognitive enhancement. In SIENNA D3.1, we explained the difference identified by Coenen et. al. between therapeutic non-enhancing, therapeutic enhancement and non-therapeutic enhancement applications.[115] To reiterate, one can frame the distinction as follows: if drugs have an effect in the presence of disease states, they fall on the therapeutic side (for example, drugs such as lithium or antimicrobials). If such a drug has no enhancement benefits, then it is a therapeutic non-enhancing drug. For a drug to be considered an enhancer, it must produce beneficial effects in the absence of illness.

The problem with drawing this distinction is that most drugs become classified as enhancements only after they have been created and used to treat individuals with impairments and/or diseases. These applications will fall under the categories of therapeutic enhancement. For instance, while today antidepressants only have modest positive results on healthy people and moderate efficacy on individuals who are depressed, it is possible to imagine that antidepressants in the future might be developed to safely improve the mood in a more pronounced fashion in healthy individuals as well.[116] At some point, there may be drugs that offer no therapeutic benefit to the user whilst improving cognitive capability of healthy individuals and would thus be classified as non-therapeutic enhancement. In the practical application of medications, there is ambiguity in the therapeutic enhancement distinction. Furthermore, although we have explained the non-enhancing/therapeutic/non-therapeutic distinction in relation to cognitive enhancement, this distinction will also apply to the other categories of enhancement we discuss later in the report.

[110] Hyman, Steven E., "Cognitive Enhancement: Promises and Perils," *Neuron* Vol. 69, No. 4, 2011, pp. 595–598.
[111] Giles, Grace E., Caroline R. Mahoney, Tad T. Brunyé, Aaron L. Gardony, Holly A. Taylor, and Robin B. Kanarek, "Differential Cognitive Effects of Energy Drink Ingredients: Caffeine, Taurine, and Glucose," *Pharmacology Biochemistry and Behavior* Vol. 102, No. 4, 2012, pp. 569–577.
[112] Ibid, p. 595.
[113] Franke, A. G., C. Bonertz, M. Christmann, M. Huss, A. Fellgiebel, E. Hildt, and K. Lieb, "Non-Medical Use of Prescription Stimulants and Illicit Use of Stimulants for Cognitive Enhancement in Pupils and Students in Germany," *Pharmacopsychiatry* Vol. 44, No. 02, 2010, pp. 60–66.
[114] Farah, Martha J., Judy Illes, Robert Cook-Deegan, Howard Gardner, Eric Kandel, Patricia King, Eric Parens, Barbara Sahakian, and Paul Root Wolpe, "Neurocognitive Enhancement: What Can We Do and What Should We Do?," *Nature Reviews Neuroscience* Vol. 5, No. 5, 2004, pp. 421–425.
[115] Coenen, et. al., op. cit., 2009.
[116] Hyman, op. cit., p. 596.

On the therapeutic side, drugs that are designed to target individual's memory can be used to erase memories of trauma where individuals may be suffering from posttraumatic stress or assist in dealing with cues that propel addicts to relapse.[117] Since these options modify an individual's memory we count them as a therapeutic-enhancing drug, despite our inability to find studies to test the drug on healthy individuals, with the expectation that such memory modifications could be triggered even if the user is not at risk of posttraumatic stress. Drugs that target the initial induction of long-term potentiation (the strengthening of synapses) include Cortex Pharmaceuticals' Amakines®, while drugs that target the later stages of memory consolidation include Memory Pharmaceuticals' molecule MEM1414®.[118] Due to the invasiveness of the application on individual's memory, such drugs must pass safety regulations before being administered. This demonstrates that there is a need for more testing to clarify efficacy, as well as greater assessment of any risks and side-effects. While many cases are based on small-scale clinical trials, there is an overall deficiency in statistical data on the effects of using cognitive enhancing drugs on healthy individuals, as well as in different contexts (e.g. dosing, long term use or variation of tasks).[119]

Conversely, if cognitive enhancement drugs become widely available, their **misuse** is also a possibility that raises concern.[120] For instance, consider that criminals may wish to use memory modification drugs to suppress their conscience after committing misdeeds.[121] It might also be possible that individuals (not necessarily criminals) may desire to maintain the superior mental capabilities that pharmaceutical cognitive enhancers promise for an extended duration, which will mean these enhancers could cause an addiction for individuals who wish to remain in a cognitively altered state that such drugs and substances induce.[122]

An additional concern is the effect that these drugs and substances may have on **inequality within the general population** once they become available. For example, once their value is demonstrated, might people be categorised as sub-normal if they are not enhanced by such drugs? In such circumstances, how would health insurance be engaged to provide access to such drugs and how might such claims alter the economic underpinning of insurance? After all, insurance works as long as only a fraction of people need to make claims, but in this case, all people would be determined as being in need. Without such provision through national health care, then there will likely emerge an increasing 'opportunity gap' between the rich and enhancement literature versus the poor and lesser educated.[123] Cognitive enhancement may thus be a cause to further widen this gap if only a select few gain access to the opportunity to improve their cognitive capabilities. Cost and access barriers could therefore compound disadvantages faced by groups in low socioeconomic status in education and employment.[124]

[117] Ibid, p. 597.
[118] Farah et al, op. cit., 2004, p. 422.
[119] Ferrari et al, op. cit., 2012, p. 223.
[120] Peterkin, Alexander L., Catherine C. Crone, Michael J. Sheridan, and Thomas N. Wise, "Cognitive Performance Enhancement: Misuse or Self-Treatment?," *Journal of Attention Disorders* Vol. 15, No. 4, 2010, pp. 263–268.
[121] Hyman, op. cit., 2011, p. 597.
[122] Chan, Sarah, and John Harris, "Cognitive Regeneration or Enhancement: the Ethical Issues," *Regenerative Medicine* Vol. 1, No. 3, 2006, pp. 361–366.
[123] Hyman, op. cit., 2011, p. 597.
[124] Farah et al, op. cit., 2004, p. 424.

Furthermore, considerations of access to cognitive enhancement are inextricable from the potential for a **pharmacologic performance arms race** to ensue, whereby those who are not able or interested in using cognitive enhancers may feel coerced to start using them to keep up with those who can more easily afford them.[125] A study conducted by Franke et al assessing the use of prescription and illicit stimulant use in 1 547 students and pupils in Germany found that prevalence rates for non-medical use of prescription stimulants was higher in pupils with lower academic marks, along with prescription and illicit stimulant use being higher with those that belonged to a fraternity or sorority, showing the coercive element in the use of these drugs and substances.[126] A similar study shows this is also the case for American students in fraternities or sororities.[127] It is also worth noting that the tendency to use prescription and illicit pharmaceutical cognitive enhancement is far more prevalent with those best informed about the potential benefits as well as risks, and where the benefits are important for cognitive performance such as in academia.[128]

If use of cognitive enhancement becomes common in the workplace, a related risk emerges: employers may **coerce** workers to utilise cognitive enhancements as a requirement to keep their job.[129] Whether or not such a practice would constitute a form of abuse has yet to be established; for example, consider the case of a police force requiring members to maintain a certain level of fitness with the understanding that an unfit officer could endanger not just their own life but those of the persons they may be required to protect. If it is determined that there are professions requiring peak cognitive performance and cognitive enhancement becomes especially safe and effective, it may not be seen as a problem for an employer to require their employees use an enhancement drug. Even if regulation is developed to prevent employer coercion in circumstances falling below this threshold, i.e. if a business wants to require employees to use cognitive enhancement purely to increase profits without regard for the employees' well-being, an extremely competitive market could encourage workers to feel coerced without explicit direction from their superiors, especially if co-workers who use cognitive enhancement are praised while non-users do not receive praise.[130] In other words, even with legal and/or regulatory protection, employer coercion could still occur indirectly.

Whether in the workplace or education, another issue with widespread adoption of sophisticated cognitive enhancement is that it could **change norms related to fairness**. Unlike sports, fairness in the workplace and education is rarely, if ever, governed in a unified way. Although cheating can occur, i.e. by stealing trade secrets or plagiarising another's work, the use of 'performance-enhancing' applications is a grey area. Workers and students are often encouraged to make use of every (legal) advantage available to them, even when their peers may not have access to the same options. For example, an employee may be encouraged (or, perhaps considering the previous ethical issue, coerced) to take a language class to allow them to join efforts in expanding their company to foreign countries,[131] or a student may be encouraged to study with a professional tutor to boost test scores.

[125] Ibid, p. 597.
[126] Franke et al, op. cit., 2011, p. 65.
[127] Ferrari et al, op. cit., 2012, p. 222.
[128] Ibid, p. 222.
[129] Garasic, Mirko D., and Andrea Lavazza, "Moral and Social Reasons to Acknowledge the Use of Cognitive Enhancers in Competitive-Selective Contexts," *BMC Medical Ethics* Vol. 17, No. 1, 2016.
[130] Schelle, Kimberly J., Nadira Faulmã¼Ller, Lucius Caviola, and Miles Hewstone, "Attitudes toward Pharmacological Cognitive Enhancementâ€'a Review," *Frontiers in Systems Neuroscience* Vol. 8, 2014.
[131] Example offered during the SIENNA Foresight Workshop in London, January 2019.

These examples are not commonly considered cheating or unfair in a problematic way. Thus, it may be the case that using drugs to achieve similar results will also see few regulations or legal developments. Besides the more nuanced issues discussed above, such a development in society could lead employees and/or students to use cognitive enhancement applications that could result in drawbacks. For example, a drug that boosts focus might reduce creativity.[132] The ethical legitimacy of these choices requires a comprehensive understanding of any trade-offs in terms of skills, their longevity and reversibility, the means by which they are administered and what this requires of individuals, and the system of regulation and monitoring that surrounds such practices. Without due consideration to each of these elements, it is difficult to apply their use in any way that attends to matters of professional responsibility or duty of care.

Minors and adolescents present further ethical issues for cognitive enhancement.[133] First, a young person's body/brain may react differently from an adult body/brain, resulting in different risks when using cognitive enhancers. Second, young persons may not yet understand concepts such as consent, yet their guardians may encourage them to use cognitive enhancement to compete with their peers, resulting in further problems related to coercion. Some parents/guardians may feel it's necessary for their child to use cognitive enhancement due to the perception that their child's classmates are already using cognitive enhancement. In this sense, while the application of cognitive enhancements to young people may appeal, especially when they are confronting significant stress, the risks may simply be too hard to ascertain at this stage, as does the legitimacy of using such means for a child who may be unable to consent to such use.

The reliance on these drugs and substances to improve an individual's cognitive capacities can also be seen as **challenging prevailing ideas of what it means to be a person**,[134] valuing life despite its imperfections, as well as undermining the value and dignity of hard work if all one needs is a pill to achieve better cognitive performance.[135] Moreover, besides pharmaceutical drugs and substances, other 'natural,' i.e. non-technological, tested means of improving cognitive functions include: physical exercise (to improve attention, processing speed, executive function and memory especially in children and middle aged adults), sleep (especially for memory consolidation to improve learning performance and creativity), meditation (as a way to improve attention and cognitive flexibility), mnemonics (for memory retention) and computer training through games (for attention, memory retention and brain plasticity). Another technological mean for cognitive enhancement is brain stimulation (such as non-invasive transcranial direct current stimulation and transcranial magnetic stimulation, and invasive deep brain stimulation and direct vagus nerve stimulation, for memory retrieval and retention).[136] The full effectiveness of many of these means remains contentious, even though an increasing number of

[132] Müller, U., J.b. Rowe, T. Rittman, C. Lewis, T.w. Robbins, and B.j. Sahakian, "Effects of Modafinil on Non-Verbal Cognition, Task Enjoyment and Creative Thinking in Healthy Volunteers," *Neuropharmacology* Vol. 64, 2013, pp. 490–495.
[133] Graf, William D., Saskia K. Nagel, Leon G. Epstein, Geoffrey Miller, Ruth Nass, and Dan Larriviere, "Pediatric neuroenhancement: Ethical, legal, social, and neurodevelopmental implications," *Neurology* Vol. 81, No. 17, 2013, pp. 1558–1559.
[134] Mohamed, Ahmed Dahir, "Neuroethical Issues in Pharmacological Cognitive Enhancement," *Wiley Interdisciplinary Reviews: Cognitive Science* Vol. 5, No. 5, 2014, pp. 533–549.
[135] Farah et al, op. cit. 2004, p. 425.
[136] Dresler, Martin, A. Sandberg, K. Ohla, C. Bublitz, C. Trenado, A. Mroczko-Wasowicz, S. Kuhn, and D. Repantis, "Non-Pharmacological Cognitive Enhancement," *Neuropharmacology* Vol. 64, 2013, pp. 529–543.

purported cognitive enhancement applications are now entering markets, at least in North America and Europe. Therein, yet another ethical issue relates to transparency about unknown effects of options that may require less robust testing before entering the market.[137]

Another nuanced issue is that even though most cognitive enhancements are developed to improve lives it may be the case that in sometimes enhanced capacity **does not improve quality of life or wellbeing**. First, consider happiness levels in individuals with higher-than-normal IQ compared to average IQ: one possible explanation for correlation is that higher cognitive functioning may result in an individual becoming more aware of everything they lack and thus decrease their overall wellbeing.[138] Furthermore, enhancing wellbeing in general has been shown to present many ethical challenges.[139]

Cosmetic enhancement

Cosmetic enhancements are interventions that improve the cosmetic traits of a human being. There are two subcategories of cosmetic enhancement: *aesthetic* and *body modification*. Aesthetic enhancements improve one's physical features to better accord with social ideals, such as cosmetic plastic surgery. Body modification entails augmenting oneself by introducing new (primarily) cosmetic features, such as 'installing' magnetic fingertips. Whether a body modification best fits the category of cosmetic enhancement or physical enhancement will depend on how the enhanced or new capability will be used: if it is merely a novelty, it is not a physical enhancement, but if it adds or improves functionality in a more meaningful way then it may also be a physical enhancement. Advances in prosthetic technology may lead some individuals to seek prosthetic limbs that enhance their performance beyond biological limbs and also appeal to their unique aesthetic sensibility, further blurring the line between cosmetic and physical enhancements.[140]

One of the primary aims for cosmetic enhancement is to **increase a user's self-appraisal**, helping them to feel that their appearance better conforms to the definition of beauty they and/or their society subscribes to. The ideal case of a cosmetic enhancement procedure will result in both the individual who uses a cosmetic enhancement application and the people they regularly interact with feeling the user's appearance is more appealing than before the intervention.

Widespread cosmetic enhancement may **change norms** related to appearance, confidence and/or permissibility in society. In fact, it appears there is precedence demonstrating this is already beginning to occur in societies that have embraced cosmetic surgery, for example with patients who use the techniques to appear more western-looking, such as via skin lightening, nose jobs to reduce size and eye-fold removal. Hogle notes that Asian women in the Global West often associate their natural features with dullness and passivity, and thereby attempt to embody values via cosmetic

[137] Hauskeller, Michael, *Better Humans? Understanding the Enhancement Project*, Routledge, London, 2014.
[138] Veenhoven, Ruut, and Yowon Choi, "Does Intelligence Boost Happiness? Smartness of All Pays More than Being Smarter than Others," *International Journal of Happiness and Development* Vol. 1, No. 1, 2012, pp. 5–38.
[139] Nagel, Saskia K., "Enhancement for Well-Being Is Still Ethically Challenging," *Frontiers in Systems Neuroscience* Vol. 8, 2014.
[140] Gales, Alain, "Alternative Prosthetics That 'Speak from the Soul'," *BBC News*, BBC, January 5, 2015. http://www.bbc.com/news/av/magazine-30551860/alternative-prosthetics-that-speak-from-the-soul. (especially at 03:40min): "...*the conversation changes from one of pity to one of amazement...*"

enhancement, such as independence that they associate with "Western eyes."[141] Caplan & Elliott suggest this type of procedure implicitly reinforces racist social norms that suggest Caucasian features are superior to those of other races.[142] Okopney claims this leads to a "colonization" of women's bodies all over the world to meet Western norms of beauty, meaning cosmetic enhancement threatens women's identities by monoculturalism.[143] On a more general level, as cosmetic enhancement options advance beauty norms tend to increase, making it increasingly difficult for each generation to meet the bar without technology, creating a greater dependence on cosmetic enhancement.[144]

The right to modify one's body via cosmetic enhancement remains contentious with regards to some procedures in the field. For example, Chaipraditkul argues for a laissez-faire approach, claiming everyone has the right to pursue their own image of a perfect body and to spend their money as they wish.[145] Hogle argues that having control over one's own appearance can be empowering, allowing those who use cosmetic enhancement to become active agents who can change their position and role within society.[146] However, others, such as De Sousa, argue that cultural ideals and norms exerted by popular media influence the decisions of patients to choose elective cosmetic surgeries, reducing their autonomy, or at least influencing their choices.[147] De Sousa also claims an increase in ambulatory clinics and lack of self-regulation together with poor information about risks of elective cosmetic surgeries have combined to increase the risk of proceeding with cosmetic surgery.[148] Meanwhile, a third camp, including Tiefer and Braun, acknowledges both sides of this debate, noting that choices in the modern environment are sometimes shaped by sexist thoughts and social pressures/attitudes, making the autonomy of one's choice for elective cosmetic surgery questionable.[149,150] Michala et. al. focus on cases of genital cosmetic surgery, arguing that the common concerns that often lead individuals to undergo such procedures rely on false perceptions driven by cultural pressure and poor information about potential risks.[151] The few who defend practices such as female circumcision tend to argue along the lines that prejudging cultures who value the practice amounts to a form of paternalism.

Cultural ideals related to appearance are often established through popular media. Tiefer suggests that increasing use of cosmetic enhancement is motivated by (primarily) women's desires to live up to

[141] Hogle, Linda F., "Enhancement Technologies And The Body," *Annual Review of Anthropology* Vol. 34, No. 1, 2005, pp. 695–716.
[142] Caplan, Arthur, and Carl Elliott, "Is It Ethical to Use Enhancement Technologies to Make Us Better than Well?," *PLoS Medicine* Vol. 1, No. 3, 2004.
[143] Okopny, Cara L. "Reconstructing women's identities: The phenomenon of cosmetic surgery in the united states," *University of South Florida Scholar Commons*. 2005.
[144] Tiefer, Leonore. "Female Genital Cosmetic Surgery: Freakish or Inevitable? Analysis from Medical Marketing, Bioethics, and Feminist Theory," *Feminism & Psychology* Vol. 18 (4), 2008.
[145] Chaipraditkul, Napat. "Thailand: beauty and globalized self-identity through cosmetic therapy and skin lightening," *Ethics Sci Environ Polit* Vol. 13:27-37, 2013.
[146] Ibid.
[147] De Sousa, Avinash "Concerns about cosmetic surgery," *Indian Journal of Medical Ethics* Vol. 4 (4), 2008.
[148] Ibid.
[149] Tiefer, op. cit., 2008
[150] Braun, Virginia, "Female Genital Cosmetic Surgery: A Critical Review of Current Knowledge and Contemporary Debates," *Journal of Womens Health* Vol. 19, No. 7, 2010, pp. 1393–1407.
[151] Michala, Lina, Lih-Mei Liao, and Sarah M Creighton, "Female Genital Cosmetic Surgery: How Can Clinicians Act in Womens Best Interests?," *The Obstetrician & Gynaecologist* Vol. 14, No. 3, 2012, pp. 203–206.

unrealistic ideals as a **tool that is needed for them to feel normal**.[152] Furthermore, failures to approach increasingly idealized standards could increase suicide rates and worsen the lives of people who suffer from body dysmorphic disorder. Sarwer et. al. report that "Retrospective studies of persons who have undergone cosmetic surgery or other treatments have found that greater than 90 percent experienced either no change or a worsening in their body dysmorphic symptoms," and also find the suicide rate of women undergoing cosmetic surgery is two to three times higher than expected from a normal population.[153]

Since cosmetic enhancement technologies are in many ways already established in modern society, another present aim within HET is to **offer safe, easily accessible options**. Even though the overall safety of cosmetic surgeries has improved, the technique is still, by definition, surgical. As noted in SIENNA D3.1, a long-standing issue in enhancement is the debate on what counts as enhancement vs. treatment. Atiyeh et. al. are critical about the implications of cosmetic surgery shifting from being seen as a treatment to enhancement, since the acceptability of risks and complications may be lower for elective, or otherwise 'unnecessary,' procedures.[154] Mac Pherson points out there has been a rise in nonsurgical cosmetic enhancement (i.e., "Botox® injections, collagen injections, chemical peels, laser hair removal and sclerotherapy") as demand has increased, noting that in most areas anyone with a medical license is allowed to conduct these procedures even if they don't have sufficient training or experience, as can sometimes be the case in spas and wellness centres.[155] Atiyeh et. al. further explain how salons and spas are often run by nonphysician clinicians who will hire one physician that often is not on site in order to receive medical supplies. This practice misleads patients by the promise they will receive high-quality care at low prices from such establishments, where the lack of adequate medical training or supervision poses a public safety threat.[156] Despite the safety concerns, Mac Pherson's study also shows that nonsurgical cosmetic enhancement has a high positive effect on self-esteem, self-confidence and perception of oneself.[157]

As cosmetic surgery becomes safer and less invasive, it also becomes less tightly regulated by expert professions. In turn, this allows lower level qualified people to administer such procedures, which then also opens up a consumer market around such choices. This leads to **a greater influence of fashion and lifestyle trends to influence people's decisions to seek out such changes**, rather than some notion of medical need. Although the expectation that looser standards will indeed lead to such trends remains speculative, some additional ethical issues for cosmetic enhancement become apparent when contemplating the possibility. If cosmetic enhancement becomes so ubiquitous that one's body shape or form is a fashion choice similar to one's choice of clothing,[158] there may be increased safety issues that occur long-term from routine application of cosmetic enhancement. Unless procedures are

[152] Tiefer, op. cit., 2008.
[153] Sarwer, David B., Gregory K. Brown, and Dwight L. Evans, "Cosmetic Breast Augmentation and Suicide," *American Journal of Psychiatry* Vol. 164, No. 7, 2007, pp. 1006–1013.
[154] Atiyeh, Bishara S., Michel T. Rubeiz, and Shady N. Hayek, "Aesthetic/Cosmetic Surgery and Ethical Challenges," *Aesthetic Plastic Surgery* Vol. 32, No. 6, 2008, pp. 829–839.
[155] MacPherson, Susan, "Self-Esteem and Cosmetic Enhancement," *Plastic Surgical Nursing,* Vol. 25, No. 1, 2005, pp. 5–20.
[156] Atiyeh et. al., op. cit., 2008.
[157] MacPherson, op. cit., 2005.
[158] Qureshi-Wales, Queenie, "Is Body Modification Just About Looking Good?," *European Echo*, December 14, 2017. http://europeanecho.com/2017/12/14/body-modification-just-looking-good/.

carefully regulated, the 'elective' nature of cosmetic enhancement could lead to a dearth in clinical study to ensure that routine application is safe, especially for new products and procedures. Furthermore, it is unclear who would control changes in 'body fashion' if society were to develop in such a way. Central to this is the way in which the culture of advertising is regulated alongside such procedures. If cosmetic enhancement is heavily regulated, it seems possible that government or state entities might attempt to police body fashions to limit safety risks, which raises additional issues about how much control such entities ought to have over individuals' lives. Alternatively, if body fashion is driven by consumer demand in the same way modern clothing-based fashion often is today, this could lead to swift changes that could place dangerous demands on individuals who value keeping up with the latest fashions.

The concept of a society in which cosmetic enhancement is so widely available that it enables the perception that body shape and form are malleable also highlights ethical issues related to **medicalisation** (the progressive extension of the boundaries of psychiatry, mental health practice and psychopharmacology leading to judging more "normal" emotional and social problems as targets for medical treatment), which occurs when marketers advertise products in ways that make previous norms seem like deficiencies that only the commercialised products can help with. Advertisers may work to condition the public toward believing cosmetic enhancement options are necessary to fit into society. What is considered "beautiful" in one season may be advertised as "ugly" in the next, leading some to purchase products and procedures that may be harmful with routine, long-term use.

Physical enhancement

Physical enhancements are interventions that improve or introduce new physical abilities. Potential targets for physical enhancement are *performance*, *endurance*, or the *addition of new abilities (additive)*. Performance enhancements increase the capacity to effectively complete physically demanding tasks, like running quickly or lifting heavy objects. Endurance enhancements increase the capacity to engage in physically demanding tasks for extended periods of time. In some cases, performance and endurance enhancements will overlap; i.e., a single intervention may increase performance in such a way that also improves endurance, or vice-versa. Additive enhancements add new physical abilities that an individual could not have without the enhancement, i.e. adding novel abilities, like seeing clearly in the dark.

Physical enhancement techniques include the use of anabolic steroids to increase muscle mass, "blood doping" (that improves oxygen delivery) as well as human growth hormone to increase muscle endurance and strength.[159,160] Other than biomedical interventions (such as performance enhancing drugs or gene therapy, which introduces human performance-related genes into muscle and tissue), there also exists the development of devices such as hypoxic chambers to help climbers in altitude endurance training,[161] and the "Glove®" developed by Heller and Grahn that reduces overheating from

[159] Kourany, Janet A., "Human Enhancement: Making the Debate More Productive," *Erkenntnis* Vol. 79, No. S5, 2013, pp. 981–998.
[160] Solomon, Louis M., David S. Mordkoff, and Rebekka C. Noll, "Physical Enhancement of Human Performance: Is Law Keeping Pace with Science?," *Gender Medicine* Vol. 6, No. 1, 2009, pp. 249–258.
[161] Miah, Andy, "Physical Enhancement: The State of the Art," Essay, *Enhancing Human Capacities*, Wiley-Blackwell, Chichester, 2011, pp. 266–273.

physical exertion. When this device is used by military personnel, athletes and emergency service personnel, users improved their endurance by 30-60%.[162] In the near future, prosthetics are expected to offer improved capabilities over biological limbs. Thus, there is the possibility that athletes using such artificial limbs may eventually participate in events like the Olympics, and in the further future advances in robotics and bionanotechnology may give rise to cybernetic body parts that can greatly surpass the natural human body.[163]

One general aim for physical enhancement is **to offer low-risk options**. Some of the risks associated with physical enhancement techniques, such as the use of anabolic steroids for athletes and non-athletes, include liver tumours, high blood pressure and infertility when these substances are used for a long period of time.[164] These serious risks are often coupled with only modest boosts to performance or capability. Gene therapies must first be approved by clinical regulatory bodies such as the US Food and Drug Administration (FDA) before becoming a viable enhancement technique.[165] In the context of competitive sports, the World Anti-Doping Code devised by the World Anti-Doping Agency (WADA) provides the international standard for setting the regulations that determine the testing, adjudication and punishment of athletes as well as any of their support staff who engage or assist in an athletes' use of physical enhancement techniques or substances.[166] Athletes as well as non-athletes who utilize performance enhancement substances and techniques face restrictions on their autonomy regarding what they can and cannot do to their bodies, especially if said substances and techniques are prohibited.

Beyond risks to the human body, there are also concerns about the perception of individuals who take advantage of physical enhancement techniques, specifically the perception that those who use these techniques in competitive domains **undermine their quest for authentic or traditional physical excellence**.[167] Concerns of fairness thus affects how those who make use of performance enhancement techniques and substances are seen. Equality may also be hampered as a divide emerges between enhanced and unenhanced individuals and groups.[168] Therefore, while on the one hand physical enhancement techniques may give athletes and non-athletes an 'edge' in their performance, it is also necessary to bear in mind the health risks, legal risks (such as being banned from competitive sporting events for a period of time and/or losing their accolades) and social concerns over fairness and equality. Due to these risks, not all physical enhancement techniques can be considered to improve the lives of individuals or society as a whole.

According to Lin & Allhoff, when we think of the raised levels of competition that physical enhancement could bring about we should first stress that natural advantages and inequities already exist in our current societies.[169] Differences between performance have therefore always been present

[162] Ibid, p. 268.
[163] Allhoff, F., Lin, P., Moor, J., and Weckert, J. *Ethics of Human Enhancement: 25 Questions & Answers* prepared for the US National Science Foundation. 2009.
[164] Kourany, op. cit., 2014 p986.
[165] Solomon, op. cit. 2009.
[166] Ibid, p. 254.
[167] Kourany, op. cit., 2014, p. 991.
[168] Allhoff et. al., op. cit., 2009 p. 21.
[169] Lin, Patrick, and Fritz Allhoff, "Untangling the Debate: The Ethics of Human Enhancement," *NanoEthics* Vol. 2, No. 3, 2008, pp. 251–264.

and are organic. Physical enhancement will only become a problem if enhancement technologies begin to offer huge advantages in life. "A huge advantage" is defined as someone having more access to resources than others, e.g. when an enhanced person has a better chance to secure a particular job than an unenhanced person.[170] In such cases, *in*equality may stand as a larger issue than equality: "This is where the gap between enhanced and unenhanced persons may be too wide to bridge, making the latter into dinosaurs." Individuals who choose, or worse don't have the means, to use physical enhancements could be left behind.[171] This may become especially true in highly competitive markets, where employers could coerce workers, or potentially even force them, to use physical enhancements.[172]

Furthermore, Lin & Allhoff argue that sports is a field which will change "dramatically" if enhanced people become allowed to compete alongside non-enhanced people.[173] The claim is not that enhanced people should be kept from competing alongside non-enhanced people, but that this would most likely lead to the breaking of current-held records.[174] In turn, physical enhancement would then change sports careers and adjust current sporting programs.[175] This is related to the general aim to **improve physical performance**.

A bigger issue attached to physical enhancement for Lin & Allhoff is the potential hindrance of moral development. Although they do not specifically talk about this issue in athletic performances, it seems that hindrance of moral development can be applied to anything that is perceived as an 'achievement,' including sports.[176] There is a widely held notion that achievements are hollow and worthless without struggle, sacrifice and/or effort. When technology gives us easier access or trivialises opportunities to compete without having to go through the usual struggle, some may argue we would then lose our moral character as human beings. As a response to this, however, Lin & Allhoff point out that this is a romantic notion of what it means to be human that is largely based on the frailty of the human condition.[177]

Douglas describes the ideal of struggling for your achievements in sports as the "Athenian ideal," where the outcome of the game should only be determined by natural ability.[178] In modern society (at least in the global West), the value of sports seems to be linked to the idea that natural ability brings specific athletes to the top. Effort, however, is an important factor in sports competition as well. However, Douglas points out that both factors are naïve since even the simplest of sports relies, at

[170] Ibid, Lin & Allhoff, 2008, p. 259.
[171] Ibid, Lin & Allhoff, 2008, p. 259.
[172] Firfiray, Shainaz, "Microchip Implants Are Threatening Workers' Rights," *The Conversation*, The Conversation Trust (UK) Limited, November 22, 2018. https://theconversation.com/microchip-implants-are-threatening-workers-rights-107221.
[173] Lin & Allhoff, op. cit., 2008, p. 260.
[174] McCullough, Sarah Rebolloso, "Body Like a Rocket: Performing Technologies of Naturalization," *Third Space* Vol. 9, No. 2, 2010.
[175] Lin & Allhoff, op. cit., 2008, p. 260.
[176] Mouratidou, Katerina, Dimitrios Chatzopoulos, and Sofia Karamavrou, "Moral Development in Sport Context: Utopia or Reality?," *Hellenic Journal of Psychology* Vol. 4, No. 2, 2007, pp. 163–184.
[177] Lin & Allhoff, op. cit., 2008, p. 261.
[178] Douglas, Thomas, "Enhancement in Sport, and Enhancement Outside Sport," *Studies in Ethics, Law, and Technology* Vol. 1, No. 1, 2007, pp. 1-15.

least in part, on technology: "Even in the least technology-friendly sports, such as running and swimming, some relatively high-tech equipment, training schedules, and nutritional supplements are permitted, and access to these technologies may affect outcomes."[179] Technology is and has therefore been part of and influenced sports since their genesis. The "Athenian ideal" may thus merely be an ideal that has never existed in reality. This notion could open up the discussion about what role technology, and especially more enhanced technology, plays and could play in sports. For example, perhaps society (locally or globally) could change such that a majority no longer values a 'clean' game or performance from athletes more than the entertainment derived from the spectacle of the competition itself.

Another general aim for physical enhancement is to **provide enhancement options to those who can't normally afford them**, thereby reducing inequalities. Future enhancement applications may become available that could be prohibitively expensive, and thus require some form of sponsorship for use by all but the wealthiest individuals. In this scenario, the question of ownership stands out: if an enhancement intervention involves changing the biochemistry of an individual's body, does the sponsor who pays for the intervention then come to own some part of this individual's body? Furthermore, if it turns out that ownership is shared in even minor ways, would this mean a sponsor becomes liable when a device is used outside the intended contexts?

Similar to one of the general aims for cognitive enhancement, physical enhancements are expected to be developed, at least in part, to **improve lives**. However, there may be an important differentiation between the enhancement of *capacity* (or capability) and the enhancement of *well-being*.[180] For example, If athletes undergo physical enhancement in pursuit of outdoing their competitors without considering the long-term effects of the applications they use, they may ultimately diminish the overall wellbeing in their lives.

Affective & emotion enhancement

Readers of SIENNA D3.1 will notice we have altered the description of this category enhancement from *affective enhancement* to *affective & emotion enhancement*. However, for the most part we have not modified the definition of the category; rather, we have expanded the terms used to better clarify the class of technologies we include. *Affective & emotion enhancements* are interventions that improve and/or provide greater control over a human's affect and/or emotion. Potential targets for affective & emotion enhancement are *mood, emotion* and possibly *empathy*. Mood enhancements give a user control over their mood, such as by allowing a user to quickly, perhaps (in the future) even instantaneously, transition from feeling anxious about work while at home to feeling more comfortable. Emotional enhancements alter the user's emotional state, for example by making a user feel happy quickly, or perhaps (in the future) even instantaneously, after taking a pill. In addition, emotional enhancements may be used with a clear objective to allow a user to experience what they perceive as the 'correct' emotion in some situations, e.g., when a woman who has recently given birth

[179] Ibid, p. 6.
[180] Matthews, Michael D., and David M. Schnyer, *Human Performance Optimization: the Science and Ethics of Enhancing Human Capabilities*, Oxford University Press, New York, 2019.

does not have the affective feelings for her baby that she expects.[181,182] An important research domain in affective & emotion enhancement is so-called 'love drugs' designed for individuals to improve their affective relationships. Empathy can be considered as another subcategory for affective enhancements, and includes enhancements that improve an individual's capacity to understand the affect or emotional state(s) of others.

A primary aim of affective & emotion enhancements is **to allow individuals to take control of their experiential states via technology**. Although most existing enhancement options in this category are at least related to treatments developed to alleviate depression and mental illness, the range of options is expected to develop over the next twenty years to meet this aim.[183] Furthermore, these treatments are now often prescribed to people whose condition is not recognized as illness or abnormality (i.e., nonclinical purposes). Such mood enhancers reportedly make users feel "better than well," i.e. they feel energized, more alert, more able to cope with the world, and to understand themselves and their problems.[184]

Brülde notes that cosmetic (i.e. superficial/recreational) use of mood-enhancing drugs could interact in unfortunate ways with certain tendencies of the broader culture, like reinforcing perfectionism, reinforcing certain social norms and values, and encouraging an inability to accept one's own limitations.[185]

If one becomes able to easily 'pick' how to feel by using HET, one could experience a **loss of meaning in life**.[186] By controlling one's experiential states, an individual may miss out on insights, inspirations or other valuable experiences that occur in the midst of turmoil, strife, trauma or other forms of unwanted and/or unexpected events. The consequences of this may be catastrophic in terms of being able to judge situations, but this may only be a disadvantage if one is ever without the capacity to enhance. The ethical issue here is really over whether one pre-selects enhancement to avoid the risk of dysfunction, even if it may not arise, and thus depends upon the value placed on lessons learned from hardships.

Furthermore, the introduction of a wide variety of affective & emotion enhancements that allow users to control their experiential states could lead to the **medicalisation** of socially acceptable experiential

[181] The treatment/enhancement distinction poses difficulties for this example: if such a pill is prescribed to the mother, this would clearly be a treatment. If the mother purchases the pill from a store without medical guidance, this could still be seen as a case of self-medication rather than enhancement, or as an enhancement if social expectations do not explicitly require certain affective feelings in such a case.
[182] Kahane, Guy, "Reasons to Feel, Reasons to Take Pills," Essay, *Enhancing Human Capacities*, Wiley-Blackwell, Chichester, 2011, pp. 166–178.
[183] The likelihood of such development was discussed at the SIENNA London Foresight Workshop on HET. We note that some guests disagreed with the expectation such developments will occur in the next twenty years, but this disagreement was not the majority opinion.
[184] Berghmans, Ron, Ruud ter Meulen, Andrea Malizia, and Rein Vos, "Scientific, Ethical, and Social Issues in Mood Enhancement," Essay, *Enhancing Human Capacities*, Wiley-Blackwell, Chichester, 2011, pp. 151–165.
[185] Brülde, Bengt, op. cit., 2011.
[186] Danaher, John, "Hyperagency and the Good Life – Does Extreme Enhancement Threaten Meaning?," *Neuroethics* Vol. 7, No. 2, 2013, pp. 227–242.

states.[187] Medicalisation is the progressive extension of the boundaries of psychiatry, mental health practice and psychopharmacology leading to judging "normal" emotional and social problems as targets for medical treatment. Advertisers could invest in marketing campaigns to promote 'happy' drugs as an essential ingredient for successful parties or 'sad' drugs as a vital accessory one must always have when attending funerals.[188] Even if this scenario does not occur, perhaps due to regulation forbidding the pharmaceutical companies that develop and distribute these hypothetical affective & emotion enhancers from medicalisation, the availability of such drugs could lead to similar effects via social coercion. For example, a generation that grows up with access to these drugs could naturally come to view them in the ways described above.

One of the major concerns raised in the discussion about mood-enhancing technologies is their **impact on personal identity, authenticity and personality**. Tackling these issues greatly depends on how we understand or define relevant notions, which raises a complex philosophical discussion. Vos discusses whether we need the concept of personal (or human) identity for judging the outcome of mood enhancement, whether an ethical judgment is required to evaluate what is meant by "good," "better," or "bad," and whether human beings have an obligation or duty to enhance their mood. He illustrates his point on distinguishing between two types of mood enhancing drugs: "mood-improving" drugs (SSRIs), i.e. drugs that promote positive mental states, or at least help curtail negative mental states such as depression, and "memory-smoothing" drugs (beta blockers), i.e. drugs that dilute the intensity of certain strong experiences when they are later recalled.[189]

Berghmans et. al. identify some questions which deserve attention in this context, like: How might mood enhancers affect identity?[190] Furthermore, Kahane raises the worry that the use of positive mood enhancers will corrupt our emotional lives.[191] He argues that "although [the worry] has genuine force, it does not add up to a persuasive objection to the biomedical enhancement of mood." He supports this claim suggesting "In an important respect, our emotional lives are already awry." These questions often emerge from worries related to the many ways in which enhancements that alter fundamental brain function intersects with our understanding of what it means to be a person, to be healthy and whole, to do meaningful work, and to value human life in its imperfection.

Many supporters of the biomedical enhancement of mood explicitly or implicitly base their case on the appeal to hedonic reasons (i.e., if mood enhancers make you feel better, then take the pill). There are, however, different reasons that need to be considered here – what Kahane calls affective reasons. Affective reasons indicate that "we have reasons to respond positively to the good and negatively to the bad."[192] It can be argued that affective reasons should be given priority over hedonic or pragmatic reasons, otherwise we would corrupt our emotional lives and distort our relation to what matters. For

[187] Ibid.
[188] Henry, Michael, Jennifer R. Fishman, and Stuart J. Youngner, "Propranolol and the Prevention of Post-Traumatic Stress Disorder: Is It Wrong to Erase the 'Sting' of Bad Memories?," *The American Journal of Bioethics* Vol. 7, No. 9, 2007, pp. 12–20.
[189] Vos, Rein, "What Is Good or Bad in Mood Enhancement?," Essay, *Enhancing Human Capacities*, Wiley-Blackwell, Chichester, 2011, pp. 194–206.
[190] Berghmans et al, op. cit., 2011.
[191] Kahane, Guy, op. cit., 2011.
[192] Ibid.

example, taking a mood enhancer to overcome grief would lead to feeling contrary to one's affective reasons.

Positive mood enhancers might be said to corrupt our emotional lives in two ways: first, they make us feel contrary to reason by making us feel good (or even just "neutral") when we ought to feel bad; second, even when mood enhancers make us feel good when we should feel good, they prevent us from genuinely responding to our affective reasons.[193] These objections suggest that when a person uses mood enhancers he or she is at most conforming to one's values. This can be problematic for one's authenticity (which involves being true to oneself, or at least to one's values).[194] Kahane writes: "Even if I should feel happy, because things are going so well, and a mood enhancer makes me feel happy, this happiness merely conforms to my affective reasons. For it seems that I feel happy because of the pill, not because I am responding to the fact that things are good."[195] Vos contrasts positive mood enhancers, arguing there is one clear uncontroversial position to take in the debate: that is, "mood states which generate clearly bad effects are to be prevented or interfered with in an ethically sound way."[196] As long as Vos' advice is followed, issues related to affective & emotion enhancement options that induce controversial experiential states may be avoided.

Kahane further argues that even conforming to our affective reasons is still better than nothing: "It might be best to directly feel grief in response to a loss, but if some emotional inhibition prevents this, it would still be better to feel grief by artificial means, than not to feel grief at all."[197] He responds to the conformity objection by emphasizing that we don't have a clear answer to the question what ought we to feel overall (is it better to have strong or moderate emotions; rapidly changing feelings or lasting and stable, etc.). Until we have answers to these and similar questions, how can we be confident that positive mood enhancers would corrupt our emotional lives? Ultimately, Kahane takes a favourable stance toward mood enhancers by emphasizing that people tend to agree that it's better to look on the bright side of things (i.e. the existence of good matters more than evil) and insofar as mood enhancers allow us to better respond to our positive reasons than they are something to favour.[198] Vos points out there may be a duty or obligation to pursue positive affective enhancements, depending on how one cashes out concepts like 'good' or 'bad.'[199]

Another issue is **medicalisation**, which can be taken as a wider ethical issue than discussed above. Berghmans et. al. highlight the example of shyness as indicative of a medicalisation problem, where "extreme" shyness[200] is increasingly seen as a mental illness in itself, rather than as a symptom of

[193] Ibid.
[194] Bolt, Ineke, and Maartje Schermer, "Psychopharmaceutical Enhancers: Enhancing Identity?," *Neuroethics* Vol. 2, No. 2, 2009, pp. 103–111.
[195] Kahane, op. cit., 2011.
[196] Vos, op. cit., 2011.
[197] Kahane, op. cit., 2011.
[198] Ibid.
[199] Vos, op. cit., 2011.
[200] Thanks to a reviewer for pointing out "extreme shyness" is not the terminology used in medicine, which is important to understand the ethical concern. Our point about medicalisation in this space pushes past current medical terminology in conjunction with observed sociological trends about how individuals think about shyness, i.e. the worry is that although shyness may not be a clinically diagnosed "disorder" today, our concern is that it may become such in the near future following the trend of medicalisation.

traditionally diagnosed disorders such as social phobia, social anxiety disorder and avoidant personality disorder.[201] Properly drawing the line between what is "normal" and "pathological" depends on historical, cultural and societal factors in the conceptualisation of mood, the demarcation of psychiatric illnesses and diagnoses, as well as different society-level methods for dealing with the suffering of individuals. Brülde also points out this risk, suggesting what is today regarded as "ordinary low mood" could be "pathologized" as a "larger sphere of human problems" becomes medicalised.[202] Earp et. al. also explain how these issues could creep into affective & emotion enhancement technologies designed and marketed to help with love and romance.[203]

The problem of regulation of enhancement drugs is closely related to medicalisation and questions about **risks and side effects**. In order to regulate their use, enhancement's risk-benefit ratio needs to be assessed. This entails further questions about who would be in charge of such assessment and consequently the regulation of enhancements. Schermer & Bolt point out a legitimate worry in this context is the increase of iatrogenic effects, meaning "the costs in terms of risks and side effects would not weigh up against the advantages."[204] They then note that we should look at the risks and side-effects relative to the gained benefits.

Schermer & Bolt point out further issues related to the treatment/enhancement distinction related to labels for affective enhancements. Labelling can, they claim, have different effects on persons who suffer from a disorder.[205] The distinction between treatment and enhancement (or disease and normal functioning) can have effects primarily in terms of one's self-understanding and the way they are looked upon by others. A medical label can provide certain advantages, like explaining one set of behaviour and an excuse for a different set of deviant behaviour, but it also involves disadvantages as society often frames mental disorders as taboos. On the other hand, it may appear better to avoid using disease labels for not lowering the self-image and confidence of individuals, but removing these labels entirely means leaving no explanation of why certain individuals may perform poorly or exhibit deviant behaviours following a treatment.

Another set of concerns relates to issues of agency, justice and fairness in the **access** to mood-enhancing drugs. If mood-enhancing technologies do not become available to all who might want to use them, the following questions about justice arise: *Will the use of mood enhancers lead to a competitive advantage?* and *Would opportunities for increasing welfare be unequally distributed among those who can afford to use such technologies and those who cannot afford these?*[206] Regulating access raises issues of fairness and equality from different angles. Schermer & Bolt write, "With regard to access, one might argue that if people could benefit from a drug in some way, whether this is in the form of 'treatment' or in the form of 'enhancement,' it would not be fair if access were precluded. […] Reasons to prohibit the use of such drugs might still be found, however, in their societal effects, for

[201] Berghmans et al., op. cit., 2011.
[202] Brülde, op. cit., 2011.
[203] Earp, Brian D., Anders Sandberg, and Julian Savulescu, "The Medicalization of Love," *Cambridge Quarterly of Healthcare Ethics* Vol. 25, No. 4, 2016, pp. 759–771.
[204] Schermer, Maartje, and Ineke Bolt, "ADHD and the Gray Area between Treatment and Enhancement," Essay, *Enhancing Human Capacities*, Wiley-Blackwell, Chichester, 2011, pp. 179–193.
[205] Schermer & Bolt, op. cit., 2011.
[206] Berghmans et al., op. cit., 2011.

example because they could stimulate a rat race society or create unfair inequalities."[207] Successfully navigating the regulatory landscape could prove to be one of the most pressing challenges as the field of human enhancement emerges into a clear, nuanced scientific field in its own right. Improper regulation could easily increase existing gaps between low- and high-income individuals and societies. On the other hand, if some enhancement options or techniques require expensive resources, it might not be possible to ensure low-income populations, who might benefit more, receive them. Another side of the justice argument is the possibility that mood-enhancing drugs could reduce natural inequality. However, reducing natural inequality (sometimes also called natural lottery) could reduce human diversity.

These concerns are closely related to the problem of political implications of mood enhancement. Some of the questions raised in this context are: *Is taking tablets a viable alternative to creating better communities through social and economic commitment? Is taking medicines an acceptable complement to poor housing, failing education, and unsafe local environments? Would these issues ever become "recognized public health problems" that would justify, for example, adding medicines to the water supply such as fluoride was added to prevent tooth decay?*[208] and *If such a medicine was available, would governments strive to suppress the aspects of affective functioning that are uncomfortable?* Berghmans et. al. conclude that scientific, ethical, and social issues raised by mood enhancement and alteration of personal resilience require further exploration, which needs to encompass empirical research and philosophical reflection. Institutions with political power are likely to drive regulation of many enhancement options, which subsequently means such institutions will play a critical role in deciding who gains access and how that access functions in accordance with such technologies.

Another aim of affective & emotion enhancement is to **erase negative affective** states, such as pain, suffering, or trauma. At first glance, options to remove experiences that are, by definition, negative may appear highly desirable. Liao & Roache argue that the possibility of regulating or inducing certain feelings and emotions in appropriate situations can be beneficial for a person's overall well-being, just as an inability to experience certain feelings and emotions can be frustrating and harmful.[209] However, several ethical issues emerge when considering the consequences of this kind of technology. For example, inexperience with negative affective states could lead to ineffective responses if one is without access to enhancement and must experience something negative, i.e., if one's feelings are hurt in an unfamiliar environment and their access to affective enhancements is blocked they may need to experience the hurt feelings.

Brülde points out that not all improvements on the hedonistic scale are good for an individual, i.e. suffering can have instrumental value that may outweigh its intrinsic badness.[210] Thus, some forms of

[207] Schermer & Bolt, op. cit., 2011. Further, they write "The important question in either case is who should assess this ratio and who should judge the acceptability of a specific risk–benefit ratio? Doctors or schmocters may have the best medical knowledge to assess a risk–benefit ratio, but they may be misguided due to the promotional activities of the industry or, in case of schmocters, may not always have the best interest of their clients as their guiding principle."
[208] Berghmans et al., op. cit., 2011.
[209] Liao, S. Matthew, and Rebecca Roache, "After Prozac," Essay, *Enhancing Human Capacities*, Wiley-Blackwell, Chichester, 2011, pp. 245–256.
[210] Brülde, op. cit., 2011.

affective & emotion enhancement used to avoid 'negative' experiences may cause more harm than good. In particular, Brülde makes seven claims regarding suffering: (1) Certain kinds of suffering can become a "source of knowledge"; in particular, it makes self-knowledge possible, but it can also improve the understanding of the suffering of others. (2) Certain kinds of suffering can have value for a person because it contributes to her personal development**,** i.e. because it tends to make her a better person. (3) A certain amount of suffering may be necessary for creative activity, critical thinking, or the like. (4) Certain kinds of suffering are functional, i.e. that it can (and should) be viewed as an appropriate response to an untenable situation. (5) Medication should, in some cases, be avoided because it is positively bad (apart from its more immediate side effects); e.g., Prozac® tends to affect people's opinions about what it is to be oneself, to redefine people's understanding of what is essential to them (i.e. is "me") and what is intrusive and pathological (i.e. is "not-me").[211] (6) In the long-term, people's personalities may sometimes change for the worse, e.g. a new personality may be "blander" and less complex than an old one. (7) "Successful" treatment with antidepressants might be bad because it tends to constitute a threat to our desire for "internal responsibility for our lives" as well as to our desire "to find meaning in our errors." [212]

However, the value one may derive from suffering could prove to be merely instrumental. Avoiding serious trauma could greatly improve some lives.[213] In the extreme case, the difference would be between a life ending prematurely or not. In less extreme cases, a life of prolonged suffering could be less preferable than a shorter life with less suffering.

Berghmans et al. raise the concern that affective & emotion enhancements may **undermine authenticity**, or the "authentic self," because it may lead to an individual not living their life as themselves, and thus they may miss out on what life has to offer. They suggest that a less happy but more authentic life should be considered a "higher" life "because it is a life in which a person knows who she is and lives out her sense of herself."[214] This means personality transformations resulting from these types of enhancement may be seen as either chemical makeovers, suggesting inauthenticity, or as chemical self-discoveries, which may contribute to one's sense of authenticity. Liao & Roache also raise this issue, casting it as a potential example of self-harm in the context of "whether pharmacologically induced emotions would really be "one's own."" [215] Being able to recognize how life is going for us and to bear a relation to reality might be equally or even more important than simply being happy. Liao & Roache write: "As a result, we want to be able to recognize when life is going well or badly, and to respond accordingly [… and] pharmacologically inducing emotions can drastically alter one's temperament and thereby alienate one from one's older, "genuine" self."[216] Chatterjee makes a connection to the common belief that "pain builds character," suggesting "eliminating pain undermines good character," meaning mood enhancements that erase negative affect may simultaneously result in disvalue for one's character.[217] Furthermore, Liao & Roache also point out that mood enhancements could undermine valuable opportunities to acquire self-knowledge by obscuring

[211] In addition to Brülde 2011, see Kramer, op. cit., 1997.
[212] Brülde, op. cit., 2011.
[213] Brady, Michael, *Suffering and Virtue*, Oxford University Press, Oxford, United Kingdom, 2018.
[214] Berghmans et al. op. cit., 2011.
[215] Liao & Roache, op. cit., 2011.
[216] Ibid.
[217] Chatterjee, Anjan, "The Ethics of Neuroenhancement," *Ethical and Legal Issues in Neurology Handbook of Clinical Neurology*, 2013, pp. 323–334.

uncomfortable beliefs for users via "giving affective support to the contrary beliefs [users] more readily acknowledge."[218]

Affective & emotion enhancers could affect the 'social self' and have repercussions on personal relationships (e.g., a person using enhancers not being recognized by others). Furthermore, trying to eliminate negatively valued experiences could lead to an overall lower level of well-being. Berghmans et al. explain that leading a good life and being happy seems to depend also on so-called contrast experiences (e.g., sadness, grief, and suffering are inherently part of human life, as much as are feelings of joy, happiness, and elevated mood).[219] However, Berghmans et. al. also note the questions related to changes in self-understanding are mainly speculative and at least partly empirical. Brülde suggests a further risk regarding social responsibility, in that successful mood enhancement might encourage society to ignore root causes of social problems and instead medicate its members.[220]

Moral enhancement

Moral enhancements are interventions that modulate or otherwise allow one to improve their moral bearing. Potential targets for moral enhancement range from *limited* enhancements, for example interventions designed to 'correct' behaviours considered deviant in one's society, to more *robust* interventions that greatly alter or allow for the modulation of moral deliberation. Although literature, whether in the media, via government policy or elsewhere, rarely labels existing interventions as moral enhancements, arguably the use of anaphrodisiac drugs to prevent problematic sexual behaviour may be considered a form of limited moral enhancement.[221] Another class of existing limited moral enhancements may be drugs that reduce implicit bias.[222] Robust moral enhancements have been the focus of significant debate by ethicists over the last decade.[223] A successful moral enhancer of this kind will be an intervention that alters many of the underlying characteristics within an individual that, when combined, result in enhanced moral decision-making to improve the individual's overall moral outcomes.

Douglas attempts to refute bioconservative arguments against human enhancement, i.e. claiming that engaging in biomedical enhancement is not morally permissible, by presenting moral enhancement (as

[218] Liao & Roache, op. cit., 2011.
[219] Berghmans et al, op. cit., 2011.
[220] Brülde, op. cit., 2011.
[221] See for instance Cochrane, Joe, "Indonesia Approves Castration for Sex Offenders Who Prey on Children," *The New York Times*, The New York Times, May 25, 2016. https://www.nytimes.com/2016/05/26/world/asia/indonesia-chemical-castration.html; Reilly, Jill, "Paedophile Nursery Worker Asks to Be Chemically CASTRATED to Curb His Sexual Urges ... and Says He'll Take His Human Rights Case to Strasbourg If He Has To," *Daily Mail Online*, Associated Newspapers, February 20, 2014. http://www.dailymail.co.uk/news/article-2563908/Paedophile-nursery-worker-asks-chemically-CASTRATED-curb-sexual-urges-says-hell-human-rights-case-Strasbourg-to.html; BBC. "ADHD Treatment 'May Reduce Risk of Criminal Behaviour'," *BBC News*, BBC, November 22, 2012. http://www.bbc.com/news/health-20414822.
[222] Terbeck, Sylvia, Guy Kahane, Sarah Mctavish, Julian Savulescu, Philip J. Cowen, and Miles Hewstone, "Propranolol Reduces Implicit Negative Racial Bias," *Psychopharmacology* Vol. 222, No. 3, 2012, pp. 419–424.
[223] Persson, Ingmar, and Julian Savulescu, "Getting Moral Enhancement Right: The Desirability Of Moral Bioenhancement," *Bioethics* Vol. 27, No. 3, 2011, pp. 124–131.

a whole) as a counter-argument.[224] In particular, Douglas uses the general promise of moral enhancement to counter bioconservative's arguments motivated by the following: (1) objectionable motives, (2) objectionable means, (3) objectionable consequences, (4) change in identity and (5) restrictions to freedom. If the primary aim of **improving moral decision-making** is achieved, the example of moral enhancement (in general) can prevent the negative outcomes predicted by these five objections.

Kaebnick suggests that moral enhancement is an unusual type of enhancement that might appeal even to those who oppose the general idea of altering human nature through enhancing biotechnologies (i.e., many of those who support the bioconservative's arguments against human enhancement).[225] His argument begins with an uncontroversial premise: almost everyone is in favour of improved moral behaviour. However, there are different ways of understanding what would constitute a moral enhancement. Kaebnick highlights how different views about the nature of morality and the notion of autonomy have different implications for whether, and how, moral enhancement should be carried out. He suggests that these different views make it difficult to know how to conduct moral enhancement and this consideration should lead us to be cautious about endorsing proposals to enhance morality.

It might well be, however, that moral enhancement is not only difficult to define and to bring about but actually not the best way to make moral progress. Powell & Buchanan defend this view in the same text in which Kaebnick's chapter appears.[226] They challenge proponents of moral enhancement by defending an evolutionary account of morality which conflicts with the account often assumed by such proponents. Instead, traditional defenders of moral enhancement have tended to depict morality as being dominated by in-group concerns and a lack of compassion for out-groups. However, Powell and Buchanan argue that at some point in our evolutionary history our moral psychology underwent an 'inclusivist shift' that is inconsistent with that depiction. They do not deny that we need to make moral progress to meet the challenges we face today in a globalized world, but they suggest that these challenges are better met by cultural moral enhancement than by technological moral enhancement.

However, even if the primary aim of improving one's moral decision making is achieved, this may introduce further ethical issues. For example, the use of moral enhancements could be seen as **limiting for freedom of choice**.[227,228] If robust moral enhancements become available and there is sufficient evidence to believe they genuinely improve moral decision-making, the public may come to expect individuals in some population groups to have an obligation to make use of such moral enhancement.[229] In the criminal justice system, judges could come to coerce or force criminals to use

[224] Douglas, Thomas, "Moral Enhancement," Essay, *Enhancing Human Capacities*, Wiley-Blackwell, Chichester, 2011, pp. 465–485.
[225] Kaebnick, Gregory E, "Moral Enhancement, Enhancement, and Sentiment," Essay, *The Ethics of Human Enhancement: Understanding the Debate*, Oxford University Press, Oxford, 2016, pp. 225–239.
[226] Powell, Russell, and Allen Buchanan, "The Evolution of Moral Enhancement," Essay, *The Ethics of Human Enhancement: Understanding the Debate*, Oxford University Press, Oxford, 2016, pp. 239–261.
[227] Harris, John, "Moral Enhancement And Freedom," *Bioethics* Vol. 25, No. 2, July 2010, pp. 102–111.
[228] Shook, John R., "Is Moral Enhancement a Right, or a Threat to Rights?," *Royal Institute of Philosophy Supplement* Vol. 83, 2018, pp. 209–231.
[229] Persson, Ingmar, and Julian Savulescu, *Unfit for the Future: the Need for Moral Enhancement*, Oxford University Press, Oxford, 2014.

moral enhancement for behavioural correction.[230] Alternatively, if a person using moral enhancements undertook a crime, the question of liability could instead turn and possibly implicate the developers of the drug (most likely a pharmaceutical company) for some kind of product failure.

Moral enhancement use for behavioural correction may not be limited to criminal justice cases.[231] Another general aim of moral enhancement is to **reduce immoral decision-making**. However, it is not always clear what authority "correct" behaviour ought to come from. Depending on the behaviour in question, sources can include religion, ethics, science or even long-held tradition. If a robust moral enhancement leads to a tendency to adopt a particular ethical framework, individuals who subscribe to traditions whose teachings conflict with that framework may find the use of such interventions problematic. Indeed, there are occasions when civil disobedience is the appropriate response to authority.

Longevity enhancement

Longevity enhancements are interventions that extend a human's expected lifetime. Longevity enhancements may be *preventative* or may improve one's *senescence* or *durability*. Preventative enhancements stop or reduce negative effects of disease or disability, such as a vaccine. Senescent enhancements stop or slow the aging process of the body. Durability enhancements improve one's ability to survive or recover from harm or damage. Longevity enhancements are one of the hardest categories of HET to classify since almost all modern technologies that could fit the category are better understood as and seen as treatments, while the anticipated enhancements in the category tend to be highly visionary and often fall outside our aim to focus on ethical issues of HETs expected within the next 20 years.

One of the fundamental aims of longevity enhancement is to **extend--potentially indefinitely--the length of the human life span**. If such technology is developed, few people would die of old age, although other natural causes, such as illness, or non-natural causes, such as accidents, could still result in death. However, if most humans suddenly have a significantly increased life expectancy due to life extension technology, several ethical issues arise, such as overpopulation, burdens on the environment and burdens upon young(er) generations.

The planet may have a "carrying capacity" for the amount of human beings that can live sustainably. It is not our intention to answer the question of whether or not there is, in fact, some certain numerical population past which planet Earth can no longer sustain humanity, therefore it is beside the point to spell out the details of theories related to this question, such as the specific issues that arise from Hardin's so-called "tragedy of the commons."[232] Rather, what we are concerned with is that the advent of successful life extension technologies may stand as an important factor in regards to sustainability in both regional and global situations. This concern is observed by Allhoff et. al.[233], among others,

[230] Shaw, Elizabeth, "Offering Castration to Sex Offenders: the Significance of the States Intentions," *Journal of Medical Ethics* Vol. 40, No. 9, 2013, pp. 594–595.
[231] Specker, Jona, Farah Focquaert, Kasper Raus, Sigrid Sterckx, and Maartje Schermer, "The Ethical Desirability of Moral Bioenhancement: a Review of Reasons," *BMC Medical Ethics* Vol. 15, No. 1, 2014.
[232] Hardin, Garrett, "The Tragedy of the Commons," *Science* Vol. 162, No. 3859, 1968, pp. 1243–1248.
[233] Allhoff, Fritz, Patrick Lin, and Jesse Steinberg, "Ethics of Human Enhancement: An Executive Summary," *Science and Engineering Ethics* Vol. 17, No. 2, 2010, pp. 201–212.

noting that an overcrowded planet will put extra pressure on natural, and in-particular non-renewable, resources. An overpopulated country will have trouble providing the elements necessary for a successful life to all individuals living there, and this can also apply at the global scale.

Temkin considers one solution for general overpopulation issues due to life extension may be for humanity to expand our natural habitat to outer space, thus reducing burdens on planet Earth.[234] The feasibility of this solution is difficult to judge, especially within the next 20 years, but so too is the feasibility of developing the type of life extension technology that could genuinely cause damaging overpopulation issues. Bostrom & Roache suggest overpopulation may not be cause for great concern, at least in the short-term, observing that growth in the standard of living within a country appears to coincide with a reduction in birth-rate, and thus they argue that the best solution to overpopulation issues with life extension technology is to increase the standard of living and education in lower and middle-income countries.[235] Furthermore, there is a great deal of work that may be done to more evenly distribute populations and resources across geographic space, before overpopulation may be characterised as a legitimate concern. Historically, the accumulation of people around mega-cities over the last 20th century may be to the wider detriment of life on earth and be a wholly inadequate means of managing population growth, but some critical and significant politico-economic transformations are required to address these problems.

Closely related to overpopulation is the issue of **environmental and generational burdens**. If the average natural age rises even modestly, Fritz et. al. note that adjustments must be made by society to solve financial conflicts, such as changing the retirement age and rethinking the framework behind concepts such as pension systems.[236] Temkin further suggests that people may resist increasing the retirement age, because some may not want to continue working past a certain point.[237] However, Bostrom & Roache note that society already promotes 'life extension' via safety gear, modern medicine and other practices, and thus they suggest addressing specific concerns for life extension technology requires new paradigms, because these technologies will increase a human's "healthspan," i.e. the sustainability of their capacities, alongside lifespan.[238] Although a healthier elderly population may change the dynamic in elder-care and economic contribution to society from this group, Barazzetti also notes that life-extension technology may harm younger generations due to significantly increasing competition on the job market.[239]

Life extension may introduce further issues related to **intergenerational justice**, as noted by Mordacci. He points out that life-extending technologies prolong each life stage, further increasing various burdens previously discussed (financial, environmental, etc.) each time a new generation begins.[240]

[234] Temkin, Larry, "Is Living Longer Living Better?," Essay, *Enhancing Human Capacities*, Wiley-Blackwell, Chichester, 2011, pp. 350–367.
[235] Bostrom, Nick, and Rebecca Roache, "Ethical Issues in Human Enhancement," *New Waves in Applied Ethics*, Pelgrave Macmillan, 2008, pp. 120–152.
[236] Allhoff et. al., op. cit., 2010.
[237] Temkin, op. cit., 2011.
[238] Bostrom & Roache, op. cit., 2007.
[239] Barazzetti, Gaia, "Looking for the Fountain of Youth: Scientific, Ethical, and Social Issues in the Extension of Human Lifespan," Essay, *Enhancing Human Capacities*, Wiley-Blackwell, Chichester, 2011, pp. 398–409.
[240] Mordacci, Roberto, "Intergenerational Justice and Lifespan Extension," Essay, *Enhancing Human Capacities*, Wiley-Blackwell, Chichester, 2011, pp. 410–420.

Furthermore, Barazzetti notes that the burden on natural resources due to population growth is also likely to change the difference in opportunity between wealthy and low & middle-income countries because such technology is likely to appear first in the most developed regions.[241]

Furthermore, there are specific ethical issues related to who will gain **access** to life extension technologies. For instance, Overall identifies that life expectancy varies depending on factors such as gender, race and socioeconomic class.[242] For the sake of equality, she argues, society must erase some of this variability. In addition, this existing variability could lead to only the wealthy and elite using life extension technology due to economic factors. The most powerful members of society, with life-extension ensuring they continue to live and have the opportunity to impact the world, could choose to consolidate their power and limit life-extension outside of their class. This consolidation could come about via subtle manoeuvres such as buying the companies that produce life-extension technology or more overt manoeuvres such as hiring paramilitary organisations to seize the production sites and stocks of this technology. Overall encourages the focus in life extension tech development to fall on prolonging the lives of those who have not had the opportunities to make the most of their present life. Temkin expands this worry to also apply to political and social dynamics, noting that political power tends to reach its apex only after several decades, thus individuals with such power could utilize life extension in attempt to consolidate their power and ensure younger generations never have the chance to promote their different political ideals.[243] Barazzetti notes, too, that a larger group of older citizens participating in the voting process could cause similar political issues.[244] Young, healthy individuals will not be in a position to utilize longevity enhancements to increase their political impact until they are no longer young and/or healthy, at which point their perspectives may have morphed, either naturally or via a variety of other possible influences, to conform to those of the older generation.

Underpinning the rationale to promote longevity enhancements is the proposition that it is appropriate to treat aging as a disease, rather than a condition of life and this idea has been championed especially by biogerontologist Aubrey de Grey.[245] However, several philosophers[246,247] have analysed the possibility for life extension technology to potentially contradict another general aim of longevity enhancement: to **lead to not just longer but more meaningful lives**. Bernard Williams gave one of the earliest modern arguments suggesting the prospect of immortality may in fact be something to avoid due to boredom.[248] Without the knowledge that one's life will have a definite ending, roughly within a certain amount of time, Williams suggests that life could lose its meaning, as personal ambitions and goals are achieved or given up. Temkin also raises this worry, questioning

[241] Barazzetti, op. cit., 2011
[242] Overall, Christine, "Lifespan Extension: Metaphysical Basis and Ethical Outcomes," Essay, *Enhancing Human Capacities*, Wiley-Blackwell, Chichester, 2011, pp. 386–397.
[243] Temkin, op. cit., 2011.
[244] Barazzetti, op. cit., 2011.
[245] Volpicelli, Gian, "Meet Aubrey De Grey, the Researcher Who Wants to Cure Old Age," *Vice*, VICE, May 23, 2014. https://www.vice.com/en_us/article/mgbb9v/meet-aubrey-de-grey-the-researcher-who-wants-to-cure-old-age.
[246] Temkin, op. cit., 2011.
[247] Williams, Bernard, "The Makropulos Case: Reflections on the Tedium of Immortality," *Problems of the Self*, 1973, pp. 82–100.
[248] Williams, op. cit., 1973.

whether we will retain the passion to start from the bottom to learn new disciplines over and over again to avoid boredom over an indefinite lifetime.[249] However, Glover doubts this, arguing that:

> "I am not convinced that someone with a fairly constant character need eventually become intolerably bored, so long as they can watch the world continue to unfold and go on asking new questions and thinking, and so long as there are other people to share their feelings and thoughts with. Given the company of the right people, I would be glad of the chance to sample a few million years and see how it went"[250]

Bostrom & Roache also respond to Williams' argument suggesting that individuals would set different goals if they could know their lifespan would be radically longer than what is currently possible.[251] Individuals could choose projects expected to take centuries to complete, rather than focusing on achieving common 'long-term' goals that take decades today. Overall responds to Williams' argument suggesting that little things in life, such as enjoying a meal or spending time with family, are "renewable resources" that will enable users of life extension technology to avoid boredom.[252] Whether the average individual might tire of such "renewable" activities is an empirical question, although it stands to reason that, for example, one might be able to enjoy a wide assortment of different meals over the course of several years such that they have a newly positive experience with the same food they tried a decade ago but haven't experienced since.

Kass also argues that meaning comes, at least in part, from recognizing and appreciating life because we are aware of its limited time frame.[253] Following this reasoning, if life can be extended indefinitely, then we may lose touch with notions that commonly seem to instil meaning into our lives and the possibility of death. However, Temkin argues that it may be better to never lose a loved one than to know the value of life that emerges from knowing its fragility, making this potential loss of meaningfulness preferable to the effects of death.[254] Temkin also points out, as noted above, that life extension by itself will not necessarily lead to a total loss of death in human society, since death by accident, war or disease are likely to still apply and could preserve the sense of meaning discussed by Kass. Another loss in meaningfulness may come from the loss of the social aspect of death, according to Lafontaine.[255] The prospect of dying due to old age is a norm that tempers certain social traditions and tendencies, for example in terms of the role of caretaker shifting from parent caring for their children to children caring for their parent. In a society where death only occurs due to accidents, disease or malfeasance, these social aspects may be lost.

Longevity enhancements may **complicate concepts of identity**. Barazzetti suggests life extension could cause a lack of continuity between the mental states of one's early life and one's life more than a century later.[256] If psychological continuity is a necessary ingredient to ensure personal identity, this

[249] Temkin, op. cit., 2011.
[250] Glover, Jonathan, *Causing Death and Saving Lives*, Penguin Books, Harmondsworth, Middlesex, 1988.
[251] Bostrom & Roache, op. cit., 2007.
[252] Overall, op. cit., 2011.
[253] Kass, Leon R., *Toward a More Natural Science*, Free Press, 1985.
[254] Temkin, op. cit., 2011.
[255] Lafontaine, Céline, "Regenerative Medicine's Immortal Body: From the Fight against Ageing to the Extension of Longevity," *Body & Society* Vol. 15, No. 4, 2009, pp. 53–71.
[256] Barazzetti, op. cit., 2011.

could be a serious metaphysical problem for such enhancement. However, many theories of identity reject the need for mental continuity from life-state to life-state, and it's unclear what would practicably be lost, i.e. how the living one does through their life might change, if Barazzetti's theory is correct. For example, Overall refutes a similar argument from Williams, who suggests an individual whose personality has changed since their childhood should be seen as a wholly different individual if the changes are significant enough, arguing that as long as life choices are made consciously then there is no harm to one's identity as one's personality changes over time.[257]

Some philosophers have pointed out longevity enhancements may result in new or worsened forms of **discrimination**. For example, Lafontaine observes that increased life expectancy to date has led to the undervaluing and denigration of older people, who are increasingly treated as children and denied their identity.[258] Although the general debate tends to frame life-extension technology as an option that will improve the autonomy of "elderly" individuals, Lafontaine raises a compelling possibility that could emerge if society fails to more adequately find value in the experiences of the elderly. If life extension merely prolongs life without reducing the sources of reduced functioning often at play in the infantilization of the elderly today, those who choose to use life extension may find themselves treated with far less autonomy than they may expect. In addition to discrimination, longevity enhancements could further exacerbate **inequality**, depending on who receives the enhancements. If the technology enters a free consumer market at a prohibitively high cost, then it's likely only the wealthiest individuals will use the technology, deepening existing inequalities between classes. This points to the need for dramatic social reconfigurations, rather than, necessarily, to the rejection of life extension.

Bond points out how longevity enhancements could change the structure of families and kinship, increasing the importance of friendship, resulting in **changes to social relations and structures**.[259] In modern society, grandparents often play an active role in their grandchildren's upbringing, and rarely great grandparents also help out for the earliest years of a child's life. With life extension, the number of simultaneously-existing generations could complicate relationships, as great-great-great-great-grandparents (etc.) co-exist with their youngest kin. Furthermore, concepts like marriage could be strained when a "lifetime" relationship has a literally indefinite endpoint, compared to modern lifetimes rarely surpassing 100 years. Temkin further observes that intergenerational differences may become less important when contemplating families coexisting for many centuries, requiring changes to family structures.[260] Potential changes could be positive or negative, such as increases of cases of polygamy or incest, or a greater or lesser importance of family loyalty and duty.

5.2 Ethical issues with regard to fundamental techniques, methods and approaches

Machine/AI/computer-based augmentation

[257] Overall, op. cit., 2011.
[258] Lafontaine, op. cit., 2009.
[259] Bond, John, "Enhancing Human Aging: The Cultural and Psychosocial Context of Lifespan Extension," Essay, *Enhancing Human Capacities*, Wiley-Blackwell, Chichester, 2011, pp. 435–452.
[260] Temkin, op. cit., 2011.

Computational means of achieving human enhancement can be framed in terms of external hardware and software systems that aim to amplify an individual's abilities. These systems are developed from the convergence of fields including nanotechnology, biotechnology, information technology and cognitive science that provide insights into brain structure and function, along with how signals are processed in the interaction of interfaces between sensors, computers, brains and prosthetic devices.[261] Such amplification can come from personal computers, and their software used for displaying information in multiple visualized ways, keeping diverse items and files in memory, as well as data mining to process volumes of information that human perceptual systems cannot hold.[262] In the context of therapeutic interventions, there are assistive technologies for cognition (ATC) that address functional activities that require cognitive skills such as attention, executive reasoning, prospective memory and self-monitoring either for enhancement or inhibiting specific behaviours, which may be further developed for enhancement purposes.[263]

Developments in ATCs has also allowed for greater links between human users and external systems, i.e. through the use of virtual and smart environments and wearable devices that display significant informational cues to assist users with their day to day activities. These technologies make it possible for the storage and retrieval of information, which traditionally is performed by an individual's brain, to be offloaded to these external devices, while still requiring the reasoning of individuals to properly utilize them.[264] ATCs range from personal digital assistants (PDAs)[265], alarms that remind individuals of their medication schedules (as well as provide guidance on recognising medication and dosage) up to interactive robotic caregivers.[266]

Another class of AI/machine-based enhancement is found in more invasive computational technologies, which include the use of brain-computer interfaces, cochlear implants (used to regain hearing), artificial retinas and functional electric stimulation for paralysis treatment.[267] These technologies aim to intervene with physical and cognitive deficits, but may in future be used by healthy individuals to be able to access and control software tools, the Internet and virtual reality applications, as well as hardware devices such as robotic limbs.[268] In applications where these interventions give greater mobility and cognitive functionality to individuals who may lack these functions (for instance, using deep brain stimulation to treat individuals with Parkinson's[269]), these technological

[261] Sarewitz, Daniel R., and Thomas H. Karas, "Policy Implications of Technologies for Cognitive Enhancement," January 2007.
[262] Bostrom and Sandberg, op. cit., 2009, p. 320.
[263] LoPresti, Edmund Frank, A Mihailidis, and N Kirsch, "Assistive Technology for Cognitive Rehabilitation: State of the Art," *Technology in Cognitive Rehabilitation* , Psychology Press Ltd, New York, 2004.
[264] Ibid, Bostrom and Sandberg, 2009, p. 320.
[265] Kapur, Narinder, E. L. Glisky, and B. A. Wilson, "Technological memory aids for people with memory deficits" *Technology in Cognitive Rehabilitation* , Psychology Press Ltd, New York, 2004.
[266] LoPresti et. al., op, cit., 2004, p. 6.
[267] Bostrom & Sandberg, op. cit., 2009, p. 321.
[268] Ibid, p. 321.
[269] Wolpe, Paul Root, "Neurotechnology and Brain-Computer Interfaces: Ethical and Social Implications," *Emerging Technologies and Ethical Issues in Engineering: Papers from a Workshop*, The National Academies Press, Washington , DC, 2004, pp. 57–66.

enhancements can therefore play a positive role in improving the autonomy of individuals (such as through the use of intelligent cognitive assistants to enable the elderly to live independently).[270,271]

However, one of the issues that these enhancements entail is how they are marketed. Individuals may have their **choices manipulated** if AI/machine enhancements are packaged as products individuals must have in the increasingly information-based modern era. Consequently, not just the body but also the minds of individuals will be treated as objects that can be improved and upgraded not for the sake of the individual, but as expressions of a technocratic mindset turning 'human nature' into a project of technological mastery.[272] Technological enhancement can therefore also be a cause for **changing prevailing notions such as human dignity**, especially when they comprise any of the following essentialist values: i) violating species boundaries by diminishing the boundary between human bodies and artificial devices; ii) limits are part of existence, and the capabilities afforded by technological enhancement trounce the limits of what humans can control; iii) modifying human nature goes against theistic beliefs about humans being made in God's image; iv) if these enhancements are based on market interests then these interests may go against the collective good; v) these enhancements may go against intangible and aesthetic values such as beauty, appropriateness and repugnance ("yuk factor").[273]

A further issue is the **cost and ownership** of AI/machine enhancement devices. If such devices prove to be exceptionally expensive, only the wealthy or corporate/government agencies could come to afford them. This raises ethical issues about who owns the device, especially if it must be implanted into one's body (perhaps even their brain) to use. In addition, the modern era has shown us how disposable new technological devices can be. If expensive AI/machine enhancements follow the same business model as high-end smart phones, for example, adopters may end up at risk of requiring frequent maintenance that could also prove to be expensive. Yet, it is more likely that the trend of emerging technologies always being initially accessible to only a few would continue, unless there is a radical change in the circulation of intellectual property associated with research and development. In this respect, the solution to the problem of unevenly distributed enhancements would be to continue the trend towards open IP and open source technology to remove the possibility of exclusivity.

Current machine-based cognitive enhancement devices offer modest benefits at best.[274] In a competitive market, advertisers may **overhype benefits and obscure risks** of the devices they promote. A regulating agency could potentially help to mitigate this issue, although the speed of development of new devices may make the regulation of such a market difficult to enforce.

[270] Bostrom and Sandberg, op. cit., 2009, p. 327.
[271] Sonntag, Daniel, "Kognit: Intelligent Cognitive Enhancement Technology by Cognitive Models and Mixed Reality for Dementia Patients," *Cognitive Assistance in Government Papers from the AAAI 2015 Fall Symposium*, AAAI Conferences, Palo Alto, CA, 2015, pp. 47–53.
[272] Bostrom and Sandberg, op. cit., 2009, p. 326.
[273] Sarewitz and Karas, op. cit., 2007, p. 19.
[274] Maslen, Hannah, Thomas Douglas, Roi Cohen Kadosh, Neil Levy, and Julian Savulescu, "The Regulation of Cognitive Enhancement Devices: Extending the Medical Model," *Journal of Law and the Biosciences* Vol. 1, No. 1, 2014, pp. 68–93.

One final ethical issue for AI/machine-based enhancement relates to the so-called "black box" problem facing some domains in AI.[275] If an individual implants an AI-controlled directly into their brain such that it regularly 'overrides' biological signals, questions of **control** arise. This type of 'cyborgisation' could lead to the advent of a new species,[276] in which cognitive capability is driven not solely by a biological (human) brain but also the machinery implanted into it.[277]

Prosthetics

According to McGimpsey & Bradford, prosthetics can be defined as "an artificial extension that replaces a missing body part such as an upper or lower body extremity."[278] There are four types of prosthetics commonly used today: transradial (an artificial limb that replaces an arm below the elbow), transhumeral (an artificial limb that replaces an arm above the elbow), transtibial (an artificial limb that replaces a leg missing below the knee), and transfemoral (an artificial limb that replaces a leg missing above the knee).[279] The leading causes for the loss or partial loss of a limb are diabetes, peripheral vascular disease, accidents and war.[280]

McGimpsey & Bradford warn about the **financial costs** of prosthetics, especially regarding reimbursement issues: "The high cost of innovative prostheses coupled with third party payer restrictions create a death in the [United States] market, which cannot be overcome by out-of-pocket payments."[281] If prosthetics that enhance capabilities beyond 'natural' human ability remain expensive, many individuals and societies are unlikely to gain access to such enhancement options. One way to make prosthetics more affordable is through 3D-printing. Choonara et al. explain that 3D-printing could lower the production costs of prosthetics and allow re-prints of defective or damaged prosthetics making the process easier, faster and, hence, cheaper.[282] However, it remains to be seen if all components for advanced prosthetics will benefit from new production methods such as 3D-printing, or whether such techniques will only increase access to prosthetics that return capability to the 'normal' level.

Military prosthetics can lead to **issues of control and ownership**. For example, a military exoskeleton, which is a type of prosthetic controlled by cybernetic implants, could be subject to interference by the

[275] Guidotti, Riccardo, Anna Monreale , and Dino Pedreschi , "The AI Black Box Explanation Problem," *ERCIM News* Vol. 116, January 2019, pp. 12–14.
[276] Thweatt-Bates, Jeanine, *Cyborg Selves: a Theological Anthropology of the Posthuman*, Routledge, Taylor & Francis Group, NY, NY, 2016.
[277] Barfield, Woodrow, and Alexander Williams, "Cyborgs and Enhancement Technology," *Philosophies* Vol. 2, No. 4, 2017, p. 4.
[278] McGimpsey, Grant, and Terry C. Bradford, *Limb Prosthetics Services and Devices Critical Unmet Need: Market Analysis*, National Institute of Standards and Technology, Gaithersburg, MD, 2015.
[279] Ibid, pp. 3-4.
[280] Ibid, p. 4.
[281] Ibid, p. 5.
[282] Choonara, Y. E., L. C. du Toit, P. Kumar, P. P. Kondiah, and V. Pillay, "3D-Printing and the Effect on Medical Costs: a New Era?," *Expert Review of Pharmacoeconomics & Outcomes Research* Vol. 16, No. 1, 2016, pp. 23–32.

soldier's State or another third party such as a hacker.[283] This would consequently lead to the wearer of the exoskeleton losing control over his/her prosthetics. At the same time, it poses the question of who is in control if the exoskeleton can be controlled by outsiders. Another issue revolves around an outsider being able to control a soldier's finger on a weapon's triggering mechanism.[284] This leads to issues of responsibility. For example, in a case where an exoskeleton is hacked by a third party and forces the soldier to act in a certain way or commit a certain act, the question comes up whether the soldier still can be held accountable or responsible for his actions.[285]

Since 2017, prosthetic technology has seen major developments, such as prosthetics with sensory feedback, prosthetics linked to neural interfaces to provide thought-controlled movement, and even optical prosthetics that restore or augment vision.[286] Due to these huge technical developments in prosthetics, **the line between therapeutic purposes and enhancement has become blurrier**. Distinguishing this line is especially important in healthcare, where decisions must be made about how to expend limited resources, sometimes in ways that result in life or death. In order to draw a clear distinction between these two different interventions, both require clearer definition.

Therapeutic purposes can be defined as interventions which restore and replace lost bodily functions. Enhancement, on the other hand, can be defined as the application of science and technology to expand cognitive and physical capacities.[287] The latter is therefore focused on improvement of already existing natural capacities, which can range from appearance to mental and physical functioning.[288] Enhancement is meant to surpass what is considered to be a 'normal' or necessary intervention to sustain a patient's health, life or well-being.[289] However, even though there is a theoretical difference between therapeutic purposes and enhancement, in practice it is difficult to make a clear distinction between the two interventions.

Hogle claims that the difference between therapeutic interventions and enhancement lies in the concept of 'normal'.[290] According to Hogle, a societal or cultural norm can be described as trying to fit all people "somewhere along a distribution curve." The idea of normality has the effect that the norm becomes something people ought to be. The norm is then no longer a neutral, centred position to take, but something to strive for. Simultaneously, being average then becomes deficient. Enhancements, in such a case, could become used for maintenance or needed self-improvements, rather than a luxury. Thus, whether an intervention can be seen as therapeutic or as enhancement is dependent on the norms we manage in a specific context in a specific time.

[283] Dinniss, Heather A. Harrison, and Jann K. Kleffner, "Soldier 2.0: Military Human Enhancement and International Law," *Dehumanization of Warfare*, Springer, Cham, Switzerland, 2018, pp. 163–205.
[284] Ibid, p. 197.
[285] Ibid, p. 198.
[286] Ibid, p. 165.
[287] Ma, Eunjeong, "Body and Enhancement Technology: An Introduction," *East Asian Science, Technology and Society* Vol. 10, No. 1, September 2015, pp. 1–4.
[288] Hogle, op. cit., 2005.
[289] Ibid, p. 697.
[290] Ibid, p. 697.

A further ethical issue for prosthetics is whether there ought to be different guidelines for **private vs professional use**.[291] Many existing prosthetics are devices used by individuals both in the home and workplace, which return their capability close to 'normal' functioning. However, large prosthetics, such as military exoskeletons discussed above, and also including private-sector exoskeletons, i.e. for lifting heavy objects in warehouses, may become commonplace in professional/work environments but prove to be too cumbersome for common use at home. If the capabilities of some prosthetic devices are significantly different than others, i.e. an exoskeleton may enable a user to forcibly breach a reinforced door whereas a prosthetic arm would only allow the individual to operate a handle or keys, there may be a need for ad-hoc regulation based on the capabilities granted by the prosthetic device.

Although unlikely to raise concerns in the near future, eventually prosthetics may not be confined to athletic performance. Prosthetic eyes, ears or other sensory organs could be developed, leading to further ethical questions about sensory prostheses, which currently include devices that restore some sensory function for individuals who lose or naturally have diminished sensory capability, such as hearing aids. Although ocular prosthetics have a long way to go before becoming as ubiquitous as non-invasive hearing aids, the future looks promising.[292] Future devices raise the empirical question of whether technology can surpass the maximal capacities of healthy biological organs. Studies on vision, for example, demonstrate some of the challenges that must be overcome by future devices if they are to enable enhancement by suggesting the human visual system utilises pre-cognitive computation for tasks like shape recognition.[293,294] If hurdles can be overcome, perhaps by offloading visual processing to an external device (already investigated in some experiments[295]), then some day optical prostheses could come to not just enhance capacities above healthy norms, but also potentially expand one's visual abilities. For instance, in the future a prosthetic eye might be designed to 'flag' features of the environment to more easily identify items in one's periphery, an auditory prosthetic could automatically upload sounds processed by the device to cloud storage, an olfactory prosthetic could distinguish a victim's scent for a criminal, or tactile feedback on a prosthetic finger could be increased to detect the sensation from a locking mechanism hitting the proper numbers of a combination lock sequence, raising ethical issues about privacy, security, liability and more.

3D-Printing & tissue-engineering

[291] Brown, Abbe, Shawn H. E. Harmon, Rory O'Connor, Sita Popat, and Sarah Whatley, "Body Extension and the Law: Medical Devices, Intellectual Property, Prosthetics and Marginalisation (Again)," *Law, Innovation and Technology* Vol. 10, No. 2, March 2018, pp. 161–184.
[292] Zrenner, Eberhart, Karl Ulrich Bartz-Schmidt, Heval Benav, Dorothea Besch, Anna Bruckmann, Veit-Peter Gabel, Florian Gekeler, et al., "Subretinal Electronic Chips Allow Blind Patients to Read Letters and Combine Them to Words," *Proceedings of the Royal Society B: Biological Sciences* Vol. 278, No. 1711, 2010, pp. 1489–1497.
[293] Firestone, Chaz, and Brian J. Scholl, "'Please Tap the Shape, Anywhere You Like,'" *Psychological Science* Vol. 25, No. 2, 2014, pp. 377–386.
[294] Potter, Mary C., Brad Wyble, Carl Erick Hagmann, and Emily S. Mccourt, "Detecting Meaning in RSVP at 13 Ms per Picture," *Attention, Perception, & Psychophysics* Vol. 76, No. 2, 2013, pp. 270–279.
[295] Nirenberg, S., and C. Pandarinath, "Retinal Prosthetic Strategy with the Capacity to Restore Normal Vision," *Proceedings of the National Academy of Sciences* Vol. 109, No. 37, 2012, pp. 15012–15017.

The fields of tissue engineering and regenerative medicine primarily aim to restore the impaired function of cells, tissues or organs through repairing, replacing and regenerating these components of the body through the use of 3D printing, patterning and assembly techniques that make use of what are referred to as biomaterials (human cells combined with synthetic materials).[296,297] Beyond the use of tissue engineering to supplement the demand for tissue grafts and organ transplants, 3D printed products are also used in research, pharmaceutical drug testing, and for modelling diseases.[298] As such, beyond the more utilitarian concern of providing greater availability of artificial tissues and organs for patients in need, these products also have a commercial value, especially when they become patented by the institutions and researchers that create them.[299] There are a number of 3D-printing devices, including inkjet, bioextrusion and laser-assisted printers, and there are also rational design and autonomous self-assembly based techniques for the patterning and assembly of artificial components.[300]

The viability and benefits of these printed products depends on the clinical testing that they must be put through, given the fact that the patients these artificial components are inserted into may experience unknown side effects. An additional concern is that that end-stage patients may wish to undergo clinical trials using these interventions with high expectations, but they may be desperate for treatment without taking into consideration the risks involved.[301] More so, the hope of 3D-printed tissues and organs being available for all immediately may not be a real promise, as it is more likely that **wealthier individuals and groups will benefit first**, while those who cannot will have to rely on waiting for traditional organ transplants.[302] It is also possible that these artificial tissues and organs may be used for more than just restoring or sustaining individual's health, and could become useful for enhancing human performance (for instance printing bionic ears or eyes) as well as human longevity through attempts at prevention and treatment of degenerative diseases.[303] In such applications, these 3-D printed products could go beyond being constructed and used for exclusively therapeutic purposes.

The combined issues of **cost and therapy vs enhancement** raise an interesting problem: it is likely that the cost of 3D-printing devices, required for the generation of 3D-printed products, will remain expensive, especially as new techniques and innovations push the field forward. Once 3D-printed enhancement options become available, a company could attempt to create a for-profit market of such applications. However, the technology this company uses could also be used to supply 3D-printed

[296] Otto, I A, C C Breugem, J Malda, and A L Bredenoord, "Ethical Considerations in the Translation of Regenerative Biofabrication Technologies into Clinic and Society," *Biofabrication* Vol. 8, No. 4, July 2016, p. 042001.
[297] Vermeulen, Niki, Gill Haddow, Tirion Seymour, Alan Faulkner-Jones, and Wenmiao Shu, "3D Bioprint Me: a Socioethical View of Bioprinting Human Organs and Tissues," *Journal of Medical Ethics* Vol. 43, No. 9, 2017, pp. 618–624.
[298] Ibid, p. 1.
[299] Vermeulen et. al., op. cit., 2017, p. 4.
[300] Bishop, Elliot S., Sami Mostafa, Mikhail Pakvasa, Hue H. Luu, Michael J. Lee, Jennifer Moriatis Wolf, Guillermo A. Ameer, Tong-Chuan He, and Russell R. Reid, "3-D Bioprinting Technologies in Tissue Engineering and Regenerative Medicine: Current and Future Trends," *Genes & Diseases* Vol. 4, No. 4, 2017, pp. 185–195.
[301] Otto et. al., op. cit., 2016, p. 4.
[302] Vermeulen et. al., op. cit., 2017, p. 4.
[303] Otto et. al., op. cit., 2016, p. 5.

organs to treat patients who may require them to survive. Thus, is there an ethical line beyond which the profit motive in this space ought to be prohibited? In other words, what (if any) are the cases in which producing 3D organs becomes unethical?

Genetic interventions

There is a strong concern that genetic modification will lead to **homogenisation** among the human species. Homogenisation refers to a limited genetic diversity, which could be caused by certain genes being modified. The homogenising of society could lead to discrimination as well as new eugenics. Due to the potential harm that could arise with the widespread implementation of genetic modification, the technique is debated in the enhancement literature.[304]

In contrast to the concerns about homogenisation, Ossareh claims that parents will eventually modify the genetics of their children according to their own standards and desires meaning that genetic diversity could, in fact, increase. Considering the various values among parents of different cultures, backgrounds, and upbringings, Ossareh finds it unlikely for society to genetically homogenise.[305] It may be true that homogenisation could occur within nations individually; however, it would require a globalisation of cultural trends to result in worldwide genetic homogenisation of the human species. In any case, whether the range of choices made by individuals based on their comprehension of what is biologically possible is likely to be greater than the variations enacted by the unrestricted selective processes of evolution remains to be seen. Yet, given that humanity's comprehension of variation is still quite limited, then it is reasonable to assume that the individual comprehension of variation choices will be narrower than what is biologically possible.

Neitzke splits the difference between the views that homogenisation is a major concern or not a concern at all, claiming that parents' ability to alter their children's genetics should be limited to improving behaviour or psychological traits that are associated with harmful social activities (predispositions to sociopathy, for example; and it should be also noted that it is not clear such traits can be modified, as the current understanding is that complex traits such as these are a product of multiple genes in conjunction with environmental effects).[306] However, even though most traits parents desire to change are not harmful, Neitzske claims the freedom of parents to change the genetic nature of their children should be restricted, reasoning that changing the genetic nature of an individual limits their self-determination and, simultaneously, limits the concept of self-determination. In addition, genetic modification could lead to power struggles in society and among populations since certain traits are more desirable than others.[307]

[304] Ossareh, Tandice, "Would you like blue eyes with that? A fundamental right to genetic modification of embryos", *Columbia Law Review*, vol. 117, 2017, pp. 729-766.
[305] Ibid, pp. 764-5.
[306] Neitzke, Alex B., "On the Genetic Modification of Psychology, Personality and Behavior", *Kennedy Institute of Ethics Journal*, vol. 22, no. 4, 2012, pp. 307-343.
[307] Ibid.

Gottweis points out that the **public perception of genetics** has never been terribly well-aligned.[308] One of the main reasons behind the tumultuous relationship is that many scientists believe that the public bases their opinions of genetic enhancement on misunderstandings and a lack of scientific information.[309] On top of that, the positive outlook on genetic enhancement by the pioneers of the 1990s has led to both high expectations and strong concerns. Even though current discourse about genetic enhancement has become much more cautious, this has not completely dispelled the anxiety built up in the previous decade. The scientific community therefore feels there is an information gap between scientists and the public. This knowledge gap leads and has led to false predictions and feelings of prejudice, which are based on a gut-feeling instead of carefully selected scientific knowledge.[310] Yet, this situation is also exacerbated by the fact that genes remain shrouded in what Nelkin and Lindee[311] describe as a kind of 'mystique.' Neither scientists nor the public know the full extent of how they function, nor what may be possible to achieve through their manipulation and this uncertainty has become a breeding ground for speculation from all corners of society.

Another ethical issue regarding genetic enhancement, and perhaps the most pivotal today, is their effectiveness.[312] Currently, only a limited number of genetic interventions have been approved by regulatory agencies to treat conditions that have no other cure. Long-term risks of genetic editing in humans largely remain unknown, and even beginning clinical studies to determine such risks raises ethical issues that make it unlikely such studies will proceed any time in the near future. Based on the known effectiveness of long-available cognitive and physical enhancements, that is to say enhancements tend to give modest-at-best boosts to performance and/or capability, it could well be the case that genetic interventions will also grant only modest-at-best boosts because many traits discussed as targets for enhancement are not primarily genetic to begin with.[313] Thus, it is imperative to understand the risks, short and long-term, of genetic interventions before genetic enhancement can become a widespread practice. This is an issue that applies beyond genetics, and for HET risks to be most adequately assessed, science needs to embrace applications for health subjects, which means a wholesale reconfiguration of its ethical foundation.

Furthermore, genetic interventions could prove to be a Pandora's box, leading to major unforeseen long-term consequences that cannot be predicted by reasoning alone. For example, some scientists are researching the viability of a technique called gene-drive that can propagate edited traits across an entire species quickly.[314] The research remains at an early stage today because it is extremely

[308] Gottweis, Herbert, "Gene therapy and the public: a matter of trust", *Gene Therapy*, vol. 9, 2002, pp. 667-669.
[309] Ibid, p. 667.
[310] Ibid, p. 668.
[311] Nelkin, Dorothy, and Mary Susan Lindee, *The DNA Mystique: the Gene as a Cultural Icon*, Univ. of Michigan Press, Ann Arbor, 2007.
[312] Phillips, Kathryn A, and Stephanie L Van Bebber, "A Systematic Review of Cost-Effectiveness Analyses of Pharmacogenomic Interventions," *Pharmacogenomics* Vol. 5, No. 8, 2004, pp. 1139–1149.
[313] So, Derek, Erika Kleiderman, Seydina B. Touré, and Yann Joly, "Disease Resistance and the Definition of Genetic Enhancement," *Frontiers in Genetics* Vol. 8, October 2017.
[314] Noble, Charleston, Jason Olejarz, Kevin M. Esvelt, George M. Church, and Martin A. Nowak, "Evolutionary Dynamics of CRISPR Gene Drives," *Science Advances* Vol. 3, No. 4, 2017.

difficult to predict how such a technique will proceed in the wild.[315] A seemingly minor flaw could hypothetically lead to a full population collapse or explosion, which could then cause other downstream effects in a wild ecosystem. Although gene-drive is primarily discussed as a technique to alter non-human species, the potential consequences raises concerns that map to further worries about how human gene editing could lead to similar unforeseen consequences. Moreover, one of the critical absences in ethical debates about enhancement technologies is how their application to non-human species may have a bearing on life on Earth more generally. Indeed, this is the debate that often focuses on genetically modified organisms and their potential to affect the survival of other species.

Nanotech-based interventions

The founding idea of nanotechnology can be traced to the vision projected by Richard Feynman of atomic-scale machines and other products with the precision and control for molecular manufacturing.[316] This vision led to the formation of the U.S. National Nanotechnology Initiative (NNI). The areas where molecular manufacturing has been aimed to produce revolutionary improvements are in computing (increasing the number of processors), medicine (to create devices that can find and destroy cancer cells), the environment (with zero-emission industrial production) and arms (ultra-smart nonlethal weapons).[317]

As a result of prioritisation decisions made early in planning for this report, only a limited sample of literature on nanotechnology was analysed. Thus, we will keep this section brief, although a lot more on nanotechnology can be said than this section describes. Primary issues are largely related to those found in the previously discussed technologies, namely **cost & ownership, clinical trials,** and **accessibility.** Similar to prosthetics and AI/machine-based implants, nanotech enhancements will likely function from within a user's body. Thus, similar questions arise about who would own a body after an expensive nanotech enhancement procedure: the entity who paid for the intervention or the individual associated with that body. Similar to genetic interventions, there are high hurdles to overcome before the field can begin clinical trials on human subjects, mainly based on uncertainties about risks. Similar to almost all enhancement technologies, nanotech-based enhancements share concerns about who will gain access to such devices. Linked to cost, it could be the case that only the wealthiest individuals and entities can use nanotech enhancements; even if costs are not prohibitive, the technology may take a long time to enter markets in low and middle-income countries.

5.3 Ethical issues with regard to general implications and risks

Ownership of expensive HET

General implications and risks associated with the expense of HET have already been discussed in the preceding sections. Here, we flag a few additional issues in this topic. First, **individual rights may be compromised**, i.e. if enhanced body parts or devices could be 'repossessed' by a corporate owner or

[315] Noble, Charleston, Ben Adlam, George M Church, Kevin M Esvelt, and Martin A Nowak, "Current CRISPR Gene Drive Systems Are Likely to Be Highly Invasive in Wild Populations," *ELife* Vol. 7, 2018.
[316] Drexler, K. Eric, "Nanotechnology: From Feynman to Funding," *Bulletin of Science, Technology & Society* Vol. 24, No. 1, 2004, pp. 21–27.
[317] Ibid, p. 24.

supplier. Imagine a society in which expensive enhancements are available to the public to lease like the automobile market operates in the US today. If an individual falls behind on payments, the leasing agency could attempt to remove the enhancement from the user. If the device in question interacts with essential bodily functions or is otherwise important for the user to complete their job or participate in society, numerous rights issues jump out.

Furthermore, if an entity other than the user of an enhancement owns the device this could impose **standards-of-use conflicts** for the user.[318] For example, a company may implement a policy that requires employees to keep their political opinions out of the workplace, or, conversely, may require employees to promote the company's preferred opinions.[319] However, if a part of the workplace is always with an enhanced employee, it becomes unclear how such a policy could be enforced if, for example, an individual with an optical prosthetic owned by their employer participates in a political rally.

If a company or other entity besides the user of an enhancement pays for the installation and maintenance of the device, the user may be at risk for further **coercive issues.**[320] For example, an individual may feel compelled to promote or otherwise advocate for a company's products, perhaps for discounts on maintenance costs or merely under the belief that the owner of the enhancement could be 'listening' and take offense if the user makes disparaging comments.

Redefinition of 'human nature'

Some human enhancement technologies raise concerns that humanity is now exceeding its authority as a species in excessively modifying its own nature. At times, these concerns engage theological anxieties, described often as "playing God" and this perspective is treated as a reason to reject HETs.[321] More broadly, this argument consists in anxieties that enhancement could lead to a **redefinition of 'human nature.'**[322] In a way that compromises some important value, which Fukuyama[323] described as 'Factor X' (a term he uses to acknowledge the fundamentally contested notion of 'human nature'), Baillie and Cassey address further.[324] This is an issue that applies to multiple categories of enhancement. Allhoff et. al. have written in the context of life extension technology suggesting that this aim can be likened to manipulating nature, which is something humans have been doing since the

[318] Maslen et. al., op. cit., 2014.
[319] Hertel-Fernandez, Alexander, *Politics at Work: How Companies Turn Their Workers into Lobbyists*, Oxford University Press., New York, 2018.
[320] Hamlett, Patrick, Michael D. Cobb, and David H. Guston, "National Citizens' Technology Forum: Nanotechnologies and Human Enhancement," *Nanotechnology, the Brain, and the Future*, October 2012, pp. 265–283.
[321] For example, see Peters, Ted, "Are We Playing God with Nanoenhancement?," *Nanoethics: the Ethical and Social Implications of Nanotechnology*, Wiley-Interscience, Hoboken, NJ, 2007.
[322] Jotterand, Fabrice, "Beyond Therapy and Enhancement: The Alteration of Human Nature," *NanoEthics* Vol. 2, No. 1, 2008, pp. 15–23.
[323] Fukuyama, Francis, *Our Posthuman Future: Consequences of the Biotechnology Revolution*, Picador - Farrar, Straus and Giroux, New York, 2007.
[324] Baillie, Harold W., and Timothy K. Casey, *Is Human Nature Obsolete? Genetics, Bioengineering, and the Future of the Human Condition*, MIT Press, Cambridge, 2014.

dawn of civilization.[325]Above, we have discussed how physical enhancements could alter opinions about athletic performance, potentially changing what we value about physical achievements.

Furthermore, certain redefinitions of 'human nature' could lead to the commodification of human beings in various ways.[326] For example, individual body parts could eventually be seen as goods to be bought, sold, traded, modified etc. in a free market. If prosthetics eventually come to allow greatly enhanced capabilities over biological limbs, healthy individuals may demand to have their normally-functioning limbs removed to receive an enhanced artificial substitute. The development of pharmaceutical enhancements and enhancements requiring medical procedures for installation and maintenance could lead to a commodification of abilities. Thus, individuals could encourage enhancement rat-races that might improve the capabilities they require in their profession.

Freedom to be 'imperfect'

In the vast majority of cases, one can argue that enhancement is undertaken, at least in part, to **increase well-being**. However, Landeweerd notes that this goal may not be achieved. Landeweerd notes that "[w]ell-being might not be decreased by having a disorder," considering cases of autism & bi-polar disorder.[327] Landeweerd further explains: "an enhanced cognition or enhanced mood does not necessarily equal enhanced well-being," because well-being "is either too subjective to define neutrally […] or too broad. Enhancement, well-being, and desirability of introduction [of a specific enhancement technology] are not interlinked".[328]

However, in contrast to the historical notion of humans manipulating nature espoused by philosophers such as Allhoff et. al.,[329] Kass warns that there might not be a limit to bioengineered perfection.[330] The reason behind his concern are the continuing gains in health and longevity which are paired with simply wanting more instead of feeling satisfied with the current results. The same can be said about biological and scientific discoveries made regarding the human psyche and mind and the increasing desire to alter and improve them.[331] Simultaneously, the strive for perfection – whether via having the perfect body or increasing life-expectancy – distracts us from what some say (like Kass) human existence should naturally be about, which is living well instead of merely staying alive.

According to Roduit et. al., there are also certain so-called perfectionist assumptions which claim that current limitations humans face are part of living a good human life.[332] Human enhancement, aimed

[325] Allhoff et. al., op. cit., 2009.
[326] Resnik, D B, "The Commodification of Human Reproductive Materials.," *Journal of Medical Ethics* Vol. 24, No. 6, January 1998, pp. 388–393.
[327] Landeweerd, Laurens, "Asperger's Syndrome, Bipolar Disorder and the Relation between Mood, Cognition, and Well-Being," Essay, *Enhancing Human Capacities*, Wiley-Blackwell, Chichester, 2011, pp. 207–217.
[328] Ibid.
[329] Allhoff et. al., op. cit., 2009.
[330] Kass, Leon, *Beyond Therapy: Biotechnology and the Pursuit of Happiness*, Presidents Council on Bioethics, Washington, D.C., 2003.
[331] Ibid, p. 10.
[332] Roduit, Johann A R, Jan-Christoph Heilinger, and Holger Baumann, "Ideas of Perfection and the Ethics of Human Enhancement," *Bioethics* Vol. 29, No. 9, 2015, pp. 622–630.

at erasing human imperfections, would therefore form a threat to these limitations and, in the end, to living a good life: "In other words, it is argued that if certain limitations can be overcome by biotechnological means, humans will no longer be able to experience real flourishing"; hence, it should be rejected.[333] Yet, Roduit et. al. believe that human enhancement can help with or guide living a fulfilling life. Instead of banishing human enhancement altogether, only human enhancement practices which could threaten or cause conflict with living a flourishing life should be limited. In order to cement their standpoint, Roduit et. al. take Martha Nussbaum's capability approach as a conception of type-perfection. [334] An ideal human should strive to develop the ten capabilities as stated by Nussbaum.[335] Using enhancement technologies to develop these ten capabilities is therefore a morally acceptable way to apply human enhancement.

However, perfectionism is not only related to enhancing the mind but also to enhancing the body. Recent decades have been marked with a boom in the beauty industry, which has affected people's bodies on a global scale. Liebelt points out how this boom has had an effect on the way bodies are framed and mostly on the common perception of what a normal body should look like.[336] Bodies, in a way, have become more standardized. Liebelt warns about how this type of thinking may link to eugenics and the binary categorization of the body in concepts such as healthy and sick, normal and abnormal, beautiful and ugly, and able-bodied and disabled.[337] Since physical beauty is linked to social status as well as the promise of social mobility, plastic and cosmetic surgery have become common ways to 'correct' the body.[338] This can be seen as the medicalization of beauty standards: bodily aspects which currently do not match the beauty standards are perceived as deformations which require surgical correction.[339]

Furthermore, the body is not only related to physical beauty but also to physical achievements and performances. Besides health and safety issues, as previously discussed in the section on physical enhancement above, doping in sports causes a lot of discussion about competitive fairness. According to Lin & Allhoff, sports would change completely if enhanced people were allowed to join alongside non-enhanced people.[340] Besides that, Lin & Allhoff point how using enhancement in sports leads to the issue of moral hindrance. Many believe that physical enhancement in sports would affect and decrease moral development.[341] Douglas refers to this as the "Athenian ideal": sport players are expected to win and compete by just using their natural talent and abilities.[342] However, the question then arises whether sport has ever been completely detached from using technology to enhance sport performances. Training centres, sport gear, high-tech equipment and nutritional supplements are

[333] Ibid, p. 626.
[334] Ibid, p. 626.
[335] Nussbaum, Martha 2003, "Capabilities as Fundamental Entitlements: Sen and Social Justice," *Feminist Economics*, 9(2/3): 33–59.
[336] Liebelt, Claudia, "Beauty and the Norm: An Introduction," in Claudia Liebelt, Sarah Böllinger and Ulf Vierke (eds.), *Beauty and the Norm: Debating Standardization in Bodily Appearance*, London, Palgrave Macmillan, 2019, 1-19.
[337] Ibid, p. 4.
[338] Idib, p. 4.
[339] Idib, p. 4.
[340] Lin & Allhoff, op. cit., 2008.
[341] Ibid, p. 261.
[342] Douglas, op. cit., 2007.

permitted but simultaneously affect outcomes. Technology is and has been already a part of the sport world therefore and influenced it since the beginning[343]. The "Athenian ideal" is hence no more than an ideal: it does not exist in real life.

Accessibility in LMC areas & expansion of inequalities

Several issues related to accessibility and inequality have already been discussed above. Additional ethical issues include the **consolidation of power** and **practical difficulties** in expanding access across borders. It is likely that those who are already powerful (whether socially, economically, militarily, etc., and whether concerning individuals or entities such as governments) will receive access to new enhancement options first, giving these entities the opportunity to increase their power. A society in which there is already extreme inequality could thereby exacerbate the issue if care is not taken to ensure the powerful, i.e. individuals with greater wealth and/or influence (social or political), do not abuse new enhancement options. The scale of disparity may lead to this issue proving to be extreme or less problematic; for instance, if one considers the economic demographic of "everyone who can afford mobile phones" as more powerful than "everyone who cannot" this is substantially different than the difference between "everyone who can afford a penthouse apartment in Manhattan" and "everyone who cannot." In the former case, it is still true a large proportion of society (globally) could be dispossessed for their lack of 'power,' though this shows how many people (globally) have reasonable economic means but are not necessarily 'powerful' (as compared to the latter case, which includes only a fraction of a percent of the population). This distinction shows how the ethical discussion about power dynamics might be considerably distorted without precision. Furthermore, it is difficult to determine precisely how accessibility of HET ought to move forward.[344] First, it remains in question whether or not there is any ethical imperative to begin with for high-income countries to help out LMCs. Especially if high-income countries already have numerous problems to solve, helping to expand access of HET may be a very low priority. Second, assuming there comes a time in which high-income countries agree to help LMCs gain access to HET, it is difficult to determine where to start. Perhaps the order of countries to receive help could follow a Prioritarianism method, although other possibilities may be preferable.

In addition, the availability of mood-enhancing technologies on the market could deepen already existing social inequalities in the following ways: Liao & Roache note that such technologies are unlikely to become affordable to everyone equally, although they also argue that societies should take responsibility to minimize this effect.[345] Furthermore, Brülde notes that although high-income individuals are likely to increase their advantages via such technologies, even if everyone gains access to the same options, this "could still be undesirable, since everyone would have to use stimulants to keep up with everybody else." He calls this a "looping effect," in which "a new technology shapes society in a way that makes us more dependent on the very same technology."[346]

[343] Ibid, p. 5.
[344] Bavelier, Daphne, Julian Savulescu, Linda P. Fried, Theodore Friedmann, Corinna E. Lathan, Schürle Simone, and John R. Beard, "Rethinking Human Enhancement as Collective Welfarism," *Nature Human Behaviour* Vol. 3, No. 3, November 2019, pp. 204–206.
[345] Liao & Roache, op. cit., 2011.
[346] Brülde op. cit., 2011.

Dual-use and misuse

Dual-use occurs when a technology is designed with a feature that results in some benefit when used that can also be used in a harmful way. A simple example in (anticipated) human enhancement is genetic modification: the technique was fundamentally designed to benefit patients by eradicating or greatly reducing harms such as genetic diseases and could potentially be used to further benefit individuals by enhancing desirable traits in the future. However, the technique can be used (hypothetically, considering this technology has not yet been widely established) in the same way to damage a patient and could potentially be used in the future to decrease desirable traits by a bad actor. Although this characterisation of technology could be considered as a trivial critique about the unpredictability of technological applications, the issue has been flagged in a number of reports on human enhancement as an important consideration, especially for developing policy.[347,348] Furthermore, the limitations of "dual-use" has become a topic of recent debate in itself.[349] Formally, the EC has defined dual-use as technologies that can be adapted "in one sector (defence or civil) for use in the other (civil or defence)," limiting the discussion to technology transfer between these sectors, whereas we will consider further issues where HET may transfer from, for example, the medical sector to the commercial sector.[350]

Misuse occurs when a technology is used in a way that was unintended, and in many cases unforeseen, by the designers. For example, imagine an enhanced prosthetic arm is designed that gives the user superhuman strength. If the user were to break into a business to commit theft due to their increased strength from the prosthetic, this would constitute misuse: although the technology enables the crime, it is hard to imagine the designers would have explicitly warranted the use of their device for such a purpose.

One ethical issue in this space relates to the **goal(s) for development** of HET. People can be harmed by mood enhancement in the case of secret use of such drugs by governments. Liao & Roache write: "Imagine a drug that reduces aggression and renders users more easy-going. [… If] used on a population-wide scale, it could have the unpalatable effect of making people more accepting of an unjust political regime."[351] The possibility of this scenario showcases a dual-use concern for the development of mood enhancement, as the underlying technology would likely be the same as mood enhancements developed to improve users' wellbeing.

The application of human enhancement in military contexts, generally speaking, has led biotechnology and bioweapons to move from conceptions of germ attacks to a potential future of biologically enhanced soldiers.[352] The effects such enhancements will have include increasing the military

[347] European Commission, *EU Funding for Dual Use: a Practical Guide for Accessing EU Funds for European Regional Authorities and SMEs*, EC, Brussels, 2014.
[348] Coenen et. al., op. cit., 2009.
[349] Mahfoud, Tara, Christine Aicardi, Saheli Datta, and Nikolas Rose, "The Limits of Dual Use," *Issues in Science and Technology*, October 5, 2018. https://issues.org/the-limits-of-dual-use/.
[350] European Commission, op. cit., 2014, p. 8.
[351] Liao, S. Matthew & Rebecca Roache. "After Prozac," in *Enhancing Human Capacities* (2011) eds Savulescu, Julian, Ruud ter Meulen & Guy Kahane.
[352] McCarty, Kristin, "Building a Better Soldier: Human Enhancement Technologies in the 21st Century," *Paideia* Vol. 1, No. 1, January 2014.; Axe, David, "This Scientist Wants Tomorrow's Troops to Be Mutant-

capabilities of countries developing these technologies. Human enhancement in military contexts is therefore also linked to the political power that can be gained from better combat results through the use of enhanced military capabilities.[353] Just as advanced conventional weapons pose dual-use risks from malicious actors such as rogue states, terrorist organisations and violent psychopaths, enhancement technologies that improve combat capability could pose similar dual-use risks were they to fall in the wrong hands.

Subdermal RFID microchip keys present additional dual-use risks. These keys are a body-modification in which a user installs an RFID chip beneath their skin, often on their hand, that can then be used with RFID readers in many ways, often as a biometric security measure. RFID keys for authentication and identification processes are already present in the commercial market. For example, an RFID key could be used to unlock a door, turn on the lights in a 'smart' home or office, open an encrypted computer file or enable automatic payment. RFID keys are faster, cheaper and more reliable than traditional biometric technologies. Even though a number of trials using such technology are now running, Kumar points out conceptual risks in terms of how extensive use of the technology could erode privacy and challenge conceptions of bodily integrity.[354] Subdermal RFID chips have also been proven to be susceptible to computer viruses that can spread to other connected technologies that interface with the keys, which shows the technology is also at risk of malicious misuse.[355]

An additional ethical issue related to dual- and misuse is **addiction and diminishing returns**. Enhancement options may prove to be highly addictive, requiring professional supervision to ensure users do not misuse the enhancement. In turn, this risk further complicates the treatment/enhancement distinction, as non-therapeutic enhancements ought to not require professional supervision for use. However, even mild risk of addiction may lead to problematic misuse of some enhancement options. Especially when coupled with the possibility of an enhancement application offering diminishing returns with prolonged use, individuals could find that addiction risks pose grave problems for some enhancements.

It's also possible that widespread adoption of enhancements may result in **discrimination**, either by non-users toward users or by users toward non-users. Especially if future enhancements prove unattainable by low-income individuals, a class divide could emerge between people who use HET and those who do not.

Safety, security and liability

Powered," *Wired*, Conde Nast, December 26, 2012. https://www.wired.com/2012/12/andrew-herr/.; Mehlman, Maxwell, Patrick Lin, and Keith Abney, "Enhanced Warfighters: Risk, Ethics, and Policy," *SSRN Electronic Journal*, 2013.

[353] Dieuliis, Diane, and James Giordano, "Gene Editing Using CRISPR/Cas9: Implications for Dual-Use and Biosecurity," *Protein & Cell* Vol. 9, No. 3, April 2017, pp. 239–240.

[354] Kumar, Vikas, "Implantable RFID Chips," *The Future of Identity in the Information Society*, 2008, pp. 151–157; Foster, Kenneth R., and Jan Jaeger, "RFID Inside: The Murky Ethics of Implanted Chips," *University of Pennsylvania Scholarly Commons*, March 1, 2007, pp. 24–29..

[355] Gasson, Mark N., "Human ICT Implants: From Restorative Application to Human Enhancement," *Information Technology and Law Series Human ICT Implants: Technical, Legal and Ethical Considerations*, 2012, pp. 11–28.

Several issues regarding safety, security and liability arise when discussing various forms of enhancement technologies.[356] For example, **testing standards** may vary if enhancements are not regulated in the same way as clinical treatments. In modern biomedical development, lengthy clinical trials are required before a new treatment is allowed to enter the free market. Often, only individuals who have little to lose will be allowed to enrol in such clinical trials because the full scope of risks may be unknown. However, non-therapeutic enhancements, despite potentially interacting with the biochemistry within a user's body in ways similar to pharmacological or other medical treatments, may face different standards to enter the market. Already, an increasing number of 'smart drugs' are becoming available in the US and Europe despite little evidence demonstrating that they are both safe and effective. It remains an open question of how legal and regulatory levels will react if a new market of bioenhancements arises, testing our notions of how much risk a healthy individual should be allowed to expose themselves to for enhancement purposes.

In the specific case of development of mood enhancing drugs, Liao & Roache write: "That the development of mood enhancement drugs might harm people during clinical trials applies generally to drugs and experimental medical procedures. So the potential harms to people of developing mood enhancement drugs should be minimized using the same methods as those that minimize potential harms arising from medical technology generally."[357] Thus, to consider the development and use of enhancement techniques follows a similar route, i.e. procedural phases, as therapeutic pharmaceutical techniques. For example, Chatterjee, in discussing mood enhancement via neurological intervention, writes "Virtually all medications have potential side-effects that range from minor inconveniences to severe disability or death. Regardless of the relative dangers, in disease states one weighs risks against potential benefits."[358]

Machine, computer, and/or AI-based enhancements may pose further security risks, as such applications may be at risk for **hacking** by individuals with malicious intent.[359] If a hacker gains control of, for example, a physical enhancement that could cause serious injury to the user or others, liability concerns arise about who is responsible if the device is, in fact, used in malicious ways. Therein, hacking also raises the issue of **ownership** once again: enhancement devices will likely be developed by many different actors, including programmers and engineers at the R&D level and extending to marketing agencies and customer service representatives once the devices enter the free market.

Right to privacy

The domain of privacy contains additional ethical issues for HET. First, there is the general issue of whether there may someday be a **regulatory need for individuals to register their enhancements** with

[356] Oertelt, Nadja, Adam Arabian, E. Christian Brugger, Michael Choros, Nita A. Farahany, Samantha Payne, and Will Rosellini, "Human by Design: An Ethical Framework for Human Augmentation," *IEEE Technology and Society Magazine* Vol. 36, No. 1, 2017, pp. 32–36.
[357] Liao & Roache, op. cit., 2011.
[358] Chatterjee, op. cit., 2013.
[359] Dresler, Martin, Anders Sandberg, Christoph Bublitz, Kathrin Ohla, Carlos Trenado, Aleksandra Mroczko-Wąsowicz, Simone Kühn, and Dimitris Repantis, "Hacking the Brain: Dimensions of Cognitive Enhancement," *ACS Chemical Neuroscience* Vol. 10, No. 3, 2018, pp. 1137–1148.

some agency.[360] If an individual desires to keep their HET to themselves, depending on the enhancement this could raise security concerns. Thus, widespread development of HET may require individuals sacrifice some privacy to ensure citizens are protected.[361]

Another privacy issue relates to the emerging **DIY** (do-it-yourself) enhancement scene.[362] One of the merits of DIY enhancement is an interactive community that shares information about personal experiments. However, if blueprints and parts become widely available, there may be ramifications when an individual creates a faulty DIY enhancement. Consider the risks if children or adolescents learn about DIY enhancement and undertake a project without correctly following the steps.

Even if regulation moves forward regarding the development of new enhancements, there will remain the potential for some individuals to procure enhancement options before trials are completed through back channels, i.e. signifying the potential existence of an enhancement **black market**.[363] If regulatory measures come to prohibit certain enhancements, this may exacerbate the risk for a black market to emerge, which could include any potential enhancement at any stage of development.

There is also the more mundane ethical issue that use of certain enhancements may, for example, **signal the presence of medical conditions** that a user may wish to keep private.[364] Although it's fair to assume individuals with prosthetic limbs today require the devices to perform tasks at normal levels, a world in which enhanced prosthetics become available could result in a society where this assumption is no longer warranted. Thus, if an individual loses a limb due to an accident they may desire to keep this information to themselves.

General issues related to HET and Autonomy

One useful way to distinguish autonomy conceptually, in particular when considering human enhancement, is by looking at what Bublitz and Merkel refer to as minimal capacities.[365] These capacities include: i) agents should be able to discern right and wrong, and respond appropriately to reasons for acting the way they do and reasons to change how they act; ii) agents should have self-control to act in accordance with how they discern right from wrong; and iii) agents need to have a proper understanding of the world and the consequences for their actions[366]. Bublitz and Merkel

[360] Fox, Stephen, "Cyborgs, Robots and Society: Implications for the Future of Society from Human Enhancement with In-The-Body Technologies," *Technologies* Vol. 6, No. 2, 2018, p. 50.
[361] Agar, Nicholas, *Truly Human Enhancement: a Philosophical Defense of Limits*, MIT Press, Cambridge, MA, 2014.
[362] Gaspar, Rui, and Jean-Christophe Giger, "Emerging Technologies, Emerging Risks: Current Approaches on the Future Risks of Human Enhancement Technologies," *Human Behavior and Emerging Technologies* Vol. 1, No. 1, 2019, pp. 67–68.
[363] Hall, Wayne, and John Strang, "Challenges in Regulating the Use of Stimulant Drugs for Cognitive Enhancement in Normal Individuals," *Rethinking Cognitive Enhancement*, Oxford University Press, Oxford, 2017.
[364] Klein, Eran, Tim Brown, Matthew Sample, Anjali R. Truitt, and Sara Goering, "Engineering the Brain: Ethical Issues and the Introduction of Neural Devices," *Hastings Center Report* Vol. 45, No. 6, 2015, pp. 26–35.
[365] Bublitz, Jan Christoph, and Reinhard Merkel, "Autonomy And Authenticity Of Enhanced Personality Traits," *Bioethics* Vol. 23, No. 6, 2009, pp. 360–374.
[366] Ibid, p. 361.

contend that the use of neuroenhancements, especially when they can change the personality traits and behaviour of individuals using them, can minimise these capacities and therefore diminish the autonomy individuals have. To better elaborate on this diminishing, the use of neuroenhancements can be considered in terms of direct and indirect brain interventions, whereby direct brain interventions: i) bypass an individual's rational capacities (i.e. the minimal capacities); ii) these interventions introduce an alien element that undermines an individual's authenticity; and iii) these interventions impose over an individual's self.[367] Neuroenhancements[368] (either as a pill or in the form of cranial stimulation) can be considered to bypass rational capacities because they can lead to changes in the personality and behaviour of individuals not from their own rational mechanisms, but from the physiological responses that are caused by the use of a given neuroenhancement technique (especially if an individual's personality or behaviour is altered as a side-effect that was unforeseen by use of a pharmacological substance)[369]. They may be considered as an alien element if their effects are framed as artificial opposed to natural, whereby the natural processes reinforce an individual's minimal capacities, but artificial processes are not from the individual's body and therefore they cannot be considered a result of the individual's minimal capacities (though Bublitz and Merkel caveat this point by stating that this framing relies on believing that only the natural conveys autonomy).[370]

The notion that neuroenhancements can impose themselves on an individual's self is far clearer to think of in the case of an implant taking over or replacing an individual's brain functioning.[371] Pharmacological neuroenhancements instead work on the individual's existing biological framework and thus do not necessarily impose themselves (instead they amplify e.g. raising of serotonin levels to alter an individual's mood).[372] At the same time, however, if pharmacological neuroenhancements can override an individual's personality structure (i.e. an individual who is optimistic in contrast to an individual who is depressed) and alter their neuronal functioning much faster than can be done by traditional interventions,[373] these enhancements can indeed diminish their autonomy since it hijacks what they are naturally disposed as and alters them in a way they do not necessarily control. Although this can also be reconsidered in cases where the use of neuroenhancements, especially in treating mental illnesses, can help restore minimal capacities and therefore enhance the autonomy of individuals[374] who may have these capacities inhibited by their cognitive deficiencies. Yet the foreseeable utility of using neuroenhancement techniques to alter individuals' psychological state can also be problematic if such altering is done in institutional or governmental applications where these techniques are administered in a mandatory and/or coercive manner (such as court-ordered treatment of individuals viewed as dangerous to themselves).[375]

[367] Ibid, p. 365.
[368] Clark, Vincent P., and Raja Parasuraman, "Neuroenhancement: Enhancing Brain and Mind in Health and in Disease," *NeuroImage* Vol. 85, 2014, pp. 889–894.
[369] Bublitz & Merkel, op. cit., 2009, p. 369.
[370] Ibid, p. 365.
[371] Hansson, S O, "Implant Ethics," *Journal of Medical Ethics* Vol. 31, No. 9, January 2005, pp. 519–525.
[372] Bublitz & Merkel, op. cit., 2009, pp. 365-366.
[373] Ibid, p. 366.
[374] Ibid, p. 367.
[375] Sententia, Wrye, "Neuroethical Considerations: Cognitive Liberty and Converging Technologies for Improving Human Cognition," *Annals of the New York Academy of Sciences* Vol. 1013, No. 1, December 2006, pp. 221–228.

Concerns for the shaping or diminishing of autonomy are also present in discussions of life extension technologies[376]. Life extension technologies may reinforce the autonomy of individuals in a number of ways: i) living longer without the threat of disease, ageing and death beyond one's control, by use of biotechnological means allows individuals to have greater choice, experiences and understanding of the world as a result of being freed from nature's constraints; ii) by living longer *without* the burden of disease and suffering, individuals can have longer years of active life than may be currently possible; iii) having more time to live can give individuals greater chances to fulfil their potential and talents, as well as allow them greater freedom from the pressure to do things for fear of not having time in the future. Life extension is linked to individuals having more control over the kind of person they will be, thus these technologies will be a means of enhancing self-determination - this would be an additional capacity to those mentioned by Bublitz and Merkel[377] as conditions for conceptualising autonomy (and is a capacity that is minimised in the case of athletes and non-athletes concerning use of PEDs). But conversely, removing the burden of death, disease and the encroaching of time on one's decisions, does not necessarily lead to liberation but may instead lead to listlessness and dullness (by feeling less urgency). Perhaps of even more concern though is that our capacity to imagine how such conditions may change will vary dramatically depending on the individual's life circumstances. Consider a person who has been a benefiacy of life extending technology, but who lives in conditions of extreme poverty or exploitation. In this case, having more time is hardly likely to be experienced as a wonderful opportunity to explore life's potential. Instead, without accompanying, radical social change, it will most likely involve the prolongation of their suffering, a life of further exploitation and abuse.

Similar concerns about choice and control over one's life are faced in the context of germline enhancements via gene editing[378]. If children are born with enhancements which they did not ask for, and which they were assigned/implanted because of their parents' desires, then the future choices that may be open (or closed off) for the child in their development may be conditioned by the desires of their parents, not by their own autonomous decision making. More so, while an unenhanced child may have a genetic makeup which is more contingent, a child born with germline enhancements will have a far more determined makeup, thereby limiting the kind of person they are likely to develop into (especially if the traits they develop are irreversible). But the first concern, that the enhancements made (or imposed) on a child within the womb occurs only because of the parents' desires, may be countered in situations where the enhancements serve therapeutic ends and thus may actually be for the good of the yet to be born child by allowing them autonomy which they may not have access to without the germline intervention. More so, beyond the determining power of germline enhancements on the future choices of children, what John Rawls refers to as 'General Purpose Means' (e.g. intelligence, good memory, socialization skills)[379] are also factors that parents may use to foster certain kinds of choices and life plans (by nutrition, choice of education, monitoring of friend groups). But children can frustrate these plans by developing their own means of improving their lives in their own ways, and this may also be the case with germline enhancements where the appropriate technologies may be in place to reverse the enhancement to take autonomy back in their own hands.

[376] Hildt, Elisabeth, "Living Longer: Age Retardation and Autonomy," *Medicine, Health Care and Philosophy* Vol. 12, No. 2, 2008, pp. 179–185.
[377] Bublitz & Merkel, op. cit., 2009, p. 361.
[378] Pugh, Jonathan, "Autonomy, Natality and Freedom: A Liberal Re-Examination of Habermas in the Enhancement Debate," *Bioethics* Vol. 29, No. 3, 2014, pp. 145–152.
[379] Rawls, John, *A Theory of Justice*, Belknap Press of Harvard University Press, Cambridge, MA, 1978.

Weaponisation of enhancements

Although we will explore more specific issues related to weaponisation of enhancements in the sections that follow, here we shall sketch the most general issues in this space. First, any enhancement weaponisation raises the issue of **liability**.[380] For example, if a soldier is given a weaponized enhancement for use in combat and then proceeds to use the enhancement to injure someone off the field, it may not be clear exactly who is responsible. Especially if enhancements prove to alter cognitive processes, discerning liability in this scenario could become difficult. However, even if weaponized enhancements are used in the right contexts, i.e. in a combat scenario, similar liability issues stand out when considering the possibility for a friendly-fire or accidental civilian injury or death.

Furthermore, if weaponized enhancement development accelerates, there may be an **arms-race** that could prompt militaries to cut corners in development to receive immediate advantages.[381] Above, we specified one of the ethical issues with genetic enhancement is its potential to be a Pandora's box: unforeseen risks could take decades, if not centuries, to become apparent, at which point it would be far too late to reverse course. A weaponized-enhancement arms-race could lead to a similar situation depending on the techniques used for enhancement.

6. Ethical analysis: human enhancement subfields

The following section contains an analysis of ethical issues stemming directly from products and techniques specific to the six categorical subfields identified in previous SIENNA work. Thus, although the previous section was also structured (in part) according to enhancement subfields, the present section focusses on issues directly related to the products and techniques discussed in the debate within each field, with a focus on applications that exist, although some exceptions are made for categories in which few or no products/techniques currently exist. The fact of the matter is some domains of HET are more realistic than others, some have more potential than others, and some domains are just extremely speculative with nothing germane on the cards so far as we can see. Even cognitive enhancement is extremely crude at present, mostly pharmacological, or based on very rudimentary neurostimulation tools.

6.1 Cognitive enhancement

SIENNA has identified five distinct types of cognitive enhancement products/techniques further discussed below: pharmaceutical cognitive enhancement (PCE), implanted neural interface (INI) & brain-computer interface (BCI), neuro-stimulation & neuromodulatory techniques, virtual & augmented reality (VR/AR) and memory enhancers.

PCE

[380] Allenby, Brad, "The Implications of Emerging Technologies for Just War Theory," *Public Affairs Quarterly* Vol. 27, No. 1, 2013, pp. 49`-67.
[381] Dando, Malcolm, "Novel Neuroweapons," *Neuroscience and the Future of Chemical-Biological Weapons*, Palgrave Macmillan, London, 2015.

Pharmaceutical cognitive enhancement (PCE) covers any form of cognitive enhancement delivered via pharmaceutical/pharmacological means, i.e. pills, injections or inhalants. Several drugs developed for therapeutic purposes have been found to give modest boosts to cognitive performance[382] when taken by healthy individuals, such as methylphenidate (commonly known as Ritalin®), dextroamphetamine-amphetamine (Adderall®), modafinil (Provigil®) and beta-blockers (propranolol as one example), among others (for more examples, see SIENNA D3.1: State of the Art Review of Human Enhancement, section 3.4).[383,384,385] The development of so-called nootropics/smart-drugs is a key area in human enhancement research, where concern is rising due to an increasing number of products entering markets in Europe and the USA, if not elsewhere, often with less oversight than traditionally required for treatments.[386] Ethical issues stemming from PCE include coercion, commercialisation and efficacy of products. Use of PCE also raises ethical questions about values such as authenticity and human nature.

PCE is a technology that recent studies have shown is increasingly used by students in nations with highly competitive education systems such as the USA and the UK.[387] If use continues to increase, students may face increased risks of pressure to use PCEs to remain competitive, i.e. students could be **coerced** to use these drugs due to the belief that many of their peers already use PCE.[388] Workers, especially in highly competitive professions, may face similar pressure, extending the risk beyond academia.[389] Eventually, it is anticipated that widespread use of PCEs could lead to the public creating an expectation for members of certain professions, such as airplane pilots or surgeons, to use cognitive enhancement to ensure these workers perform their jobs with maximal efficacy.[390] Furthermore, if pressures to use PCE in academia increase, eventually parents may feel obligated to give their children these drugs with the expectation it will improve the child's chances of success later in life. Thus, coercion to use PCEs is also related to paediatric health and safety. A position paper by Graf et. al. argues that "physicians have the authority and the obligation to refuse requests" for PCE from parents for their children; however, if physicians choose to grant such requests, or if regulations on procuring

[382] Depending on the drug in question, the boost tends to occur in only one area, i.e. focus *or* memory retention, and will often include a trade-off, such as decreasing creativity.
[383] Zohny, Hazem, "The Myth of Cognitive Enhancement Drugs," *Neuroethics* Vol. 8, No. 3, 2015, pp. 257–269.
[384] Smith, M. Elizabeth, and Martha J. Farah, "Are prescription stimulants "smart pills"? The epidemiology and cognitive neuroscience of prescription stimulant use by normal healthy individuals.," *Psychological Bulletin* Vol. 137, No. 5, 2011, pp. 717–741.
[385] Beversdorf, D Q., J D. Hughes, B A. Steinberg, L D. Lewis, and K M. Heilman, "Noradrenergic modulation of cognitive flexibility in problem solving," *NeuroReport* Vol. 10, No. 13, 1999, pp. 2763–2767.
[386] For example, one major finding from the SIENNA Ethics of Human Enhancement workshop held in Uppsala, Sweden June 2019 was a consensus of concern about the commercialisation of human enhancement products, especially PCE.
[387] Vagwala, Meghana Kasturi, Aude Bicquelet, Gabija Didziokaite, Ross Coomber, Oonagh Corrigan, and Ilina Singh, "Towards a Moral Ecology of Pharmacological Cognitive Enhancement in British Universities," *Neuroethics* Vol. 10, No. 3, June 2017, pp. 389–403.
[388] Schelle, Kimberly J., Nadira Faulmüller, Lucius Caviola, and Miles Hewstone, "Attitudes toward Pharmacological Cognitive Enhancement--a Review," *Frontiers in Systems Neuroscience* Vol. 8, 2014.
[389] Maslen, Hannah, Filippo Santoni De Sio, and Nadira Faber, "With Cognitive Enhancement Comes Great Responsibility?," *Responsible Innovation 2*, 2015, pp. 121–138.
[390] Goold, Imogen, and Hannah Maslen, "Obliging Surgeons To Enhance: Negligence Liability For Uncorrected Fatigue And Problems With Proving Causation," *Medical Law Review* Vol. 23, No. 3, 2014, pp. 427–454.

PCEs are relaxed, then parents could potentially endanger their children's neural development due to the forms of coercion discussed.[391]

Although current findings suggest concerns about coercion to use PCE are largely premature,[392] increasing use of PCE could impact, and thus change, perceptions of values such as authenticity and human nature. Because PCEs are used primarily in competitive arenas where the value of one's contribution or work tends to come from the quality of the end result, there may be an erosion of valuing the process of producing intellectual results. In other words, if PCE use in education becomes normalised, then the value some place on the struggle associated with learning through traditional means of study might diminish in favour of using products that allow 'shortcuts' and greatly decrease the effort required.[393] Depending on one's conception of authenticity, this risk of diminishment can be seen as a grave threat. Goodman makes a distinction between 'process goods' and 'outcome goods,' where the former counts the activity as central and the latter counts only the result of activity as valuable,[394] possibly suggesting a dichotomy that may divide workplace and academic use of PCE, i.e. where PCE may be used more often in pursuit of outcomes in the workplace and, conversely, may often subverts the process of learning when used in academia. Even in academia, some argue that fears about authenticity do not track with practice in the real world; for instance, Bedzow explains how "the tacit acceptance by academic institutions and companies of non-prescription use of cognitive enhancing drugs, despite legal prohibitions and institutional policies against it (at least at some academic institutions), creates a conflict of motivations regarding their use," further clarifying that these institutions "benefit" from users of PCE despite their official stance on the practice.[395]

The demand for effective PCEs appears to be driving dangerous trends stemming from the **commercialisation** of the development of this technology. Traditionally, pharmaceutical products require undergoing a lengthy regulatory process of clinical trials before they can be widely prescribed. In the United States, this occurs in three phases: first to assess safety, then to assess efficacy, and finally a larger study to measure what happens in a wider population. Recently, there has been a push to speed up, or otherwise avoid, the third phase, allowing drugs to enter the market with a shorter development time.[396] Part of this push can be explained by the boom in nootropic supplements, where the "brain health supplements" market is expected to grow from about $200 million in 2015 to

[391] Graf et. al., op. cit., 2013.
[392] Schelle et. al., op. cit., 2014
[393] Schermer, Maartje, "Enhancements, Easy Shortcuts, And The Richness Of Human Activities," *Bioethics* Vol. 22, No. 7, 2008, pp. 355–363.
[394] Goodman, Rob, "Cognitive Enhancement, Cheating, and Accomplishment," *Kennedy Institute of Ethics Journal* Vol. 20, No. 2, 2010, pp. 145–160.
[395] Bedzow, Ira, "The Confused Ethics of Cognitive Enhancers," *J Clin Psychiatry Neurosci* Vol. 1, No. 2, March 2018, pp. 12–14.
[396] Gower, Timothy, and Chris Gash, "Phasing Out Phase 3," *Proto Magazine*, November 27, 2017. http://protomag.com/articles/phasing-out-phase-3.

between $10-12 billion by 2025.[397,398] Supplements, i.e. products that are made primarily from dietary ingredients such as vitamins or widely-available agents like caffeine, face far less strict regulation than pharmaceutical products.[399] Aside from an occasional warning about dangerous substances,[400] regulation remains sparse, especially as many products are marketed toward individuals working in the tech industry who often shop online. The increasing demand for effective nootropic products, whether they are pharmaceutical or natural supplements, makes it difficult to navigate a complex market filled with over-hyped products that have not been rigorously tested on their own, nor in combination with other PCE or supplement agents, in which many options are ineffective. Hence, the acceleration of the supplement market may be prompting dangerous new shortcuts in the development of new pharmaceuticals, and in both cases the lack (or dwindling) of rigorous testing poses safety risks to users.

BCI & INI

A brain-computer interface (BCI) is a system that translates signals from the brain for use in an external device. An implanted neural interface (INI) is a device surgically implanted into a human brain. Although both technologies are closely related, there are some instances of INIs that are not BCIs (i.e., a deep-brain stimulation electrode, which sends electrical signals to a specific area of the brain but does not receive output from the brain) and vice-versa (i.e. an electroencephalograph (EEG)-controlled robotic arm, which does not require surgical implantation to function). However, since both technologies involve interaction with the human brain many of the ethical issues of both technologies are shared. Ethical issues for BCI and INI include safety, security and commercialisation, with values (potentially) impacted by the technology including human nature, privacy and autonomy.

One of the key differences between INI and BCI is that INIs require surgery to function. Modern INIs are almost exclusively found in therapeutic treatments such as deep-brain stimulation (DBS) or cochlear implants, with projects underway to develop implants that restore vision or improve memory.[401] Thus, when examined for its enhancement potential, INI is a technology that currently offers few, if any, benefits for a healthy individual that could justify the risk associated with undergoing brain surgery. In other words, **safety** for users (in particular, those who wish to enhance) remains an

[397] "Brain Health Supplements Market Size Worth $10.7 Billion by 2025: Grand View Research, Inc.," *Yahoo! Finance*, Yahoo!, June 19, 2019. https://finance.yahoo.com/news/brain-health-supplements-market-size-100500114.html.
[398] "Global $11.6 Billion Brain Health Supplements Market to 2024 | Markets Insider," *Business Insider*, Business Insider, September 12, 2017. https://markets.businessinsider.com/news/stocks/global-11-6-billion-brain-health-supplements-market-to-2024-1001642530.
[399] Chaker, Anne Marie, "Nootropic or Not? Brain-Booster Business Raises Concerns," *The Wall Street Journal*, Dow Jones & Company, April 10, 2019. https://www.wsj.com/articles/nootropic-or-not-brain-booster-business-raises-concerns-11554912076.
[400] "Dietary Supplement Trade Associations Warn Consumers of Dangerous Substance Illegally Posing as a Dietary Supplement," *Council for Responsible Nutrition*, November 5, 2018. https://crnusa.org/newsroom/dietary-supplement-trade-associations-warn-consumers-dangerous-substance-illegally-posing?mod=article_inline.
[401] Hochberg, Leigh, and Thomas Cochrane, "Implanted Neural Interfaces: Ethics in Treatment and Research," *Neuroethics in Practice*, July 2013, pp. 235–250.

ethical issue for INIs. DBS electrodes have been found to help patients with severe neuropsychiatric disorders, such as Parkinson's disease and migraines, and in one study an increase in patient's memory was reported as a side-effect of stimulating the hypothalamus to correct obesity.[402] Other than a modest boost to memory, enhancement of other (cognitive or otherwise) capabilities has not been found in DBS research. If future INI devices are safely developed and found to greatly improve capabilities, the autonomy issue of where society should draw the line on reasonable levels of risk may arise, i.e. whether or not society should allow consumers to undergo brain surgery to put an enhancement device inside their skull. For now, however, it is unlikely anyone healthy would seek to use INI devices for enhancement, thus the question of risk primarily remains in the domain of bioethics concerning patient rights and autonomy.

For BCIs, risks tend to be lower than INIs because many BCI devices do not require surgery for use. However, concern is growing regarding use of BCIs by healthy individuals for enhancement, especially of so-called do-it-yourself (DIY) devices.[403] BCIs can now be built by a user using instructions found online or purchased as a cognitive enhancement or entertainment product for use at home without professional guidance. Most research on BCI focuses on patient groups who use BCI for therapeutic purposes, making it difficult to determine effects for healthy individuals.[404,405] Long-term effects, or effects of using DIY BCI methods in conjunction with other (cognitive) enhancements, are poorly understood due to a lack of clinical study. A number of issues with DIY brain stimulation are reported by Wurzman et. al., including the risk of enhancing one cognitive ability potentially decreasing another cognitive ability.[406] Thus, safety is a key ethical issue for modern BCI technologies even as an increasing number of BCI enhancement products are now sold to consumers. Because there already exists a (growing) commercial marketplace of consumer BCI enhancement products, if research eventually determines there are significant negative effects that lead to restrictions on the sale of such devices another consequence could be the emergence of a black market for restricted BCI technologies.

Any technology that interacts with a human brain raises **privacy** and **security** issues. Although direct brain-to-brain communication remains in its infancy and is far from reaching the point where two individuals can share fully coherent linguistic thoughts via a BCI device, the technology is no longer

[402] Hamani, Clement, Mary Pat Mcandrews, Melanie Cohn, Michael Oh, Dominik Zumsteg, Colin M. Shapiro, Richard A. Wennberg, and Andres M. Lozano, "Memory enhancement induced by hypothalamic/Fornix deep brain stimulation," *Annals of Neurology* Vol. 63, No. 1, 2008, pp. 119–123.
[403] Burwell, Sasha, Matthew Sample, and Eric Racine, "Ethical Aspects of Brain Computer Interfaces: a Scoping Review," *BMC Medical Ethics* Vol. 18, No. 1, 2017.
[404] For example, (1): Hong, Xin, Zhong Kang Lu, Irvin Teh, Fatima Ali Nasrallah, Wei Peng Teo, Kai Keng Ang, Kok Soon Phua, Cuntai Guan, Effie Chew, and Kai-Hsiang Chuang, "Brain Plasticity Following MI-BCI Training Combined with TDCS in a Randomized Trial in Chronic Subcortical Stroke Subjects: a Preliminary Study," *Scientific Reports* Vol. 7, No. 1, 2017.
[405] For example, (2): Holz, Elisa Mira, Loic Botrel, Tobias Kaufmann, and Andrea Kübler, "Long-Term Independent Brain-Computer Interface Home Use Improves Quality of Life of a Patient in the Locked-In State: A Case Study," *Archives of Physical Medicine and Rehabilitation* Vol. 96, No. 3, 2015.
[406] Wurzman, Rachel, Roy H. Hamilton, Alvaro Pascual-Leone, and Michael D. Fox, "An Open Letter Concerning Do-It-Yourself Users of Transcranial Direct Current Stimulation," *Annals of Neurology* Vol. 80, No. 1, 2016, pp. 1–4.

science-fiction.[407] Concerns about "mind reading" that are overblown today are worth keeping in mind as the technology matures. Assuming the technology continues to advance, outputs from a BCI device could give an agent insights into a user's "thoughts, emotions, states or attitudes, potentially affecting people's moral or social behaviour."[408] A malicious actor could use data from a BCI to influence or enforce messaging, such as a corporation producing targeted advertisements based on information taken from a (future) consumer neural implant. Furthermore, criminals could attempt to hijack an INI device in a way similar to modern-day 'ransomware,' which is software that denies access to a computer device until the user inputs a password that is often offered only for a substantial fee. Computer-based hardware can be hacked, and if there is enough value to make the effort to do so worthwhile then new devices will be at risk.

Eventually, if data is transferred to and from neural devices wirelessly then these security risks could grow substantially, and introduce further concerns about **responsibility and liability**. For example, these issues are likely to arise if another agent, whether in the form of a hacker, an individual on the opposite side of a brain-to-brain link or another form, can use this technology to gain control of inputs and outputs to a user's brain and cause the user to perform a task they would otherwise not perform.[409] Even without malicious intent, responsibility remains a concern due to the fallibility of BCI devices: who is legally responsible if use of a BCI results in harm or financial loss?[410]

Consumers are already beginning to use cognitive enhancing BCI (or at least products advertised with such effects) in their homes. Although the prospect of consumer-driven neural implants, requiring surgery to install, repair and upgrade, remains science-fiction that is probably at least twenty years away, the increasing integration of devices into individuals' lives raises questions about **human nature**, especially when the device in question directly impacts the user's brain. Patients who use BCI devices report the integration of the device into their lives as resulting in the device becoming part of who they are, in some cases even meaning the device becomes part of their body.[411] As external devices become integrated into human life, society will have to adopt a stance on how to confront new ways of being. For example, Carter & Palermos report a case in which the cyborg artist Neil Harbisson, who uses a custom-built prosthetic device he calls the 'eyeborg' that converts colours into soundwaves, was approached by police who thought his prosthetic could film them.[412] Neural implants could introduce

[407] Trimper, John B., Paul Root Wolpe, and Karen S. Rommelfanger, "When 'I' Becomes 'We': Ethical Implications of Emerging Brain-to-Brain Interfacing Technologies," *Frontiers in Neuroengineering* Vol. 7, 2014.
[408] Cinel, Caterina, Davide Valeriani, and Riccardo Poli, "Neurotechnologies for Human Cognitive Augmentation: Current State of the Art and Future Prospects," *Frontiers in Human Neuroscience* Vol. 13, 2019.
[409] Hildt, Elisabeth, "What Will This Do to Me and My Brain? Ethical Issues in Brain-to-Brain Interfacing," *Frontiers in Systems Neuroscience* Vol. 9, 2015.
[410] Mccullagh, Paul, Gaye Lightbody, Jaroslaw Zygierewicz, and W. George Kernohan, "Ethical Challenges Associated with the Development and Deployment of Brain Computer Interface Technology," *Neuroethics* Vol. 7, No. 2, 2013, pp. 109–122.
[411] Drew, Liam, "The Ethics of Brain–Computer Interfaces," *Nature* Vol. 571, No. 7766, 2019.
[412] Carter, J. Adam, and S. Orestis Palermos, "Is Having Your Computer Compromised a Personal Assault? The Ethics of Extended Cognition," *Journal of the American Philosophical Association* Vol. 2, No. 4, 2016, pp. 542–560.

new capacities, for instance allowing individuals to catalogue their lives in novel ways using internet-connected technologies.[413]

Neuro-stimulation / neuromodulatory techniques

Neuro-stimulation/neuromodulatory techniques (referred to as neuromodulation below) is a group of technologies that primarily includes devices that provide electrical or magnetic stimulation to a human brain. Most neuromodulation systems make use of implanted electrodes that give off electric pulses to stimulate neural tissue. It is generally believed that the pulses of neuromodulation systems interfere with and block electrical signals of the nervous system that cause symptoms, and that they have effects that are similar to those that would result from lesioning neural tissue.[414] For further details about the types of neuromodulation that exist, see SIENNA D3.1: State of the Art Review of Human Enhancement, section 3.7. Ethical issues for neuromodulation include consumerism, safety and coercion, and values at risk include personal identity, free will and autonomy.

Like BCI & INI, neuromodulation today is primarily used as a therapeutic technology. Currently, the major applications are in managing chronic pain, spasticity, epilepsy, incontinence, and movement disorders. Therapies in these areas been proven safe and efficacious in randomized controlled trials, and are currently reimbursed by most health-care insurers. Advances in neuromodulation techniques also offer the promise of new therapeutic interventions for patients with neuropsychiatric disorders. Deep brain stimulation (DBS) and transcranial magnetic stimulation (TMS) are techniques that show particular promise in this area of application, and experimental treatments already exist for mental illnesses like depression, obsessive-compulsive disorder, anxiety disorders, and addiction. In addition, products, such as the Thync Calm or the Foc.us, are now available for consumers and promise cognitive enhancement.[415] Furthermore, a Do-It-Yourself (DIY) 'brain-hacking' community has emerged in the space, consisting of individuals who construct home-built tDCS devices.[416] The rise of at-home neuromodulation devices raises questions about long-term safety, as well as safety for individuals who may use multiple devices over a short period of time.

Biomedical treatment of mental disorders has traditionally raised moral and philosophical concerns because they affect the brain, and thereby have the potential to affect personal identity and free will. In what follows, we will consider how neuromodulation of the brain has been described to potentially affect free will and personal identity, respectively, and what moral questions should consequently be considered. Neuromodulation could affect **free will**, first of all, because it could impair our ability to make our own decisions or choose our own actions. Free will is the mental faculty by which we are capable of exercising control over our actions and decisions. It is impaired when actions and decisions are partially or wholly controlled by external factors, and neuromodulation could be such an external

[413] Swan, Melanie, "The Future of Brain-Computer Interfaces: Blockchaining Your Way into a Cloudmind," *Journal of Evolution & Technology* Vol. 26, No. 2, 2016, pp. 60–81.
[414] Mcintyre, Cameron C, Marc Savasta, Lydia Kerkerian-Le Goff, and Jerrold L Vitek, "Uncovering the Mechanism(s) of Action of Deep Brain Stimulation: Activation, Inhibition, or Both," *Clinical Neurophysiology* Vol. 115, No. 6, 2004, pp. 1239–1248.
[415] Brenninkmeijer, Jonna, and Hub Zwart, "From 'Hard' Neuro-Tools to 'Soft' Neuro-Toys? Refocusing the Neuro-Enhancement Debate," *Neuroethics* Vol. 10, No. 3, February 2016, pp. 337–348.
[416] HCE Wiki, "Transcranial direct-Current stimulation," *The Human Cognitive Enhancement Wiki*, n.d. http://hcewiki.zcu.cz/hcewiki/index.php/Transcranial_direct-current_stimulation.

factor. Philosophical theories of free will usually equate it with the freedom to choose one's own actions. Such freedom is usually held to require an ability to deliberate: an ability to reflect upon one's desires and values and to consider alternative ideas about what to do and how to do it.[417] A straightforward definition of free will is hence "the ability to choose one's own actions based on a process of deliberation in which one decides on a course of action based on a consideration of one's desires and values as well as the situation that one finds oneself in". If deliberation as a basis of one's actions is therefore absent, free will is absent as well: actions that have not been subjected to deliberation are reflex-like, and therefore not freely chosen.

Yet, an action can be based on a deliberative process and still not be free. This is because deliberative processes can themselves fail to be free, because their outcome has been predetermined by some factor beyond one's control. One way in which deliberative processes may have a predetermined outcome is when an overriding, controlling desire skews the deliberative process in such a way that one has no effective choice but to act on that desire. This happens for example in addiction, where agents can strongly influence or even override a person's deliberative process. A second way in which deliberation may be unfree is through manipulation by an external agent of someone's deliberative cognition. An external agent may control the inferences drawn and judgments reached in deliberation, thereby predetermining the outcome of deliberative processes. In this case, it is not so much the affective as it is the cognitive component of deliberation that is being controlled.

Studies have shown that neurostimulation can affect free will. In one study, Ammon and Gandevia[418] demonstrated that by stimulating frontal regions that are involved in movement planning in either the left or right hemisphere of the brain it was possible to influence which hand people move. Although their decision-making was clearly influenced, subjects still reported that their choices were made freely. Leentjens et al.[419] reports a case of a patient being treated for Parkinson's disease with DBS who seemed to lose a large part of his ability to deliberate when DBS was initiated, and regained it only after the pulse generator was switched off. An impairment or loss of free will due to neuromodulation could be morally problematic for at least two reasons. First, and most importantly, free will has traditionally been seen as a necessary condition for personhood. To be a person is to have free will, amongst other things. Secondly, someone who acts without free will cannot be held responsible for his actions. If actions are partially or wholly caused by neurostimulation, then a person cannot be held fully accountable for its actions. This, of course, would have major legal ramifications as well. For these reasons, it is of major importance that neuromodulation of the brain does not seriously impair free will. Yet, it is currently difficult to guarantee that treatments do not impair free will, as the mechanism of action of neuromodulation and the neurobiological conditions for free will are both ill-understood. Caution is therefore advised, and experimental research and therapy should include assessments of behavioural evidence of possible impairments to free will. It should also be considered, however, that free will is already impaired in many psychiatric disorders, like OCD, anxiety disorders, depression and addiction, due to the presence of compulsory thoughts, desires and

[417] O'Connor, Timothy, and Christopher Franklin, "Free Will," *Stanford Encyclopedia of Philosophy*, Stanford University, August 21, 2018. http://plato.stanford.edu/entries/freewill/.
[418] Ammon, K, and S C Gandevia, "Transcranial Magnetic Stimulation Can Influence the Selection of Motor Programmes.," *Journal of Neurology, Neurosurgery & Psychiatry* Vol. 53, No. 8, January 1990, pp. 705–707.
[419] Leentjens, A F, V Visser-Vandewalle, Y Temel, and F R Verhey, "[Manipulation of Mental Competence: an Ethical Problem in Case of Electrical Stimulation of the Subthalamic Nucleus for Severe Parkinson's Disease]," *Ned Tijdschr Geneeskd* Vol. 148, 2004, pp. 1394–8.

behaviours. In such cases, part of the aim of treatment is to restore free will. For these cases, it is much easier to justify treatment through neuromodulation, even if neuromodulation itself could introduces new impairments to free will.

Apart from impacting free will, neurostimulation of the brain also has the potential to impact **personal identity**. Neurostimulation could change persons by altering their moods, cognition, behaviour, and basic personality traits. Some such changes may be intended whereas others may be unintended side-effects. These changes raise ethical questions similar to those that have been raised in relation to psychopharmacology and psychosurgery. A first question is whether biomedical interventions into the brain could harm a "true" or "authentic" self by modifying and engineering brain function. Some have argued this; for example, an advisory report to the European Committee appeals to principles of human dignity and inviolability in stating that neural implants should "not be used to manipulate mental functions or change personal identity."[420] Even when such a principled stance against changes to personal identity is rejected, there could be more practical reasons to be cautious about neuromodulation techniques that affect personal identity. Major changes in personality could come at great expense because they would require significant adaptations by both the user and his social environment. Suppose, for example, that an individual could use a neuromodulation device to help regulate feeding behaviour so that a user with a tendency to consume more calories than necessary can achieve their desired weight. As Rees Cosgrove has pointed out (albeit in the somewhat different context of a treatment for an eating disorder), such a change may provoke a severe identity crisis, since the user will still have a distorted body image, and will see themselves as colossally overweight.[421] Because neuromodulation systems can be turned off, users may display quite different moods and behaviours depending on whether the system is functioning or not, which may lead to a further destabilization of identity. Using neuromodulation for enhancement therefore requires adequate research into the short-term and long-term implications for personal identity, and users and their environment should be adequately informed about the potential consequences for identity and how to deal with them.

A further complication is introduced by the fact that neuromodulation allows for real-time control. An external programmer or programming device can in real time switch a user's implant on or off or influence its mode of operation. It is also possible to equip an implant with sensors that cause its operation to be dependent on contextual factors. Scenarios are therefore possible in which neuromodulation is calibrated by measurements of bodily function, brain activity or behaviour, or in which its operation depends on location. A neuromodulation system used to suppress sexual urges of a sex offender could for example be designed to only be active outside the home. The possibility of such real-time control by third parties raises further ethical questions about individual **autonomy**.

Additional ethical issues stem from how future neuromodulation techniques could, and indeed are now beginning to, be used to enhance nonpathological undesirable psychological traits like shyness or neuroticism to a more desirable level or normal traits to a supranormal level, i.e. contribute to **medicalisation**. Studies show that neuromodulation can be used to enhance cognition and moods

[420] European Group in Ethics In Science, "Ethical Aspects of ICT Implants in the Human Body," *Jahrbuch Für Wissenschaft Und Ethik* Vol. 10, No. 1, 2005.
[421] The President's Council on Bioethics, Transcripts, Session 6: Neuroscience, Brain, and Behavior V: Deep Brain Stimulation, June 25, 2005. http://www.bioethics.gov/transcripts/june04/session6.html.

beyond normal levels. It has been shown, for example, that TMS can increase the excitability of the cortex so as to improve performance in procedural learning tasks, motor tasks, classification, working memory, and many other tasks.[422] As part of the growing trend of HET, the emergence of field of cosmetic neurology has been envisioned that engages in the modulation of motor, cognitive and affective systems of the brain so as to improve them to the pleasure of consumers.[423,424] Neuromodulation could be at the forefront of this new field. Such a development would raise new questions: Should people be allowed to enhance their own minds, and should there be limits to such enhancement? How can benefits and harms of psychological enhancement be balanced? What new inequalities may emerge because of enhancement?

Although highly speculative, future neural implants that make use of neurostimulation could be used for monitoring and control of individuals or populations, such as the regulation of aggression. Having a neural implant could become a standard requirement for certain professions, such as the military. In the worst case, this could lead to a brave new world, a neurototalitarian society where emotion, behavior and potentially even thoughts are subjected to monitoring and control.

VR/AR

Virtual reality (VR) emerged in the 1980s with developments in computing systems that simulate digital environments for a user to experience through either a datasuit or dataglove, tracked and rendered on a computer.[425] VR rendering systems have four essential elements: a virtual world (the space and objects users interact with), immersion (the sensation of being present in the virtual world), sensory feedback (sensory data about the virtual world based on user input) and interactivity (the responsiveness of the virtual world to user actions). The distinction between a virtual world in general and virtual reality in particular can be framed as follows: a virtual world is "an interactive computer-generated environment" and virtual reality "is a special type of virtual world that involves location-and movement-relative sensory feedback."[426] A point of concern in the development of VR technologies is the capacity for individuals to live out experiences in virtual worlds (especially the more sophisticated these technologies become) and possibly neglecting real world concerns. Conversely, these technologies may also have the potential to allow users to experience greater empathy,[427,428,429] as well

[422] Bostrom & Sandberg, op. cit., 2009.
[423] Chatterjee, Anjan, "Cosmetic Neurology," *Neurology* Vol. 63, No. 6, 2004, pp. 968–974.
[424] Muhammed, Kinan, "Cosmetic Neurology: the Role of Healthcare Professionals," *Medicine, Health Care and Philosophy* Vol. 17, No. 2, 2013, pp. 239–240.
[425] Brey, Philip, "Virtual Reality and Computer Simulation," *The Handbook of Information and Computer Ethics*, Wiley, Hoboken, NJ, 2008, pp. 361–384.
[426] Ibid, p. 363.
[427] Fisher, Joshua A., "Empathic Actualities: Toward a Taxonomy of Empathy in Virtual Reality," *Interactive Storytelling Lecture Notes in Computer Science*, 2017, pp. 233–244.
[428] Louie, Alan K., John H. Coverdale, Richard Balon, Eugene V. Beresin, Adam M. Brenner, Anthony P. S. Guerrero, Laura Weiss Roberts. 'Enhancing Empathy: A Role for Virtual Reality?' in *Academic Psychiatry* Vol 42, 2018, pp.747-752.
[429] Bertrand, Philippe Jérôme Guegan, Léonore Robieux, Cade Andrew Mccall, and Franck Zenasni, "Learning Empathy Through Virtual Reality: Multiple Strategies for Training Empathy-Related Abilities Using Body Ownership Illusions in Embodied Virtual Reality," *Frontiers in Robotics and AI* Vol. 5, 2018.

as arousing specific emotional affects.[430] Empathy is an important aspect of social bonding, useful for taking another person's perspective, as well as being more altruistic when noticing others are in need.[431]

Empathy is increased in VR by designing an environment in which users can experience and role play outside of their daily life, especially when the actions performed have seemingly moral consequences.[432] However, the question of what exactly users of VR systems feel empathy towards remains. Fisher reveals that it may be that the individual using a VR system may feel empathy for what the VR designer represents as a particular subject (e.g. a digital refugee child) rather than the subject in lived reality (i.e. the child in real life).[433] On the other hand, an experiment shows individuals that participated in a VR environment to experience the world as someone with colour blindness (against a control group that only imagined what it was like) were evaluated to have greater empathy.[434] This evaluation was based on the fact that the participants in the VR environment volunteered more time and effort in helping students in creating a website for people with colour blindness.[435] Furthermore, an experiment by Felnhofer et. al. revealed that creating virtual environments in specific ways (i.e. through choice of lighting, sounds, textures, objects) produced varying emotions (e.g. joy, anger, boredom, anxiety and sadness) in the participants.[436] Users therefore will be able to not only get a sense of life beyond their daily circumstances, but they may also become dependent on staying within VR environments, especially those that are designed for arousing positive emotions. Similar to the concern with whether mood enhancements drugs should be easily accessible to improve one's mood in an immediate manner, VR technologies, especially those purposefully designed to arouse specific emotions, may warrant closer examination as they become more immersive and potentially supersede real environments.

Augmented reality (AR) allows users the ability to experience computer-generated virtual objects that coexist within the same space as the real world the user is inhabiting through the use of a headset, handheld device or spatial display.[437,438] The modalities of human sensory input for AR devices mainly include sight, sound and touch.[439] AR devices can enhance the capacity for individuals in different domains to see, work on and manipulate objects in new ways. However, given that AR technologies are predominantly produced and used in the developing world, this means that only certain countries and their respective workforces will benefit from these technologies. And even within the developed

[430] Felnhofer, Anna, Oswald D. Kothgassner, Mareike Schmidt, Anna-Katharina Heinzle, Leon Beutl, Helmut Hlavacs, and Ilse Kryspin-Exner, "Is Virtual Reality Emotionally Arousing? Investigating Five Emotion Inducing Virtual Park Scenarios," *International Journal of Human-Computer Studies* Vol. 82, 2015, pp. 48–56.
[431] Bertrand, et. al., op. cit., 2018, p. 2.
[432] Fisher, op. cit., 2017, p. 239.
[433] Ibid, pp. 237-8.
[434] Louie, et. al., op. cit., 2018.
[435] Ibid, p. 749.
[436] Felnhofer, et. al., op. cit., 2015, p. 53.
[437] van Krevelen, D. W.F., and R. Poelman, "A Survey of Augmented Reality Technologies, Applications and Limitations," *The International Journal of Virtual Reality* Vol. 9, 2010, pp. 1–20.
[438] Billinghurst, Mark, Adrian Clark, and Gun Lee, "A Survey of Augmented Reality," *Foundations and Trends® in Human–Computer Interaction* Vol. 8, No. 2-3, 2015, pp. 73–272.
[439] Van Krevelen & Poelman, op. cit., 2010.

countries, most AR technologies are still significantly expensive and thus will remain accessible to only businesses or wealthy individuals.

Memory enhancement

Some people wish they could improve their memory. Perhaps a student might struggle with recalling an equation at the right time to pass a math test. On the other hand, some people wish they could forget a traumatic experience. For a soldier, memories of the battlefield can haunt their civilian life until the day they die. Recently, researchers have begun investigating some drugs that may prove effective in allowing people to modify their memories.[440] Whether to enhance or edit existing memories, these memory modification technologies (MMTs) could become available to consumers soon.[441] Although it's unclear when MMT products could become available to the public, the emerging nootropic and DIY neuromodulation markets suggest a market of profitable products will appear as soon as research and clinical trials can be completed. Thus, it is not entirely premature to begin contemplating the ethical issues that are likely to follow the emergence of a commercial MMT market.

Like many bioenhancers, MMTs could pose **safety** concerns due to harmful side-effects. Because certain elements of human memory remain poorly understood, it could be the case, for example, that a drug boosting short-term memory could negatively impact long-term memory, or could disturb previously-stored memories.[442] Even if there are no harmful side-effects, the enhancement of memory consolidation could result in a user remembering far more details than intended, potentially making it more difficult to utilise the enhanced memories in daily life by making it difficult to pick out meaningful details.

Furthermore, if a user comes to rely on MMTs in daily practice this could result in a loss of **authenticity** for the user.[443] For example, a CEO may impress her clients by remembering the name, age and school district of their client's child, but if they never could have recalled these details without the MMT this could be evidence of inauthenticity. Also consider a case in which a journalist uses MMT to dampen their emotional reaction during an interview: in this case, the journalist's questions may be inauthentic because they are circumventing the reactions they would have without the MMT. Another concern related to autonomy arises in cases where MMT might be used for cognitive offloading, i.e. in the form of a neural implant with a 'map'-style navigational function: if a user accesses such a function, can they claim the knowledge, i.e. of which roads to take to get from point A to point B, comes from them or only from the implant?[444]

MMT is an (emerging) enhancement technology category that may introduce new ethical issues related to **social norms**, and it is especially difficult to navigate the space in terms of separating

[440] Erler, Alexandre, "Does Memory Modification Threaten Our Authenticity?," *Neuroethics* Vol. 4, No. 3, 2010, pp. 235–249.
[441] Liao, S. Matthew, "The Ethics of Memory Modification," *The Routledge Handbook of Philosophy of Memory*, 2017, pp. 373–382.
[442] Cabrera, Laura Y., and Bernice S. Elger, "Memory Interventions in the Criminal Justice System: Some Practical Ethical Considerations," *Journal of Bioethical Inquiry* Vol. 13, No. 1, 2015, pp. 95–103.
[443] Erler, op. cit., 2010.
[444] Heersmink, Richard, and J Adam Carter, "The Philosophy of Memory Technologies: Metaphysics, Knowledge, and Values," *Memory Studies*, 2017.

treatment uses from enhancement. Probably, the most realistic near-term MMT will be used to dampen traumatic memories to treat post-traumatic stress disorder (PTSD).[445] One might argue anyone who uses a memory-dampening drug to deal with a traumatic memory is doing so in a therapeutic way, thus this use of MMTs cannot be enhancement. However, if such drugs enter the consumer market it could be the case that some individuals will use the technology to dampen memories that many wouldn't agree are 'traumatic,' yet in some way 'enhance' the user's life to avoid. Henry et. al. speculate about "a drug advertisement in which someone is encouraged to take propranolol after an embarrassing or humiliating experience at the office."[446] Thus, consider the following issue with this class of MMTs: if many victims choose to use MMTs for therapeutic purposes, society may come to see the more volatile emotional reactions of victims who choose not to use biomedical MMTs as inappropriate. Many social activists suggest in some areas there is a 'rape culture,' in which victims are routinely accused of provoking their assault. Widespread use of MMTs could lead to the enablers of 'rape culture' to claim that the harm caused to victims isn't serious because victims could 'easily' forget their assault with MMTs. On the other hand, rather than helping a PTSD victim find relief by dampening their traumatic experience, MMTs could hypothetically instead be used to make sure a criminal feels guilty about their harmful actions by amplifying the emotional valence of the action.[447] Such a scenario raises further issues about **coercion and consent** regarding the use of drugs in the prison system. If an offender is offered a lighter sentence based on the use of a risky MMT that carries the potential for harmful side-effects, the result could be an injustice perpetrated against the criminal. There's a fine line when it comes to possible uses of MMTs on criminals: if the drug successfully rehabilitates a criminal, it seems the result would be a benefit to society. However, if the criminal is coerced to use a drug that drastically changes their personality or true self by rearranging or changing the emotional impact of their memories, it could be that use of the drug may result in the person who existed prior to taking the drug ceasing to exist.

Cabrera & Elger raise a subsequent worry by suggesting MMTs could be used "for obtaining confessions from criminal offenders," i.e. raising concerns about **justice**.[448] For instance, if a criminal is made to swallow a pill that somehow causes them to tell an officer or judge details of their memories against their will, it seems such a confession would be forced, and may be unjust. Furthermore, they point out "there is always the worry of [MMTs] being abused by the system to convert its citizens into puppets with no powers of critical reflection to protest against the system."[449] For a government system to mandate the use of MMT across an entire population would require significant effort that would likely be strongly opposed, but the possibility may exist, especially if the MMT could be secretly administered, for example, to the water supply.

The **accessibility** of human enhancement technologies, i.e. the (in)ability for individuals to effectively utilise such options, remains a widely debated issue across the entire field of human enhancement. A recurring worry relates to high costs for advanced technologies exacerbating social, political and

[445] Henry, Fishman & Youngner, op. cit., 2007, pp. 12–20.
[446] Ibid, p. 18.
[447] Cabrera & Elger, op. cit., 2015.
[448] Ibid.
[449] Ibid, p. 100.

economic inequalities as the field matures. If MMTs are developed but are only available to the wealthy due to excessive costs, this could expand class divides.[450]

6.2 Physical enhancement

PED

One of the fundamental aims of physical enhancement is to extend a person's performance capacity in a specific area of human experience, by using either physically enhancing drugs/substances (PEDs) or through the use of techniques such as supplements and, more so in the future, gene therapy. One major domain where the use of PEDs and other physically enhancing techniques draw interest is in the domain of sports and debates have taken about such applications since the 1980s. This interest is being generated because a range of issues that exist in the use of PEDs, not just for athletes but also for physicians, sporting committees such as the World Anti-Doping Agency (WADA) and society in general. It is important to note that WADA also tests for cognitive enhancements; thus, the focus on performance enhancement in this section is not meant to characterise the practices of WADA, for which the physical/cognitive distinction is inconsequential to ethical frameworks, or other agencies, but rather as an ad-hoc category separation specific to SIENNA's classifications of HET overall.

Bloodworth et al.[451] and Waddington et al.[452] both point out that there are three guiding criteria used by WADA to test for the legitimacy of a doping method. When considering to ban a substance or method they inquire into whether it can 1) have an adverse effect on the health of athletes, 2) whether it is performance enhancing, and 3) if it can negatively affect the image or spirit of sport. The first of these arguments is based on studies that have found that the use of certain PEDs such as Anabolic, Androgenic Steroids (AAS) can lead to a range of medical conditions when taken in above-stipulated doses. The analysis of Finnoff and Chimes[453] illustrates that AAS abuse can cause "adverse effects such as hypertension, cardiomyopathy, left ventricular hypertrophy, dyslipidemia, myocardial ischemia, adverse coagulation and platelet aggregation effects."[454] Researchers also comment on the fact that a number of the substances on the banned list for competitive sports were in use predominantly to treat ailments, but are now being used as PEDs. In the context of alpinists, Cushing et al.[455] point out how substances such as acetazolamide and dexamethasone are used to give climbers a competitive edge, but there is a need for physicians to weigh in on how substances used for treatment ought to (assuming

[450] Liao, op. cit., 2017.
[451] Bloodworth, A. J., A. Petróczi, R. Bailey, G. Pearce, and M. J. Mcnamee, "Doping and Supplementation: the Attitudes of Talented Young Athletes," *Scandinavian Journal of Medicine & Science in Sports* Vol. 22, No. 2, 2010, pp. 293–301.
[452] Waddington, Ivan, Ask Vest Christiansen, John Gleaves, John Hoberman, and Verner Møller, "Recreational Drug Use and Sport: Time for a WADA Rethink?," *Performance Enhancement & Health* Vol. 2, No. 2, 2013, pp. 41–47.
[453] Finnoff, Jonathan T., Gary P. Chimes, and Thomas H. Murray, "Performance-Enhancing Drugs," *Physical Medicine and Rehabilitation* Vol. 2, No. 4, 2010, pp. 285–293.
[454] Ibid.
[455] Cushing, Tracy A., Scott E. Mcintosh, Linda E. Keyes, George W. Rodway, Robert B. Schoene, Buddha Basnyat, and Luanne Freer, "Performance-Enhancing Drugs—Commentaries," *Wilderness & Environmental Medicine* Vol. 23, No. 3, 2012, pp. 207–211.

it is even possible to do so) be used as PEDs. For this reason, it is necessary that athletes know clearly not only the gains to be had from using PEDs but also the costs.

In the case of physical enhancement techniques **safety** is also a key concern that warrants the attention of regulatory bodies and medical professionals, given the associated gains and risks of their use. The gains of using PEDs can take the form of increase sprinting capacity from intake of human growth hormone as well as with non-prohibited substances such as creatine, which enhances power, and beetroot juice, which enhances endurance, and which can overall lead to improvement of athletic performance capacities.[456] Such gains would indeed give athletes using these substances a competitive edge over competitors who do not use them, and fears of being at a disadvantage, as well as not knowing if/how many of one's competitors are using PEDs, introduces what Ehrnborg and Rosen refer to as "the doping dilemma."[457] Such a dilemma (a variant of the prisoner's dilemma) occurs whereby athletes may be likely to use PEDs because of the "suspicion/conviction that everyone else is using it and therefore one must use it to compete under the same conditions."[458] Such a dilemma can become heightened because not only do athletes face pressures to win (i.e., for honour, fame as well as cash prizes) that may drive them to using PEDs, but also because new techniques such as gene therapy may make it possible for athletes to gain physical enhancements that may not be detected by regulatory committees like WADA. This is pointed out by Miah,[459] and more recently by Gould,[460] who states that gene therapy may be attractive to athletes because it introduces molecules that are "potentially identical to endogenous proteins,"[461] which means it would be more difficult for antidoping regulators to catch instances of doping when testing. As for the risks involved with the use of PEDs, sustained use of anabolic steroids for athletes and non-athletes can lead to liver tumours, high blood pressure and infertility when these substances are used for a long period of time.[462] In the context of competitive sports, the World Anti-Doping Code devised by WADA provides the international standard for setting up the regulations that determine the testing, adjudication and punishment of athletes as well as any of their support staff who assisted in the athletes' use of physical enhancement techniques or substances.

An additional ethical issue is how **invasive antidoping policies can be on the lives of athletes**. Athletes, for instance, need to regularly provide doping authorities with information about their whereabouts, in addition to dealing with testing procedures becoming ever more sophisticated. That said, most elite athletes "accept the inconveniences associated with antidoping regulations and testing because they support antidoping efforts that aspire to level the field of play,' according to Finnoff & Chimes.[463] The stringency and invasive implementation of antidoping policies are therefore justified so long as they

[456] Thompson, Helen, "Performance Enhancement: Superhuman Athletes," *Nature* Vol. 487, No. 7407, 2012, pp. 287–289.
[457] Ehrnborg, Christer, and Thord Rosén, "The Psychology behind Doping in Sport," *Growth Hormone & IGF Research* Vol. 19, No. 4, 2009, pp. 285–287.
[458] Ibid.
[459] Miah, Andy, *Genetically Modified Athletes: Biomedical Ethics, Gene Doping and Sport*, Routledge Taylor & Francis Group, London, 2005.
[460] Gould, David, "Gene Doping: Gene Delivery for Olympic Victory," *British Journal of Clinical Pharmacology* Vol. 76, No. 2, 2013, pp. 292–298.
[461] Ibid.
[462] Kourany, op. cit., 2014, p986.
[463] Finnoff & Chimes, op. cit., 2010, p. 287.

promote the ethical goal of fairness of competition among athletes. However, such invasiveness may not only be about ensuring competitive fairness or the health of athletes. Waddington et al.[464] focus on the treatment of recreational substances, such as marijuana, by WADA and contend that these substances are prohibited because they appear to damage the image or spirit of sport. Such a concern, the authors find, may be due to what they refer to as the 'spillage' of public anxieties about drugs into sporting arenas. The effect of this 'spillage' is that athletes will face punitive consequences for the use of substances such as marijuana, even if their use neither enhances the performance of athletes nor has health risks for the athlete (like the risks of AAS mentioned above). Thus, the third argument used by WADA, that is prohibiting certain substances helps to maintain the spirit or image of sport, for Waddington et al. represents WADA reaching beyond traditional sporting concerns, and into regulating the lifestyle of athletes.[465]

Image and performance enhancing drugs (IPEDs) include anabolic steroids, growth hormones, peptide hormones and other drugs used to increase not only muscular structure but also modify an individual's appearance.[466,467] IPEDs can be distinguished from PEDs by the fact that while PEDs are used in predominantly competitive sports domains, IPEDs are used more recreationally and in more illicit contexts.[468,469] For this reason, IPEDs face regulatory pressure as not only are these drugs reported to be obtained illegally, but also because they have associated adverse health risks. Thus, IPEDs are considered by anti-doping authorities, media and policymakers as threats to both the individual and the social body.[470] The health risks associated with IPED use include increased risk of cardiomyopathy, myocardial infarction, metabolic, neurologic, renal and musculoskeletal disorders, as well as psychological effects such as aggression, depression and mania.[471] Individuals who experience these adverse effects are reported to more likely wait for the symptoms to go away or treat them themselves than seek medical help due to the illicit nature of most IPEDs.[472]

While IPED use and supply are considered criminal, within recreational bodybuilding communities these substances are considered part of the lifestyle, i.e. as one of several components such as training and nutrition, leading to a normalisation of these substances in these communities in terms of use as well as supplying.[473] Thus, another ethical issue for IPED is **social coercion**, i.e. the risk of members of

[464] Waddington et. al., op. cit. 2013
[465] Ibid.
[466] Bates, Geoff, and Jim McVeigh, *Image and Performance Enhancing Drugs 2015 Survey Results*, Public Health Institute, Liverpool John Moores University, 2016.
[467] Begley Emma, Jim McVeigh and Vivian Hope, *Image and Performance Enhancing Drugs 2016 National Survey Results*, Public Health Institute, Liverpool John Moores University, 2017.
[468] Ven, Katinka Van De, and Rosa Koenraadt, "Exploring the Relationship between Online Buyers and Sellers of Image and Performance Enhancing Drugs (IPEDs): Quality Issues, Trust and Self-Regulation," *International Journal of Drug Policy* Vol. 50, 2017, pp. 48–55.
[469] Ven, Katinka Van De, and Kyle J.d. Mulrooney, "Social Suppliers: Exploring the Cultural Contours of the Performance and Image Enhancing Drug (PIED) Market among Bodybuilders in the Netherlands and Belgium," *International Journal of Drug Policy* Vol. 40, 2017, pp. 6–15.
[470] Ven, Katinka Van De, "'Blurred Lines': Anti-Doping, National Policies, and the Performance and Image Enhancing Drug (PIED) Market in Belgium and The Netherlands," *Performance Enhancement & Health* Vol. 4, No. 3-4, 2016, pp. 94–102.
[471] Bates & McVeigh, op. cit., 2016, p. 8.
[472] Ibid.
[473] Ven & Mulrooney, op. cit., 2017, p. 13.

a certain community/culture feeling pressure to engage in illicit behaviour. Even so, the perceived benefits and seeing their use as part of their training regiment lead to these risks not being enough to mitigate the use of IPEDs for many individuals. As a result of reports of adverse health effects, a number of countries have devised initiatives to deal with the rising consumption of IPEDs. These initiatives aim to stop the supply of IPEDs as well as penalize those found using them, for instance through the establishment of anti-doping police units in countries such as France, Italy and Belgium, while in other countries such as the Netherlands there is a focus instead on harm reduction strategies.[474]

An additional ethical issue for PEDs is that widespread use may lead to a **redefinition of human norms**. If easily accessible drugs, especially if future versions prove much more safe and effective, enable athletes to greatly outperform 'normal' human standards, then the bar for what constitutes "average" performance may rise and, thus, become unattainable for individuals who choose not to use PEDs, no matter the reason.[475] This issue could be more of an issue for professional competition, such as sport, than in the workplace, education or at home, where standards of fairness and the valuation of achieving athletic excellence may not be as high.

3D Bioprinting

One of the fundamental aims of the production of artificial organs and tissues through the use of 3D printing techniques is to address the overwhelming demand for organ transplants, and the need for methods to supplement traditional organ donations.[476,477,478,479] The use of these techniques fall under the term "bioprinting," whereby the domains of digital information and biology intersect, as bioprinting attempts to transform digital information into models that can mimic how human organs function.[480] Bioprinting techniques follow two principles: dispersion and additive manufacturing. Dispersion is the breaking down of complicated designs and structures into abstractions of simpler subsystems and components, and additive manufacturing works on the recognition that materials can be used to build designs from simple arrangements to complex structures.[481] The process of construction of such structures involves starting with a digital blueprint of the object made using computer-aided design (CAD) software, which translates the blueprint into a path for the printing machine to follow in its assembly of a real object (such as organs) from organic (such as pluripotent

[474] Ven, op. cit., 2016, p95.
[475] Fraleigh, Warren P., "Performance-Enhancing Drugs in Sport: The Ethical Issue," *Journal of the Philosophy of Sport* Vol. 11, No. 1, 1984, pp. 23–28.
[476] Harbaugh, Jeremy Thomas, "Do You Own Your 3D Bioprinted Body?," *American Journal of Law & Medicine* Vol. 41, No. 1, 2015, pp. 167–189.
[477] Vermeulen, Niki, Gill Haddow, Tirion Seymour, Alan Faulkner-Jones, and Wenmiao Shu, "3D Bioprint Me: a Socioethical View of Bioprinting Human Organs and Tissues," *Journal of Medical Ethics* Vol. 43, No. 9, 2017, pp. 618–624.
[478] Hacıoglu, Askican, Hakan Yılmazer, and Cem Bulent Ustundag, "3D Printing for Tissue Engineering Applications," *Journal of Polytechnic*, February 2018.
[479] Derakhshanfar, Soroosh, Rene Mbeleck, Kaige Xu, Xingying Zhang, Wen Zhong, and Malcolm Xing, "3D Bioprinting for Biomedical Devices and Tissue Engineering: A Review of Recent Trends and Advances," *Bioactive Materials* Vol. 3, No. 2, 2018, pp. 144–156.
[480] Harbaugh, op. cit., 2015, p169.
[481] Ibid, p. 170.

stem cells) and inorganic materials (such as ceramic).[482] There are a number of approaches to 3D bioprinting, i.e. biomimicry, autonomous self-assembly and mini-tissue building blocks,[483] as well as different types of bioprinters, namely ink-jet, microextrusion and laser-assisted bioprinters.[484] Ink-jet and microextrusion bioprinters are cheaper and easier to use, while laser-assisted bioprinters are more expensive. The choice of printer has an effect on the type of structures that can be constructed, as well as affecting the kinds of cells that can be used in the bioprinting process. For example, factors such as the level of pressure, heat and choice of biomaterials affects the performance of each of these printers.

Bioprinting techniques are primarily part of the field of regenerative medicine. The field of regenerative medicine uses techniques that produce functioning organs in vitro through the combination of replication of cell lines and the implementation of 3D printing in the healthcare industry, allowing for the production of bone replacements, as well as organs such as kidneys and livers.[485] For these procedures to be successful, the choice of materials in the construction of artificial organs is important, and the types of materials used are referred to as biomaterials. These materials are meant to allow for successful transplanting in a patient with minimal chance of rejection, and include biodegradable polymers, ceramics, hydrogels, and combinations of these materials.[486] In order for bioprinting to become a real alternative and supplement to traditional organ donations, three factors affect the field's viability: automation, integration and quality control. The development of 3D printing technology and techniques address the automation concern, as robotic control allows for better manipulation of biomaterials as well as improvements in speed and resolution of structure construction.[487] Integration involves the process through which vascular networks in the bioprinted organs can be grown by combining a bioreactor (the environment for the vascular network) with the bioprinter.[488] Quality control is the final concern, as a poorly design product could have adverse effects if used in transplantation procedures, thus necessitating the need for well-formed planning phases as well as sensors to follow the organ printing process.[489] Quality control is an important part of the bioprinting process due to the safety issues that are likely to arise, given issues of biomaterial degradation and tissue integration, biocompatibility and the emergence of DIY communities using bioprinting techniques in non-medical settings for non-medical interventions.[490] Such risks prompt the need for regulations such as the EU Tissues and Cells Directive to ensure the quality and safety of cell and tissue material from patients used in the successive stages of donation, procurement and testing.[491]

As bioprinting involves the merging of digital information and biological materials, beyond concerns of design techniques and their feasibility, there is also the concerns of framing who **owns** the artificial organs and tissues once they are printed and used, as well as the potential property interests of the

[482] Vermeulen et. al., op. cit., 2017, p1.
[483] Hacioglu et. al., op. cit., 2018, p221.
[484] Ibid, pp. 222-3.
[485] Harbaugh, op. cit., 2015, p168.
[486] Ibid, p. 172.
[487] Ibid, p. 173.
[488] Ibid, p. 174.
[489] Ibid, p. 174.
[490] Kritikos, Mihalis, *3D Bioprinting for Medical and Enhancement purposes: Legal and Ethical Aspects*, Science and Technology Options Assessment for the European Parliament Research Service, 2018.
[491] Ibid, p. 12.

genetic and digital information used in the construction of these organs.[492] The concerns are whether researchers, under patent law, can claim ownership of the constructed organs, and whether it is possible for researchers to also claim ownership of information gained from research and experimentation. Legislatively, to be able to claim this ownership it must be shown that the genetic information and organs have distinctively different characteristics from those found in naturally occurring environments.[493] While biomaterials are often proprietary products that are not naturally occurring and are thus likely to be patent eligible, the scans of the patient's organs are not likely to be patent eligible because they are not distinctly different from the organ they refer back to.[494] Additionally, beyond just the blueprints of patient organs, there is also the culture of patient cells used in the construction of vascular networks. While on the one hand these cells being reproduced outside of their host body makes them usable but also recognized as public goods, if patients and physicians wish to retain control access to these cells, they will become exclusive goods and likely to be patent eligible. The value of bioprinted organs will therefore be a product of whether or not they are considered as public goods or private goods, which determine not only how they (and their constituent components, i.e. blueprints, biomaterials and cells) are patented but also how their distribution becomes regulated.[495] Thus, bioprinting and its constituent parts have a value-ladenness for patients, physicians, research institutions/facilities and biotechnology companies, which means the process of bioprinting will also involve issues **over privacy, informed consent and liability.**[496] For this reason, there are associated concerns of **access** to bioprinting technologies and products,[497] as depending on how they are classified legislatively (as advanced medical therapy products or medicinal products) and thereby how they will be regulated, will affect the costs as well as distribution of bioprinted organs and services.

Bioweapons

The application of human enhancement in military contexts, generally speaking, has led biotechnology and bioweapons to move from conceptions of germ attacks to a potential future of biologically enhanced soldiers.[498,499,500] The effects such enhancements will have include increasing the military capabilities of countries developing these technologies.[501] Human enhancement in military contexts is therefore also linked to the political power that can be gained from better combat results through the use of enhanced military capabilities. However, just as advanced conventional weapons pose dual-use risks from malicious actors such as rogue states, terrorist organisations and violent psychopaths,

[492] Vermeulen et. al., op. cit., 2017, p. 4.
[493] Harbaugh, op. cit., 2015, p. 179.
[494] Ibid, p. 180.
[495] Ibid, p. 182.
[496] Kritikos, op. cit., 2018, p. 10.
[497] Vermeulen et. al., op. cit., 2017, p. 4.
[498] Mccarty, Kristin, "Building a Better Soldier: Human Enhancement Technologies in the 21st Century," *Paideia* Vol. 1, No. 1, January 2014.
[499] Axe, David, "This Scientist Wants Tomorrow's Troops to Be Mutant-Powered," *Wired*, Conde Nast, June 3, 2017. https://www.wired.com/2012/12/andrew-herr/.
[500] Blackhurst , Jack L, "The Quantified Warrior," *Armed Forces Journal*, January 13, 2014. http://armedforcesjournal.com/the-quantified-warrior/.
[501] McCarty, op. cit., 2014, p. 9.

enhancement technologies that improve combat capability could pose similar dual-use risks were they to fall in the wrong hands.

The enhancement of military personnel can be traced historically, in the case of the U.S., to the biomedical intervention of vaccinations to protect soldiers against smallpox in the American Revolutionary War from 1775-1783.[502] This biomedical focus for military application is still prevalent in military human enhancement projects in the 21st century, such as DARPA's RealNose project and Canada's electronic pass-through hearing protection for enhancing verbal signals while filtering out environmental noises.[503] There are also instances where amphetamines are used for their anti-fatigue effect on air force pilots, and modafinil to improve the performance of helicopter pilots in simulations, along with caffeine gums.[504] Beyond biomedical interventions (i.e. enhancements within the body), there are also developments of enhanced materials such as body armour and helmets with in-built sensors (to monitor health and improve perception abilities in battle situations) as well as exoskeletons and telepresence in the controlling semi-autonomous machines.[505] Virtually all human enhancements for military purposes carry dual-use risks: for example sense-enhancement could be used to illegally spy on private citizens and the type of external applications discussed above could be used to facilitate a wide variety of criminal activity.

The existence of states with enhanced soldiers requires rethinking of international laws of war and human ethics,[506] as they present risks to security of non-enhanced states as well as populaces,[507] and, furthermore, ethically challenge notions of human nature. The need to develop, as well as concern over the development of, enhancement technologies is likely to lead to a new arms race between countries leading to different treatments and responses to enhanced soldiers, from their family members and from enemy combatants.[508] This arms race and the possible risks for enhanced soldiers and those around them (especially civilian populaces) may be made more problematic if these technologies are implemented without being fully tested and refined.[509] In such cases where the risks are great, responsibility may be placed on the enhanced military personnel if they endanger civilians, but also on those in charge of implementing the enhancement (i.e., military commanders and physicians), especially if soldiers are not aware of the consequences of the enhancements they agree to given the lack of proper testing.

Wearables

Wearable computing devices are more and more pervasive. Typical fields of application are within the healthcare and lifestyle domains. Recently, the philosophical debate has been mainly about how such mHealth applications can facilitate users' autonomy and shed new light on their agency.[510] The most

[502] Lin et. al., op. cit., 2013, p. 5.
[503] Ibid, p. 25.
[504] Fritz et. al., op. cit., 2010, p. 6.
[505] McCarty, op. cit., 2014, pp. 16-17.
[506] Ibid, p. 12.
[507] Ibid, p. 20.
[508] Lin et. al., op. cit., 2013, p. 20.
[509] McCarty, op. cit., 2014, p. 19.
[510] Wagner, Nils-Frederic, "Doing Away with the Agential Bias: Agency and Patiency in Health Monitoring Applications," *Philosophy & Technology* Vol. 32, No. 1, 2018, pp. 135–154.

widely discussed ethical issues concern privacy, data security, responsibility, and paternalism,[511,512] as well as conflicts of interest between different stakeholders.

Owens and Cribb are among those who have recently argued for the autonomy enhancement potential of mHealth apps.[513] In particular, they think that such apps can foster users deliberation and decision-making capacities. Wagner has argued, drawing on the extended mind and extended will framework, that mHealth applications merely serve as volitional aids to agents' internal cognition.[514] Autonomously set goals can thus be achieved more effectively via technology.

Others are more critical towards such technologies. Lanzing, for example points to a tension between disclosing sensitive personal information and safeguarding one's autonomy: "self-tracking breaks down informational privacy boundaries that otherwise enable autonomous self-presentation within different social contexts."[515] Along those lines, it has recently been argued that such devices might be seen as digital companions rather than empowering devices.[516] When it comes to privacy and data security, a potential for intrusive, unexpected and non-consensual data collection, i.e. Amazon Alexa controversies, cannot be ignored. Even consensual data-gathering may deliver information user does not want to know or feel uncomfortable with.

Considering social issues, it has been argued that due to various factors such as access, targeting, personal resources or incentives, wearables run the risk of increasing health inequalities, thereby creating a problem of social justice.[517] This includes concerns about expensive devices potentially requiring sponsorship which might come with sponsors' demands such as asking users to follow specific protocols.

6.3 Affective & emotion enhancement

As this section focusses on the ethical issues of products and techniques of HET, we include the following to note that, currently, there are no affective & emotion enhancement products or techniques that fit the SIENNA definition of HET. Although there is limited research of anti-depressants used by healthy individuals,[518] this use has not been clinically approved, thus cannot be considered an

[511] Krieger, William H., "Medical Apps: Public and Academic Perspectives," *Perspectives in Biology and Medicine* Vol. 56, No. 2, 2013, pp. 259–273.
[512] Owens, John, and Alan Cribb, "'My Fitbit Thinks I Can Do Better!' Do Health Promoting Wearable Technologies Support Personal Autonomy?," *Philosophy & Technology* Vol. 32, No. 1, June 2017, pp. 23–38.
[513] Ibid.
[514] Wagner, op. cit., 2018.
[515] Lanzing, Marjolein, "The Transparent Self," *Ethics and Information Technology* Vol. 18, No. 1, 2016, pp. 9–16. p10.
[516] Morley, Jessica, and Luciano Floridi, "The Limits of Empowerment: How to Reframe the Role of MHealth Tools in the Healthcare Ecosystem," *Science and Engineering Ethics*, June 2019.
[517] Paldan, Katrin, Hanno Sauer, and Nils-Frederic Wagner, "Promoting Inequality? Self-Monitoring Applications and the Problem of Social Justice," *Ai & Society*, 2018.
[518] Repantis, Dimitris, Peter Schlattmann, Oona Laisney, and Isabella Heuser, "Antidepressants for Neuroenhancement in Healthy Individuals: a Systematic Review," *Poiesis & Praxis* Vol. 6, No. 3-4, 2008, pp. 139–174.

existing product. For discussion of the (general) ethical issues relevant to expected affective & emotion enhancement technologies, please refer to the previous section.

6.4 Moral enhancement

Although moral enhancement is a heavily debated topic in the ethics of human enhancement, most applications discussed are of the 'robust' variety and, importantly, have yet to be successfully developed. In this section, we discuss two exceptions, both of which are sometimes argued as not actually being moral enhancements: chemical castration and drugs used on criminals for corrective purposes.

Chemical castration

Chemical castration can be defined as a hormone therapy that takes away someone's sexual desire.[519] It is also known as androgen deprivation therapy. Chemical castration is used to treat sexual offenders and is an adjunct to the regular psychotherapy offenders receive. It can be considered a form of biomedical moral enhancement when viewed as an optional means for improving one's moral behaviour, although we note this perspective is far from dominant, as many in the field consider chemical castration to fall squarely on the *treatment* side of the treatment/enhancement distinction.[520]

The main idea behind using this form of enhancement is changing the offenders' (also referred to as Sexual Violent Predators, or SVPs, by Balsamo & Eth[521]) brain structure to reduce the likelihood of the offender committing another sexual crime or showcasing criminal behaviour in general.[522] In certain US states, biomedical interventions such as hormone therapy are already used to punish SVPs, especially those who have sexually abused or molested children.[523]

Yet, chemical castration is a much debated and controversial enhancement technology. The debate surrounding it tries to find a solution between protecting the victims of sexual violence and protecting the civil rights of SVPs.[524] According to Shaw, American research conducted on the public perception of punishing sexual offenders by using hormone therapy has been positive and supportive. It is perceived as retributive justice.[525] Retributivists usually tend to see biomedical interventions as a form of justice which the offenders deserve for their crime(s).[526] It simultaneously indicates that society does not approve of sexual offenders and will take serious charges.

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[519] Ratkoceri, Vedije, "Chemical Castration of Child Molesters – Right or Wrong?!," *European Journal of Social Sciences Education and Research* Vol. 11, No. 1, October 2017, p. 70.
[520] Shaw, Elizabeth, "Retributivism and the Moral Enhancement of Criminals Through Brain Interventions," *Royal Institute of Philosophy Supplement* Vol. 83, 2018, pp. 251–270.
[521] Balsamo, Dalia N., and Spencer Eth, "Sexual Enhancement Treatment for Sexually Violent Predators: Ethical and Legal Implications," *Journal of Sex & Marital Therapy* Vol. 42, No. 8, July 2015, pp. 702–706.
[522] Shaw, op. cit., 2018.
[523] Ibid, p. 270.
[524] Balsamo, op. cit., 2016.
[525] Ibid, p. 262.
[526] Ibid, p. 262.

In contrast to the above mentioned argument, clinicians often defend the other side of the debate since they recognize and acknowledge the fragile mental states of SVPs. The latter often suffer from chronic mental conditions and require active treatment. Even though clinicians therefore also stress the importance of treatment, the reason behind treating SVPs is different for them than society's. Whereas the public's opinion is to treat SVPs out of punishment, clinicians believe offenders should be treated for the sake of rehabilitation.[527] On the other hand, it cannot be said with certainty whether treating SVPs for the sake of punishment or out of rehabilitation is better for the sake of the offender. Balsamo & Eth, however, conclude with the statement that the unique needs of each SVP should be taken into account before deciding on whether the offender requires treatment or not — unless immediate danger is present.[528]

Criminal & Correctional Use of Moral Enhancement

Choy, Focquaert & Raine[529] and Wiseman[530] point out that there is a growing body of literature which claims undesirable behaviour such as crime and violence is determined by our biology; hence, bad behaviour is a biological problem. Even though biological or neuro interventions have for a long time been avoided, recently there is a rise in use of such means within the criminal justice system to treat socially bad behaviour.[531] Wiseman states that the interventions for social control of undesirable behaviour have usually been directed at the vulnerable citizens of society.[532] Think, for example, of the poor and the marginalized.

In 2016, however, addicted inmates in the New Hampshire prison systems were experimented on and given drugs such as Vivitrol.[533] Vivitrol is an opioid inhibitor and is used primarily because it is cheap. Whereas rehabilitation of addicted prison inmates can cost over $2 000 per month Vivitrol only costs approximately $1 000 per month.[534] The low costs of the latter solution make it a much cheaper and affordable alternative to treat addicted inmates. The general reason behind using inmates for interventions is due to the effects of addiction in prisons often being the most devastating. Prisons are therefore perceived as a place to experiment with what approach works best to deal with addiction.[535]

Wiseman[536] as well as Focquaert, Van Assche & Sterckx[537] refer to these types of biological interventions as moral enhancement. The latter authors use Buchanan's definition of (moral)

[527] Ibid, p. 5.
[528] Ibid, p. 5.
[529] Choy, Olivia, Farah Focquaert, and Adrian Raine, "Benign Biological Interventions to Reduce Offending," *Neuroethics*, February 2018, pp. 1–13.
[530] Wiseman, Harris, "The Sins of Moral Enhancement Discourse," *Royal Institute of Philosophy Supplement* Vol. 83, 2018, pp. 35–58.
[531] Choy et. al., op. cit., 2018, p. 1.
[532] Wiseman, op. cit., 2018, p. 41.
[533] Ibid, p. 42.
[534] Ibid, p. 42.
[535] Ibid, pp. 41-42.
[536] Ibid.
[537] Focquaert, Farah., Van Assche K., and Sterckx, S. (in press). "Offering neurointerventions to offenders with cognitive-emotional impairments: Ethical and criminal justice aspects," to appear in N. Vincent, T. Nadelhoffer,

enhancement: "[a] deliberate intervention which aims to improve an existing capacity that most or all human beings typically have, or to create a new capacity."[538] There are, however, two issues with this definition moral enhancement. First, there is no consensus on what it entails.[539] In transhumanist literature, the difference between (moral) enhancement and therapy is still actively debated. According to Bostrom & Roache, therapy aims to fix an individual's unhealthy state. Enhancement, on the other hand, aims to improve the state of an individual beyond its regular state.[540]

Furthermore, it is not entirely clear whether biological and neuro interventions used for prison inmates should be called moral enhancement or therapy. Even after following Bostrom & Roache's definitions of moral enhancement and repair, it remains ambiguous whether the aforementioned biological interventions should be called enhancement. Repairing prison inmates' undesirable behaviour can be seen as both therapy (fixing an unhealthy state) as well as enhancement (if an inmates' normal behaviour is immoral, changing their behaviour to moral seems to be going beyond their regular state). At the same time, it seems this distinction between enhancement and therapy does not play a role in other non-philosophical literature on treatment of addiction. For example, Galassi, Mpofu & Athanasou[541] simply refer to it as drug treatment.

Beyond the issue about whether to call biological interventions to treat addicted inmates moral enhancement, there are several related ethical dilemmas. Choy et al. mentions three ethical dilemmas related to biological interventions to improve undesirable social behaviour: 1) safety, 2) the potential threat of hurting personal identity and authenticity, and 3) coercive treatment.[542]

First, **safety** is an ethical dilemma since it raises the question whether it is morally permissible to experiment on prison inmates. Focquaert, Caruso & Shaw call this a free will argument.[543] They explain that, according to retributivists, inmates are deserving of harm and experimentation since they have broken the law due to their immoral behaviour. Retributivists follow the thought that those who have harmed deserve harm. Free will sceptics, on the other hand, disagree with this outlook. According to the latter group, harming inmates is inherently unjust because this argument lacks a libertarian type of free will. They believe in the rehabilitation of criminals instead.[544]

The general issue of safety also includes the more specific issue of physical safety. Wiseman explains that no drug comes without side-effects, meaning that the prison inmates who are taking or are forced

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and A. McCay (Eds.), *Neurointerventions and the law: Regulating human mental capacity*. Oxford University Press, Oxford.

[538] Ibid, p. 2.

[539] Focquaert, Farah, and Maartje Schermer, "Moral Enhancement: Do Means Matter Morally?," *Neuroethics* Vol. 8, No. 2, November 2015, pp. 139–151.

[540] Bostrom, Nick, and Rebecca Roache, op. cit., 2008.

[541] Galassi, Alexandra, Elias Mpofu, and James Athanasou, "Therapeutic Community Treatment of an Inmate Population with Substance Use Disorders: Post-Release Trends in Re-Arrest, Re-Incarceration, and Drug Misuse Relapse," *International Journal of Environmental Research and Public Health* Vol. 12, No. 6, 2015, pp. 7059–7072.

[542] Choy et. al., op. cit., 2018, p. 5.

[543] Focquaert, Farah, Gregg Caruso, Elizabeth Shaw, and Derk Pereboom, "Justice Without Retribution: Interdisciplinary Perspectives, Stakeholder Views and Practical Implications," *Neuroethics*, 2019, pp. 1–3.

[544] Ibid, p. 2.

to take drugs will experience side-effects too.[545] Especially with new drugs, it is never certain what the side effects might be or look like, especially in the long-term. In fact, discovering all long-term effects can require decades of testing.

Second, Focquaert & Schermer touch upon the issue of how biological interventions interfere with **autonomy and identity**.[546] They distinguish between direct and indirect interventions as well as passive and active interventions. They state that the more direct an intervention is the more passive a recipient becomes to the induced changes. The receiver of the intervention (in this case, an inmate) is namely not required to play an active role to achieve the goal. In such a case, there lies a risk that the receiver's autonomy and personal identity is harmed. According to Focquaert & Schermer, the distinction between direct and indirect is therefore morally relevant since treating a passive recipient can have major consequences for personal identity.

Third, Focquaert & Schermer point out issues related to **coercion**: namely, that direct treatment carries the risk of so-called coercive normalization or coercive change.[547] Since people hold the right to self-determination there is a limit to how one's mental state is allowed to be altered. Only with someone's consent is it allowed to treat that person. If done without consent, there is a chance that someone's narrative identity is hurt. The latter concept can be defined as the number of characteristics that make up someone's personality. Even though a person's characteristics are not static and are subject to change, these changes should be introduced coherently. If not, which will sometimes be the case with coercion, this can have negative consequences for one's sense of self.[548]

Simultaneously, it is important to note that are ethical benefits to offering prison inmates biological or neuro-interventions. This can be seen as a least-bad type of solution. Offering inmates treatment for their addiction gives them benefits such as probation, parole or sentence reduction.[549] Focquaert et al. refer to Rosati,[550] who claims that inmates are allowed to choose the sentence that in fact maximally protects their freedom and autonomy.[551] Offering sentence alternatives such as biological interventions could therefore protect and even enhance inmates' autonomy and personal identity in some cases. Focquaert & Schermer also add that neuro interventions can benefit society since it lowers the potential danger of individuals with immoral traits or socially undesirable behaviour.[552] Therefore, correctional use of these interventions can help with protecting public safety.

6.5 Cosmetic enhancement

Technologies with new ethical issues in the category of cosmetic enhancement proved difficult to identify, thus this section is limited only to sex enhancements. Traditional cosmetic enhancement interventions, such as plastic surgery to improve the aesthetic appearance of one's body, have been

[545] Wiseman, op. cit., 2018, p. 55.
[546] Focquaert & Schermer, op. cit., 2015, p. 146.
[547] Ibid, p. 146.
[548] Ibid, p. 146.
[549] Focquaert et. al., op. cit., (in press), p. 4.
[550] Rosati, Connie S, "A Study of Internal Punishment," *Wisconsin Law Review* Vol. 123, 1994, pp. 123–170.
[551] Ibid, p. 11.
[552] Focquaert & Schermer, op. cit., 2015.

widely discussed as the technique has developed, especially over the course of the 20th century.[553] Because our aim is to identify the ethical issues posed primarily by the state-of-the-art of the field (as well as what is expected within the next twenty years, or sometimes beyond when the issue will have a major impact), we have chosen not to reiterate the traditional debate on cosmetic surgery for enhancement in general. Furthermore, many of the existing issues in the debate focus on cosmetic surgery as a treatment rather than enhancement.[554] Cosmetic surgery and sex enhancement are described further in SIENNA D3.1: State of the Art Review of Human Enhancement Technologies

Sex enhancement

Female genital cosmetic surgery (FGCS) is a relatively new but popular form of enhancement. It should be noted that FGCS is different from surgery for transsexual individuals or (in theory) genital mutilation. Instead, it includes various procedures to augment the vagina such as labiaplasty, vaginal tightening, and G-spot amplifications. FGCS can be placed in the same context as other widespread female body modifications such as hair removal or the larger societal shift towards eroticizing the female body.

Michala et al.[555] point out three different ethical issues related to FGCS: 1) the cultural pressure which drives women to seek FGCS surgery, 2) the blurred lines between FGCS and female genital mutilation, and 3) the suspicion related to using FGCS to solve psychological distress which is, mostly, undertaken in the private sector.

First, Michala et al. argue that media and pornography already warp expectations of many females who opt for genital cosmetic surgery.[556] Braun acknowledges that most arguments tend to fall in favour of cosmetic enhancement on the grounds of freedom of choice, however also reflects that the influence of media and advertising ought to lead us to question whether the autonomy leading to such choices is sufficient. Hence, even though it might not be experienced as cultural pressure by the women who seek FGCS treatment, they might unconsciously still be influenced by the advertised idea of the ideal vagina.

Second, in most of the West female genital mutilation or cutting is forbidden. The World Health Organization defines genital mutilation as the removal of the external female genitalia or injuring the female genital organs.[557] However, this definition of genital cutting overlaps with FGCS practices which makes the latter controversial. In practice, FGCS overlaps with genital cutting as well.[558] The procedures and the final result can be similar to those of genital cutting. The difference between the

[553] Donohoe, Martin, "Cosmetic Surgery Past, Present, and Future," *Medscape*, WebMD LLC, August 28, 2006. https://www.medscape.com/viewarticle/542448_2.
[554] Barone, Mauro, Annalisa Cogliandro, and Paolo Persichetti, "Ethics and Plastic Surgery/What Is Plastic Surgery?," *Archives of Plastic Surgery* Vol. 44, No. 1, 2017, pp. 90–92.
[555] Michala et. al., op. cit., 2012.
[556] Ibid.
[557] Dobbeleir, Julie M.l.c.l., Koenraad Van Landuyt, and Stan Monstrey, "Aesthetic Surgery of the Female Genitalia," *Seminars in Plastic Surgery* Vol. 25, No. 02, 2011, pp. 130–141.
[558] Ibid, p. 131.

two therefore lies in the intention: genital cutting is meant to harm the functionality of the female genitals for reasons such as purification whereas FGCS is meant solely for aesthetic purposes.[559]

Third, Liao & Creighton[560] refer to FGCS as psychology with a scalpel. Instead of talking to a psychologist, cosmetic surgery becomes the psychological process which gives the patient a physical and psychological transformation. In fact, the psychological effect of vulval distress is often used as the key factor to convince women to get surgery on websites promoting FGCS. However, there is a growing number of private practices which offer FGCS. This is problematic due to the amount of money made in the sector. In the UK in 2005, cosmetic surgery in the private sector was worth 720 million pounds. In 2015, this number has risen to 3.6 billion pounds.[561] Even though there is a need for more and better research on how to help women make informed decisions about whether to get treatment to solve their psychological (vulval) distress, due to the financial reward in the sector this becomes and has become an obstacle.[562]

6.6 Longevity enhancement

Similar to affective & emotion enhancement, moral enhancement and cosmetic enhancement, we had trouble identifying ethical issues for longevity enhancement applications because there are few/no existing applications in this field. Although there is evidence of funding,[563] especially projected to increase in the private sector,[564] for research to develop longevity enhancements, existing applications are better classified as treatments that cure or prevent symptoms of aging and bodily harm.

7. Ethical analysis: application domains & population groups

The following section includes ethical analysis of issues for HET stemming from specific application domains, such as education or home uses, as well as issues that apply to specific population groups, such as children or athletes. Many issues that apply to application domains and/or population groups below have already been discussed in the previous sections in a broader context. Thus, some issues in the following subsections may seem redundant. However, here we focus on how the issue will apply specifically to the domain/group in question.

[559] Ibid, p. 132.
[560] Liao, Lih-Mei, and Sarah M Creighton, "Female Genital Cosmetic Surgery: Solution in Pursuit of Problem," *Female Genital Cosmetic Surgery: Solution to What Problem?*, Cambridge University Press, Cambridge, 2019, pp. 1–11.
[561] Ibid, p. 6.
[562] Ibid, p. 7.
[563] Zhavoronkov, Alex, "Longevity Vision Fund: Fueling The Longevity Biotechnology Boom We've Been Waiting For," *Forbes*, Forbes Magazine, February 4, 2019. https://www.forbes.com/sites/cognitiveworld/2019/02/04/longevity-vision-fund-fueling-the-longevity-biotechnology-boom-weve-been-waiting-for/#40e5266.
[564] Snelling, Sherri, "The Investor View on the $7 Trillion Longevity Economy," *Stria*, July 9, 2018. https://strianews.com/the-investor-view-on-the-7-billion-longevity-economy/.

7.1 Workplace

Esposito[565] mentions that there is a possibility of employers preferring enhanced employees because of their increased efficacy. Enhanced employees will have a greater skillset and are therefore more preferable to hire. The downside, however, is that this could lead to discrimination on the work floor due to unenhanced individuals not being hired, fired or seen as less valuable than enhanced employees. Unenhanced employees might therefore feel compelled to use HET as well in order to compete with their enhanced colleagues. In order to prevent corporate discrimination, Esposito stresses that there should be laws and regulations established which protect individuals from bias against non-enhanced people .

In other words, **competition** within the workplace may lead to issues of direct or indirect coercion during employment. For example, an employer could either explicitly direct employees to use HET to improve their productivity, performance, or relevant capabilities in order to improve the success of the business. An employee who does not wish to use HET applications could then find their employment prospects diminished in a discriminatory way. Thus, workers may feel compelled to use HET to improve their competitive value within their field even if they have qualms about using HET.

Even if a society enacts regulation to outlaw employers from explicitly requesting employees use HET, employees may still feel compelled to do so. Enhanced individuals could receive unfair advantages in employability over unenhanced peers, resulting in swift adoption of HET in the workplace. This scenario could then lead to an 'arms race' in the fields that develop HET products, which could result in corners being cut that might negatively impact the safety of new or updated options.[566]

There is a common fear that HET will **create larger inequality in society**.[567] Ways in which this could happen is 1) enhanced people enjoying larger benefits than unenhanced people and/or 2) rich people or rich societies having better and more access to HET than poor people or poor nations, thereby creating large differences between social classes. To start with the former point, Clarke[568] mentions the fear (mostly expressed by conservatists) for the probability of democracies being in danger when human enhancement will be introduced on a large scale. HET could create a power imbalance between competing groups in a society and, hence, cause the fall of a democracy and the introduction of a dictatorship: "The introduction of human enhancements that can cause significant shifts in the relative balance of power between competing groups in a society is liable to lead to the collapse of democratic states and their replacement by dictatorships, and this is an outcome that conservatives are right to fear."[569] It is possible that either individuals who choose to enhance themselves or individuals who choose not to enhance themselves could become a minority group that is discriminated against by the majority. If the best enhancement options are expensive and/or invasive, then the group that uses

[565] Esposito, Michael F, "Ethical Implications of Pharmacological Enhancement of Mood and Cognition," *Bioethics Journal* Vol. 1, No. 1, 2005, pp. 1–4.
[566] Saritas, Ozcan, "Emerging Technologies, Trends and Wild Cards in Human Enhancement," *Science, Technology and Innovation Studies Emerging Technologies for Economic Development*, 2019, pp. 243–259.
[567] Veit, Walter, "Cognitive Enhancement and the Threat of Inequality," *Journal of Cognitive Enhancement* Vol. 2, No. 4, December 2018, pp. 404–410.
[568] Clark, Steve, and , "Buchanan and the Conservative Argument against Human Enhancement from Biological and Social Harmony," *The Ethics of Human Enhancement,* , Oxford University Press, Oxford, 2016.
[569] Ibid.

these options might always remain small. Society could become further stratified, with a significantly enhanced minority facing discrimination from a lesser or unenhanced majority. On the other hand, if the enhancements within this minority raise the users' capabilities enough, these individuals could then use their advantages to control the lesser/unenhanced majority.

However, Bostrom & Sandberg[570] reject this idea, instead arguing that there has always been a natural inequality between human beings. When it comes down to intelligence, for example, there are individuals who are more cognitively gifted than others. For that reason, HET could also get rid of the inequality between the cognitively gifted and the less cognitively gifted. In that way, HET could be a large contributor to decreasing inequality and creating a fairer society.

Secondly, the perhaps limited accessibility or not equally distributed accessibility to HET could affect **fairness** between different groups in society or societies in general. The fear is that limited accessibility could widen the gap between rich and poor. Veit[571] disagrees with this concern, stating that the fear for an increasing inequality is unnecessary and simply false since most enhancement technologies are freely available online. Meditation practices, for example, are proven to have a positive effect on cognitive capacities and the aging of the brain. Since everybody has access to these free apps these cognitive enhancement technology could actually lead to less inequality. Veit's position dismisses speculative expectations about how HET could quickly advance in a consumer-driven society. If the means to enhance in the near future requires purchasing expensive devices or bodily interventions, the worry seems worth further consideration. For now, however, it's impossible to say precisely how HET might develop in the coming decades.

HET can also cause inequality between abled and disabled people. Foley & Ferri[572] explain that technology often only improves normalized ways of beings. Technology is therefore designed according to what constitutes as "normal." It is part of the larger society and embodies the larger society's norms and values. Hence, technology also embodies certain ideas about what a normal body looks like and what it can and cannot do. Technology, in this way, creates so-called new dimensions of being disabled. Furthermore, technology that is designed for disabled people often is assistive technology.

7.2 Education

It is becoming more apparent that one area where cognitive enhancements are prominent, especially in the form of nootropics or 'smart' drugs, is in the demographic of high school and university students and even professors.[573] To consider the pragmatic as well as ethical concerns that may need to be addressed given this demographic's usage, a comparison can be made to issues of performance enhancing drugs (PEDs) in competitive sports by athletes.[574] One argument against the use of nootropics in academic settings may be that they create an uneven playing field, but this assumes that

[570] Bostrom & Sandberg, op. cit., 2009.
[571] Veit, op. cit., 2018.
[572] Foley, Alan, and Beth A. Ferri, "Technology for People, Not Disabilities: Ensuring Access and Inclusion," *Journal of Research in Special Educational Needs* Vol. 12, No. 4, 2012, pp. 192–200.
[573] Goodman, op. cit., 2010.
[574] Cakic, V, "Smart Drugs for Cognitive Enhancement: Ethical and Pragmatic Considerations in the Era of Cosmetic Neurology," *Journal of Medical Ethics* Vol. 35, No. 10, 2009, pp. 611–615.

the playing field is even to begin with, which isn't the case given varying genetic and socioeconomic dispositions that students are born into. These varying dispositions mean that some students will already have better academic performance, but it seems then that nootropics will only exacerbate the unevenness of this academic playing field if only wealthier students can afford and benefit from their use. It may therefore become necessary in future for nootropics to either be offered through social programmes for underprivileged students, but also specifically for those with cognitive deficits as use of nootropics may not be as beneficial for those with already high IQs.[575] In this way nootropics could be used to level the academic playing field instead.

A second concern for the use of nootropics is that just as athletes may be coerced into using PEDs because they believe their competitors are using them, students may face similar compulsion. In such a situation, students who feel that the use of nootropics has clear academic benefits and the majority of their peers are using nootropics, then those not using them would perceive themselves to be at a disadvantage. And the only way to not be at this disadvantage is to also begin taking nootropics.[576]

However, these two concerns open up into considering whether or not the use of cognitive enhancement substances can be considered as cheating given that affordability and access to these substances might unfairly benefit only some and disadvantage others. The concern over cheating is clear when comparing the use of cognitive enhancers to performance enhancement by athletes gaining an unfair advantage over those not using enhancements.[577] This would also be the case if only a portion of students or employees are engaging in cognitive enhancement use to boost their performance, and manage to do so in a manner that allows them to outcompete their peers. The notion of cheating is coupled to concerns of fairness, whereby if only students from high-income families or wealthier individuals have access to cognitive enhancement this will only increase the already existent performance, skills and opportunities gap between the wealthy and the poor.[578,579]

Yet, as with many examples of HETs, our ethical evaluation of this technology is heavily dependent on the social circumstances that surround its use. For instance, imagine that the societal trend to be less physically active continues and that, in 50 years from now, no university students exercise, but where all of them use nootropics. It may transpire that the best way to be prepared for exams will be to exercise 1 hour each day and this impact may be even more effective than using nootropics. In these conditions, the nootropics may not be the distinguishing factor in determining success. The point is that a number of tactics may be used to achieve in life and, even if nootropics become widely available, they may not be the best way to secure success.

Bostrom & Sandberg[580] mention mental training, brain-computer interfaces, and pharmaceutical means as a selection of human enhancement technologies to help improve people's learning and

[575] Ibid, p. 612.
[576] Ibid, p. 612.
[577] Mann, Sebastian Porsdam, and Barbara J Sahakian, "The Increasing Lifestyle Use of Modafinil by Healthy People: Safety and Ethical Issues," *Current Opinion in Behavioral Sciences* Vol. 4, 2015, pp. 136–141.
[578] Greely, Henry, Barbara Sahakian, John Harris, Ronald C. Kessler, Michael Gazzaniga, Philip Campbell, and Martha J. Farah, "Towards Responsible Use of Cognitive-Enhancing Drugs by the Healthy," *Nature* Vol. 456, No. 7223, 2008, pp. 702–705.
[579] Mann & Sahakian, op. cit., 2015, p. 139.
[580] Bostrom & Sandberg, op. cit., 2009.

memory. Even though mixed evidence exists about the effect of HET for improved learning, the techniques are popular among students, who believe that HET helps them to complete their coursework such as writing papers and cramming for exams in their academic career.[581]

Study drugs can improve short-term memory, but the long-term effects of such substances might outweigh the positive short-term gains. Long-term effects include sleep deprivation and the physical deterioration of brain processing ability. It should also be noted that even though short-term memory is improved, additional risks include malnutrition, high-blood pressure, feeling anxious and increased chances of a stroke.

A primary reason for parents to give HET to their children is a combination of having high expectations for their children to succeed in life as well as wanting to protect their children from stigmatisation if they fall under the norm.[582] A child who has trouble learning is a prime example, but Powers also mentions parents who give their children growth hormones because they deemed their children to be too short as a further example of this reasoning in action.

7.3 Military

Military personnel are often in situations that demand alertness, focus and high executive functioning despite strenuous working conditions which include stress, fatigue, thermal extremes, altitude and nutritional deprivation.[583] For this reason, soldiers in the United States and in other countries have sometimes been prescribed stimulants such as amphetamines and modafinil to enhance their military performance (with soldiers in the United States legally required to take these medications if ordered to).[584] The use of cognitive enhancers remains justified in such a situation (despite the potential coercion) so long as military personnel maintain moral culpability from their actions and do not dissociate from the tasks they perform.[585] Furthermore, these substances can only be prescribed if they have been approved by the FDA, or otherwise require informed consent if this approval has not yet been granted.[586] In studies, modafinil has proven useful for enhancing sustained attention, attentional interference, spatial planning and executive functioning,[587] and the lack of modafinil or use of placebo led to fighter pilots performance declining by as much as 60-100%.[588]

[581] Abelman, Dor David, "Mitigating Risks of Students Use of Study Drugs through Understanding Motivations for Use and Applying Harm Reduction Theory: a Literature Review," *Harm Reduction Journal* Vol. 14, No. 1, June 2017.
[582] Powers, Therese, "Race for Perfection: Children's Rights and Enhancement Drugs," *Journal of Law and Health* Vol. 13, No. 1, 1999, pp. 141–169.
[583] Kelley, Amanda M., Catherine M. Webb, Jeremy R. Athy, Sanita Ley, and Steven Gaydos, "Cognition Enhancement by Modafinil: A Meta-Analysis," *Aviation, Space, and Environmental Medicine* Vol. 83, No. 7, January 2012, pp. 685–690.
[584] Greeley et. al., op. cit., 2008, p703.
[585] Mann & Sahakian, op. cit., 2015, p137.
[586] Russo, Michael B., "Recommendations for the Ethical Use of Pharmacologic Fatigue Countermeasures in the U.S. Military.," *Aviation, Space, and Environmental Medicine* Vol. 78, No. 5, 2007, pp. 119–127.
[587] Kelley et. al. , op. cit., 2012, p688.
[588] Mann & Sahakian, op. cit., 2015, p137.

That said, the analysis of the ethical issues involved in the military use of pharmacological agents, for example by Russo, brings a number of issues to light. Firstly, it may become necessary for certain armed forces (especially when operating in a coalition) to agree upon what kinds of cognitive enhancers can or should not be used.[589] This would ensure that all collaborating personnel are operating at the same level, but it also means that if one side has agreed on specific forms of cognitive enhancement, it will mean oppositional forces would need to commit to ensuring they are not at a disadvantage. Such a situation could result in a cognitive enhancement arms race. Secondly, the hierarchical structure of the military and the demand for combat supremacy may become more important than the freedom of individual military personnel to decide for themselves whether or not it is necessary to take cognitive enhancers.[590] Individuals could therefore find themselves coerced into taking cognitive enhancers by their commanders or squad members looking to gain the combative edge over their enemy combatants. Thirdly, despite the operational benefits of the cognitive enhancer, there is also the issue of the compounds of the enhancement drug remaining in the individual's body long after use and the effects at the cellular level have become irreversible. Linked to this is whether combatants in coalitions or fellow friendly soldiers are safe in sharing the same battlespace with individuals who either opt or are coerced into using cognitive enhancers that which may not only affect their behaviour upon use but even perhaps after ingestion.[591]

Chatterjee raises additional issues, though suggests "Using enhancements might be safer than not."[592] He points to the use of amphetamines as described above to improve performance, and adds that hypnotics could achieve similar results. However, Chatterjee also flags safety risks including addiction and misuse, as week as the possibility for unknown side-effects, especially related to decision-making. If enhancing drugs, such as amphetamines, effect the choices a soldier makes this raises questions about whether or not a service member should be held responsible for such decisions.[593]

7.4 Home & Recreation

Given that cognitive enhancement technologies affect the most complex and important human organ, safety should be a primary concern in their design, use and regulation, especially when despite some agreement on their therapeutic use, there is also the prevalence of 'off label' uses.[594] Safety concerns range from the unknown effects of enhancement technologies on the development of childrens' brains, along with whether the benefits of their use to patients with cognitive conditions can be translated to healthy individuals.[595] Another point of concern is the misuse of cognitive enhancing substances. Studies from 2014 (from surveys in the US) showed that illicit use of cognitive enhancement drugs were in the demographic of academically underachieving males, along with evidence that most young healthy individuals using psychostimulant drugs purchased them from illicit sources.[596]

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[589] Russo, op. cit., 2007, p. 121.
[590] Ibid.
[591] Ibid.
[592] Chatterjee, op. cit., 2013.
[593] Ibid.
[594] Greely et. al., op. cit., 2008, p. 703.
[595] Mohamed, Ahmed Dahir, "Neuroethical Issues in Pharmacological Cognitive Enhancement," *Wiley Interdisciplinary Reviews: Cognitive Science* Vol. 5, No. 5, 2014, pp. 533–549.
[596] Ibid, p. 535.

Certain stimulants are prescribed and categorised as medicine, having become familiar in the public space as part of the growing diagnosis of ADHD among children and adults.[597] Stimulants include methylphenidate (also known as Ritalin® or Concerta®), and amphetamine (often prescribed as mixed AMP salts consisting primarily of dextroamphetamine, commonly referred to as Adderall®). These substances affect specific neurotransmitters (catecholamines dopamine and norepinephrine) in the cortical and subcortical systems in the brain, responsible for enabling individuals to focus and deploy attention flexibly. They are therefore responsible for increasing the levels of these neurotransmitters, and as a consequence improving the attention of individuals with ADHD.[598]

An additional stimulant-like substance is Modafinil, also marketed as Provigil®, which was originally developed to counteract daytime sleepiness and individuals suffering from narcolepsy, but has been recognised as a cognitive enhancement agent.[599] Its effects include giving individual an energy boost, increasing alertness, as well as counteracting depression, ADHD and jet lag. While its mechanism of operation on the brain is not fully known, it is believed to affect not only dopamine and norepinephrine, but also gamma-aminobutyric acid, glutamate, histamine and orexin/hypocretin. [600]

Besides stimulants, other drugs with cognitive enhancement potential include acetylcholinesterase inhibitors (with various forms such as Aricept®, Excelon® and Razadyne®) which are used for treating mild to moderate Alzheimer's.[601] These drugs increase the levels of the neurotransmitter acetylcholine by decreasing the activity of the enzyme that normally breaks it down, which slows the degeneration of the neurons that leads to Alzheimer's.

Despite the belief in the effectiveness of stimulant as cognitive enhancement means, the results of the study conducted by Farah et. al. show that results vary and are sometimes even contradictory, with effectiveness relying on specific contexts of tests conducted (e.g. order of the tasks patients perform) and duration (i.e. intervals between tests or resting periods).[602] Farah et. al. also point out that the safety of these drugs varies depending on the dosage and frequency of use, but also acknowledge that the major risk is the threat of dependence on these drugs (specifically stimulants) and can thus lead to abuse.[603,604]

Furthermore, two other methods of cognitive enhancement include transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS). TMS makes use of electromagnetic induction with the generation of pulsating time-varying magnetic field generation through a coil of wire, to depolarize neuronal membranes and generate action potentials. This depolarization and generation of

[597] Farah, Martha J., M. Elizabeth Smith, Irena Ilieva, and Roy H. Hamilton, "Cognitive Enhancement," *Wiley Interdisciplinary Reviews: Cognitive Science*Vol. 5, No. 1, 2013, pp. 95–103.
[598] Ibid, p. 95-96.
[599] Billiard, Michel, and Roger Broughton, "Modafinil: Its Discovery, the Early European and North American Experience in the Treatment of Narcolepsy and Idiopathic Hypersomnia, and Its Subsequent Use in Other Medical Conditions," *Sleep Medicine* Vol. 49, 2018, pp. 69–72.
[600] Farah et. al., op. cit., 2013, p. 96.
[601] Ibid, p. 96.
[602] Ibid, p. 97-98.
[603] Ibid, p. 98.
[604] Mohamed, op. cit., 2014, p538-539.

action potentials can have a positive (though transient) effect on individuals' cognitive performance (on conditions ranging from post-stroke, migraines, movement disorders and depression) depending on the duration and frequency of the stimulation.[605] tDCS involves the application of small electrical currents from two surface electrodes, which alter the resting membrane potential of neurons and affects the likelihood of the firing of cortical neurons over time (e.g. cathodal stimulation decreases cortical excitability while anodal stimulation increases cortical excitability).[606]

Farah et al identify the most severe safety risks in the use of TMS is the possibility of causing a seizure in patients, but such a risk is extremely low if the procedure is administered following clear safety guidelines. While tDCS side effects include sensations of tingling, burning or pain, with no serious adverse effects as yet reported.[607]

The growing attention to human enhancement technologies, especially when used in a recreational manner, points towards a number of issues concerning notions of access, norms as well as purposes of use. For instance, the growth of the market for pharmacological cognitive enhancers (PCEs) and their use by healthy individuals has led to a divide between whether there should be unrestricted access or restricted to the use of individuals with disorders only.[608] Should drugs such as Modafinil which are intended to be used for narcolepsy and Alzheimer's, also be prescribed not just for therapeutic purposes but also for enhancing memory and mental performance?[609] But more broadly, the range of HETs as well as growing interest in their use, are likely to contribute to changing what counts as 'normal' in a number of domains, while also pointing towards differences in what HETs may symbolize across different countries. One example of this is thus some countries and cultures may view aging as a natural and normal process, 'others see aging as a pathology to be overcome.'[610] Like with aging, ideals and fears about beauty, physical performance and mental performance may prompt certain societies and individuals to invest in the use of HETs to reach the ideals and alleviate fears. Societies and individuals that engage in the use of HETs to improve these aspects of being human, will change how they become valued, likely to lead to the enhanced life being considered the new norm to be attained. Though what this may eventually lead to, as pointed out in the literature on eugenics [611,612] is that those who are not recognised as 'fit' under the new value system will likely be singled out. An instance of this is captured in Kaw,[613] whereby Asian American women "internalized American values of assertiveness and quickness and changed their appearances to match" these values.[614] Cosmetic (and potentially all other) enhancements can thus be seen as necessary, for certain individuals and groups, to become more able to fit in with the cultural values and norms of societies

[605] Farah et. al., op. cit., 2015, p. 96.
[606] Ibid, p. 96-97.
[607] Ibid, p. 99.
[608] Mann & Sahakian, op. cit., 2015.
[609] Hogle, op. cit., 2005, p. 700.
[610] Ibid, p. 701.
[611] Proctor, Robert N., *Racial Hygiene: Medicine under the Nazis*, Harvard University Press, Cambridge (Massachusetts), 2002.
[612] Weindling, Paul, *Health, Race and German Politics between National Unification and Nazism, 1870-1945*, ACLS History E-Book Project, New York, 2005.
[613] Kaw, Eugenia, "Medicalization of Racial Features: Asian American Women and Cosmetic Surgery," *Medical Anthropology Quarterly* Vol. 7, No. 1, 1993, pp. 74–89.
[614] Hogle, op. cit., 2005, p. 705.

they immigrate to. Though contrasted to this are instances where HETs such as cochlear implants, can be seen as a means of showing that a natural condition (i.e. deafness) is treated as a disease that should be remedied.[615] Likewise, the use of germ-line enhancements on the one hand may need to be prohibited because they threaten the human essence and sanctity,[616] while on the other may instead be considered a way of reconfiguring what it means to be human.[617] HET adoption may thus reflect how bodies are viewed in different cultures and contexts, as well as how these values become part of the shift and reconception of the body as a unit of biology and technology,[618] with enhancements becoming seen as upgrades.[619] This will mean that as HET use becomes more popular, those who adopt their use will begin the process through which not only what it means to be human, but what values are attributed to bodies, begin to change.

7.5 Population groups

Children & adolescents

Throughout this report, we have identified many ethical concerns that arise specifically when contemplating categories of enhancement or enhancement applications/technologies and their use on children and/or adolescents. In the following section, we will aim to avoid redundancies by identifying only the surface-level issues in the current debate(s). For further depth, we encourage the reader to both notice the deeper issues concerning this population group explored above and to examine the references on the issues identified below.

Among the most discussed topics in the literature on children/adolescent enhancement is the use of PCE, and in particular concerns about parents asking doctors for prescriptions to use as cognitive enhancement[620] and the abuse of ADHD medications as off-label cognitive enhancements by parents for their children or by adolescents.[621] The rise of PCEs as 'study drugs' in schools and universities has become the subject of numerous studies.[622,623,624,625] This has coincided with an ongoing discussion on

[615] Lee, Joseph, "Cochlear Implantation, Enhancements, Transhumanism and Posthumanism: Some Human Questions," *Science and Engineering Ethics* Vol. 22, No. 1, December 2015, pp. 67–92. p72.
[616] Fukuyama, op. cit., 2002.
[617] Bostrom, Nick, "Human Genetic Enhancements: A Transhumanist Perspective," *The Journal of Value Inquiry* Vol. 37, No. 4, 2003, pp. 493–506.
[618] Hogle, Linda F, "Life/Time Warranty: Rechargeable Cells and Extendable Lives," *Remaking Life & Death: toward an Anthropology of the Biosciences*, School of American Research Press, Santa Fe, 2003, pp. 61–96.
[619] Hogle, op. cit., 2005, p703.
[620] Graf et. al., op. cit., 2013.
[621] Graf, William D, Geoffrey Miller, and Saskia K Nagel, "Addressing the Problem of ADHD Medication as Neuroenhancements," *Expert Review of Neurotherapeutics* Vol. 14, No. 5, 2014, pp. 569–581.
[622] Zito, J M, D J Safer, S dosReis, J F Gardner, M Boles, and F Lynch, "Trends in the Prescribing of Psychotropic Medications to Preschoolers," *Jama* Vol. 283, No. 8, 2000, pp. 1025–1030.
[623] White, Barbara Prudhomme, Kathryn A. Becker-Blease, and Kathleen Grace-Bishop, "Stimulant Medication Use, Misuse, and Abuse in an Undergraduate and Graduate Student Sample," *Journal of American College Health* Vol. 54, No. 5, 2006, pp. 261–268.
[624] Ilieva, Irena P., and Martha J. Farah, "Attention, Motivation, and Study Habits in Users of Unprescribed ADHD Medication," *Journal of Attention Disorders* Vol. 23, No. 2, 2015, pp. 149–162.
[625] Abelman, op. cit., 2017.

increased rates of diagnosis of ADHD and pharmacological treatments.[626] Notably, at the same time, there remains a gap in understanding how PCEs affect the developing brains of children and adolescents. This raises specific concerns regarding the impact of the presence and the practices of enhancement on autonomy[627,628] and perception of normalcy.[629] Singh and Kelleher discuss key social and ethical concerns raised by the use of stimulant drugs for neuroenhancement and offer research, practice, and policy recommendations.[630] Graf et al. highlight the ethical, social, developmental and professional integrity issues suggesting a cautious position for paediatric neuro-enhancement in nonautonomous and nearly autonomous children and adolescents.[631] Flanigan argues in favour of greater acceptance of neuroenhancement for young patients.[632]

A new book by Nagel[633] explores the primary concerns at the forefront of the debate, namely: the effect of enhancement on the value of childhood (considering questions of self-control, autonomy, and naturalness), public perspectives on childhood enhancement, and implications for parenting, education and policy. Drerup examines how attributions of achievement and responsibility in the context of educational practices are influenced by enhancement in children and adolescents.[634] O'Connor offers a contextualisation of enhancement practices by investigating cultures of parenting, illustrating the manifold expectations and values that are relevant for families' lifestyle decisions.[635]

Although the debate remains heavily focused on neuroethics and cognitive enhancements, 'cognitive' is not the only category of human enhancement on the horizon. For instance, although not entirely new, but especially following the controversy of the CRISPR-Cas9 experiment conducted by Chinese

[626] Hinshaw, Stephen P., and Richard M. Scheffler, *The ADHD Explosion: Myths, Medication, Money, and Todays Push for Performance*, Oxford University Press, New York, NY, 2014.
[627] Graf et. al., op. cit., 2013.
[628] Lyreskog, David M, "Neuro-Enhancement at the Margins of Autonomy: In the Best Interest of Children and Elderly?," *Shaping Children: Ethical and Social Questions That Arise When Enhancing the Young*, Springer International Publishing, Cham, 2019, pp. 43–55.
[629] Krutzinna, Jenny, "Shaping Children: The Pursuit of Normalcy in Pediatric Cognitive Neuro-Enhancement," *Shaping Children: Ethical and Social Questions That Arise When Enhancing the Young*, Springer International Publishing, Cham, 2019, pp. 11–24.
[630] Singh, Ilina, and Kelly J. Kelleher, "Neuroenhancement in Young People: Proposal for Research, Policy, and Clinical Management," *AJOB Neuroscience* Vol. 1, No. 1, October 2010, pp. 3–16.
[631] Graf et. al., op. cit., 2013.
[632] Flanigan, Jessica, "Adderall for All: A Defense of Pediatric Neuroenhancement," *HEC Forum* Vol. 25, No. 4, 2013, pp. 325–344.
[633] Nagel, Saskia K., *Shaping Children: Ethical and Social Questions That Arise When Enhancing the Young*, Springer International Publishing, Cham, 2019.
[634] Drerup, Johannes, "Education and the Ethics of Neuro-Enhancement," *Shaping Children: Ethical and Social Questions That Arise When Enhancing the Young*, Springer International Publishing, Cham, 2019, pp. 125–142.
[635] O'Connor, Cliodhna, "Enhancing Young Brains in Contemporary Family Life: Exploring the Context and Scope of Pediatric Neuro-Enhancement," *Shaping Children: Ethical and Social Questions That Arise When Enhancing the Young*, Springer International Publishing, Cham, 2019, pp. 105–121.

scientist Jian-kui HE,[636] there has been a recent resurgence in both popular[637] and academic literature[638] about creating genetically enhanced children through gene-editing techniques. Furthermore, it stands to reason that many of the ethical issues discussed earlier in this report about physical, affective & emotional and moral enhancements ought to face different criticisms when the user is a child or adolescent. One of the main reasons is the developmental status of the user and the complexities of parent-child and parent-child-doctor/provider relationships, challenging our understanding of informed decision-making. Examining the child's best interest is a difficult interpretational practice by which to evaluate decisions for minors.[639]

Students & educators

The use of non-medically prescribed stimulants (NPS) and 'smart drugs' (i.e. Ritalin®, Adderall® and Provigil®) among students is based on a number of motivations, which include believing that use of NPS will enhance concentration, help with studying and increase alertness[640] along with the belief that other students are using as NPS as well.[641] A study conducted by Stoeber and Hotham[642] on students (predominantly female respondents) from the University of Kent using perfectionism as a central sheds more light on other factors that contribute to the use of 'smart drugs'. These factors include: concerns and doubts over failing exams and self-criticism of everyday actions, perception of using cognitive enhancers as cheating, societal and peer pressure for academic success, and parental pressure to be perfect.[643] But the studies conducted by Arria et. al.[644,645] on American college students reveal a contrasting picture, as the use of NPS is shown to be a response to decreases in grade point average (GPA), following a pattern of skipping class, and increasing marijuana and alcohol use. A systematic review by Munro et al[646] also revealed that users of NPS had poorer studying skills and lower GPAs,

[636] Regalado, Antonio, "EXCLUSIVE: Chinese Scientists Are Creating CRISPR Babies," *MIT Technology Review*, MIT Technology Review, November 25, 2018. https://www.technologyreview.com/s/612458/exclusive-chinese-scientists-are-creating-crispr-babies/.
[637] Cyranoski, David, "The CRISPR-Baby Scandal: What's next for Human Gene-Editing," *Nature News*, Nature Publishing Group, February 26, 2019. https://www.nature.com/articles/d41586-019-00673-1.
[638] Li, Jing-Ru, Simon Walker, Jing-Bao Nie, and Xin-Qing Zhang, "Experiments That Led to the First Gene-Edited Babies: the Ethical Failings and the Urgent Need for Better Governance," *Journal of Zhejiang University-SCIENCE B* Vol. 20, No. 1, 2019, pp. 32–38.
[639] Gaucher, N, A Payot, and E Racine, "Cognitive Enhancement in Children and Adolescents: Is It in Their Best Interests?," *Acta Paediatrica* Vol. 102, No. 12, 2013, pp. 1118–1124.
[640] Arria, Amelia M., Kimberly M. Caldeira, Kathryn B. Vincent, Kevin E. Ogrady, M. Dolores Cimini, Irene M. Geisner, Nicole Fossos-Wong, Jason R. Kilmer, and Mary E. Larimer, "Do College Students Improve Their Grades by Using Prescription Stimulants Nonmedically?," *Addictive Behaviors* Vol. 65, 2017, pp. 245–249.
[641] Arria, Amelia M., Irene M. Geisner, M. Dolores Cimini, Jason R. Kilmer, Kimberly M. Caldeira, Angelica L. Barrall, Kathryn B. Vincent, et al., "Perceived Academic Benefit Is Associated with Nonmedical Prescription Stimulant Use among College Students," *Addictive Behaviors* Vol. 76, 2018, pp. 27–33.
[642] Stoeber, Joachim, and Sarah Hotham, "Perfectionism and Attitudes toward Cognitive Enhancers ('Smart Drugs')," *Personality and Individual Differences* Vol. 88, 2016, pp. 170–174.
[643] Ibid, p. 172.
[644] Arria et. al., op. cit., 2017.
[645] Arria et. al., op. cit., 2018.
[646] Munro, Bailey A., Lisa L. Weyandt, Marisa E. Marraccini, and Danielle R. Oster, "The Relationship between Nonmedical Use of Prescription Stimulants, Executive Functioning and Academic Outcomes," *Addictive Behaviors* Vol. 65, 2017, pp. 250–257.

and linking deficient executive functioning of the brain (necessary for time management, organization, problem solving and motivation) to increased use of NPS.[647] Use of NPS is therefore a last resort for some population of students, while also being a reflection on feelings of perfectionist demands in others. The studies conducted by Arria et. al. showed that despite how use of NPS is linked to the perception of academic benefits, there were no actual improvements in the GPA of students who reported use of NPS.[648,649] With regards the demographic of users, the 2017 survey found that NPS users were predominantly from higher neighbourhood income.[650]

Workers/management

The role of cognitive enhancing drugs and substances in the work environment are a known phenomenon, ranging from the use of caffeine and nicotine, to the use of stimulants (e.g. amphetamines) to help individuals overcome fatigue, aid concentration and allow working extended periods without sleep.[651] But as a consequence of the societal view of psychoactive substances having negative effects to individual autonomy, stimulants still have a somewhat ambivalent status in the workplace.[652] Although this view is being renegotiated given the utility of these substances in improving work performance, for instance in the transportation, military and healthcare sectors.[653] What is becoming increasingly apparent, is that the prescription and use of cognitive enhancing drugs in the workplace is an extension of the notion of biological citizenship, with individuals being enjoined to monitor, manage and maximise their physiological and neuropsychological assets.[654] One example of this is how sleep is conceived not as something limited to the individual's private life, but as a key factor in the workplace (e.g. sleep deprived individuals incur losses in productivity, more likely to increase accident rates and make poorer judgements).[655] A remedy to this is for individuals to seek behavioural techniques and cognitive therapies, and as a last resort to medication through cognitive enhancement drugs. One form is the use of modafinil, for instance given to fatigued doctors[656] and also in the form of SSRIs such as Ambien CR.[657] But the use of Ambien CR carries with it side effects including headaches, somnolence, dizziness, memory problems along with changes in behaviour and think, and also likely to cause rebound insomnia as one possible withdrawal effect.[658] Thus it is necessary for individuals who seek such a remedy to their sleep for the sake of improving work performance, to be well informed before purchasing or being prescribed such drugs.

[647] Ibid, p. 251.
[648] Arria et. al., op. cit., 2017, p. 247.
[649] Arria et. al., op. cit., 2018, p. 31.
[650] Arria et. al., op. cit., 2017, p. 247.
[651] Keane, Helen, and , "Drugs That Work: Pharmaceuticals and Performance Self-Management," *Drug Effect: Health, Crime and Security*, Cambridge University Press, Cambridge, 2011.
[652] Ibid, p. 108.
[653] Bloomfield, Brian, and Karen Dale, "Fit for Work? Redefining 'Normal' and 'Extreme' through Human Enhancement Technologies," *Organization* Vol. 22, No. 4, 2015, pp. 552–569.
[654] Keane, op. cit., 2011, p. 107.
[655] Bloomfield & Dale, op. cit., 2015, p. 558.
[656] Ibid, p. 553.
[657] Keane, op. cit., 2011, p. 110.
[658] Ibid, p. 111.

Besides those suffering from sleep deprivation, another category of working individuals that may seek cognitive enhancement drugs are those suffering from ADHD, to improve concentration, memory and performance in problem solving (though these effects occur in individuals with and without a diagnosis of ADHD). Stimulant drugs such as Ritalin®, Concerta® and Adderall® are the most often prescribed, and the fact that these drugs are often prescribed long-term, has led to their use being incorporated into what it means to be a normal productive self.[659] Further, the fact that the response to individuals being overworked or unable to focus properly is for them to take cognitive enhancement drugs points to a normalisation of 'working extremely' and it being more advantageous for individuals to become 'extreme workers' (i.e. longer working hours, meeting greater effort, concentration and attention demands).[660]

Consumers

The cognitive enhancement market, both in its prescription and nonprescription of enhancing drugs, can be considered to be part of what Williams et. al. refer to as pharmaceuticalisation. Pharmaceuticalisation refers to the "translation or transformation of human conditions, capabilities and capacities into opportunities for pharmaceutical intervention."[661] Three forms or types of biomedical enhancement reflect this trend, which are normalisation (the body fitting with societal and physician-informed standards), repair (restoring or rejuvenating the body) and augmentation (improving or boosting the body's performance for an individual's competitive edge).[662] Biomedical enhancements thus have the capacity to change what normal standards of the body are going to be, along with making individuals more capable of altering aspects of their mental, physical and cosmetic features as they see fit. Such enhancements therefore can potentially give individuals greater autonomy over their bodies, but at the same time, these changes will be based on shifts in what counts as a 'normal' body. Cognitive enhancements, once they mature enough, are likely to change the way individuals relate to their bodies as well as how individuals operate within different fields in society. But the fact that medications (e.g. modafinil and methylphenidate) that were once used to treat people are now being repackaged as enhancers, reflects the creation of new drugs markets.[663] Markets which may not be under the oversight of the medical profession, especially when enhancers are sometimes taken without prescription. As such, cognitive enhancement drugs are produced for boosting cognitive capacities but also opening up new opportunities for commerce, with applications in judicial, government, military contexts as well as business and sports.[664]

Similarly, in the context of germ-line enhancements, there are two opposing positions regarding the marketing of these enhancements. On one hand, there is the *laissez-faire* position that defends 'deregulated access to germ-line enhancements and a prioritization of the rights of parents to be free

[659] Ibid, p113. .
[660] Bloomfield & Dale, op. cit., 2015, p. 554.
[661] Williams, Simon J., Paul Martin, and Jonathan Gabe, "The Pharmaceuticalisation of Society? A Framework for Analysis," *Sociology of Health & Illness* Vol. 33, No. 5, April 2011, pp. 710–725. p. 711.
[662] Ibid, p. 718.
[663] Ibid, p. 719.
[664] Eaton, Margaret L, and Judy Illes, "Commercializing Cognitive Neurotechnology—the Ethical Terrain," *Nature Biotechnology* Vol. 25, No. 4, 2007, pp. 393–397. p. 393.

to make informed choices on whether to adopt them' (Grozier and Hajzler, 2010: 16).[665] This would entail much freer access to such enhancements for individuals wishing to make use of them. But one dominant issue here is that such a freedom to enhance for the sake of improving mental, physical or cosmetic aspects of human beings will likely give greater advantages to those enhanced in society.[666] Which can be more problematic if only wealthy parents and individuals can afford and benefit from these enhancements. An important argument from the *laissez-faire* position is that while at first such enhancements will only be affordable and accessed by the wealthy, given enough market stimulus through this demand, the cost for producing these enhancements will steadily decrease to the point where the less wealthy will be able to afford them.[667] But this still means that at the outset of the distribution of these enhancements, the less wealthy will be significantly outcompeted and will be playing catch up once these enhancements become more affordable. Consequently, contrasting the *laissez-faire* position is the prohibitionist position that aims to have policymakers prevent the purchasing of such enhancements.[668] This position aims to prevent the potential of a "genetic aristocracy"[669] from forming, as more opportunities in society may become taken up primarily by those that are genetically enhanced.[670] More so, the fact that parents may be able to select specific features to be inherited and others not inherited, means that there is a need for greater structure in how the future of human beings will physiologically and genetically look like.[671] Such structure may not be possible if the *laissez-faire* approach takes free reign in the production and purchasing of germ-line enhancements.

Elderly

One of the most pressing conditions facing the elderly is the growth of neurodegenerative disorders such as dementia and Alzheimer's, the latter of which is estimated to be suffered by approximately 106 million people by 2050.[672] Cholinesterase inhibitors such as donepezil, galantamine and rivastigmine are believed to be capable of improving cognitive impairment in individuals suffering from mild to moderate Alzheimer's, by inhibiting neuronal acetylcholine breakdown.[673] The prevalence of

[665] Crozier, G. K. D., and Christopher Hajzler, "Market Stimulus and Genomic Justice: Evaluating the Effects of Market Access to Human Germ-Line Enhancement," *Kennedy Institute of Ethics Journal* Vol. 20, No. 2, 2010, pp. 161–179.
[666] Ibid, p. 163.
[667] Farrelly, Colin, "Genetic Justice Must Track Genetic Complexity," *Cambridge Quarterly of Healthcare Ethics* Vol. 17, No. 01, 2007.
[668] Crozier & Hajzler, op. cit., 2010, p. 164.
[669] Ibid, p. 164.
[670] Mehlman, Maxwell J., *Wondergenes: Genetic Enhancement and the Future of Society*, Indiana University Press, Bloomington, 2003.
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[673] Tricco, Andrea C., Huda M. Ashoor, Charlene Soobiah, Patricia Rios, Areti Angeliki Veroniki, Jemila S. Hamid, John D. Ivory, et al., "Comparative Effectiveness and Safety of Cognitive Enhancers for Treating Alzheimers Disease: Systematic Review and Network Metaanalysis," *Journal of the American Geriatrics Society* Vol. 66, No. 1, 2017, pp. 170–178. p. 171.

neurodegeneration has led to increasing hope and investment in neuroenhancements, along with structuring of daily life and food choices, to lower the potential for neurodegeneration to develop.[674] Fear over the potential for neurodegeneration is linked to a number of factors: loss of self-control (meaning less autonomy), lowering of dignity, vulnerability (especially when being cared for by strangers), along with feeling like a burden to one's loved ones.[675] The belief in neuroenhancements to alleviate the fear over neurodegeneration, can be linked to the discourse on brain optimisation highlighted by O'Connor and Joffe, which is based on the notion that use of neuroscientific technologies allows individuals to take their neurocognitive functions into their own hands[676] especially with elderly individuals.[677] Neuroenhancements for the elderly are thus likely to grant greater autonomy as well as lower the social and economic burden from the need of elderly care facilities. The neuroenhancement discourse has led to the brain no longer being viewed as 'locked natural organ', and instead as a "laboratory in which human addictions, desire, creativity, memory, violence and even love can be molecularized."[678] Such a discourse, along with the growing pharmaceuticalization that turns human capacities into opportunities for the pharmaceutical industry, may thus use neurodegeneration as a means to pressure individuals to invest more in neuroenhancement technologies.[679] Especially if better cognitive performance is linked to not only what it means to be a fully functioning self, but also to more economic and social opportunities.[680] Thus, while the promise of greater autonomy may be appealing, it is also necessary that there are clear safety protocols taken into consideration in the testing of neuroenhancements before they become commercially viable en masse to the elderly.

On the other hand, brain optimization through access to neuroenhancements may also give individuals greater empowerment, especially in the context of neurodegenerative diseases that may be overcome which previously would render individuals helpless to such diseases.[681] The demand for and production of neuroenhancements, especially in the case of the elderly but also as per the brain optimization discourse in general, aims at promoting greater control over one's cognitive state. This control is linked to improving one's sense of autonomy especially with regards aging and its effects on the brain, as well as alleviating the fears associated with neurodegeneration.

Poor & Residents of Low/Middle-income Countries (LMCs)

A point of concern not receiving as much attention as it should in the literature on HETs, is the fact that the many developments in HETs discussed in this report are taking place primarily in developed countries, meaning that the developing countries may not be able to catch up with the production of

[674] O'Connor, Cliodhna, and Saskia K. Nagel, "Neuro-Enhancement Practices across the Lifecourse: Exploring the Roles of Relationality and Individualism," *Frontiers in Sociology* Vol. 2, February 2017. p. 5.
[675] Ibid, p. 6.
[676] O'Connor, Cliodhna, and Helene Joffe, "How the Public Engages With Brain Optimization," *Science, Technology, & Human Values* Vol. 40, No. 5, 2015, pp. 712–743. p. 713.
[677] Katz, Stephen, and Kevin R. Peters, "Enhancing the Mind? Memory Medicine, Dementia, and the Aging Brain," *Journal of Aging Studies* Vol. 22, No. 4, 2008, pp. 348–355.
[678] Ibid, p. 350.
[679] Williams, Simon J., Paul Martin, and Jonathan Gabe, "The Pharmaceuticalisation of Society? A Framework for Analysis," *Sociology of Health & Illness* Vol. 33, No. 5, April 2011, pp. 710–725. p. 711.
[680] Katz & Peters, op. cit., 2008, p. 349.
[681] O'Connor & Joffe, op. cit., 2015, p. 714.

HETs. Within developed countries, it has already been mentioned that the majority of HETs are going to face accessibility issues because presently they are mostly afforded only by the wealthy, meaning that the advantages these HETs are projected to produce will only benefit a minority of consumers and users. In the long term, given enough of a market stimulus in the production and consumption of HETs, access may become better distributed allowing more people in differing socio-economic circumstances to be able to benefit from HETs.[682,683] Looking at this situation at a global level, the question is then whether or not this market stimulus will spread beyond developed countries and also allow for greater affordability and access to individuals in developing countries. Especially given the far-reaching changes to the capacities of human beings that is likely to occur in the next twenty years from the maturation of physical enhancements, germ-line enhancements, cognitive enhancements and bioweapons, those in developing countries may not feel entirely safe with developed countries having the monopoly on the production and use of HETs. This monopoly is likely to give developed countries more capacity to dictate the future of humanity, and such a monopoly will need to be tempered not just by regulatory bodies, but also by a fairer distribution of HETs. A global discussion will therefore become necessary with regards how to ensure that those in developed countries do not abuse the advantage they may soon have, regarding being at the forefront of HET production and use.

8. Conclusion

As a result of mapping the ethical issues of HET, we find there remain conceptual problems over the characterisation of HETs. For example, in the same way that a prosthetic limb may be spoken of as replacing a 'body part,' so too might a pharmaceutical be described. After all, a drug may be utilised to replace missing chemicals that promote homeostasis. While presently we do not talk of drugs as prostheses, the human enhancement debate may clarify how these different technologies are similar, requiring a new language through which to discuss the ethics of such interventions.

There is one singular thread which dominates the ethical debates about HETs and that has to do with the speculative content of the inquiries. Both advocates and critics rely heavily on multi-factorial speculations about potential scenarios that may develop as a result of embracing HETs and many of these conditions are extremely difficult to predict with any certainty. In this respect, the ethical debate over HETs may hinge on the willingness to embrace uncertainty and to suffer the consequences, but this applies also to rejecting HETs. In the future, it may transpire that an enhanced population is best able to confront the challenges of an increasingly toxic environment, which may require biological modifications in order for life to thrive. Alternatively, humanity's seemingly always fragmented knowledge of living systems may mean that interventions are made that reveal themselves to be catastrophic and irreversible for human life in the long-run. Indeed, this is the criticism often levelled at germ line genetic interventions.

For while we may have some certainty over the removal of genetic dysfunction for an individual who experiences the suffering, the broader impact on the species by removing all forms of genetic dysfunction may yet be unknown. The problem, however, is that societies must elevate the interests

[682] Crozier & Hajzler, op. cit., 2010, p. 169.
[683] Farrelly, op. cit., 2008.

of those presently alive over the lives of those who are yet to exist and this is where it becomes a difficult matter to resolve ethically. Buchanan et al.[684] describe a situation where the human population through its employment of technology, moves from 'chance to choice,' but the latter may not bring about a more desirable set of circumstances, even if it is characterised by the elevation of autonomy. In one crucial sense, humanity's willingness to explore new scientific solutions for human problems is to embrace the idea that lives are best determined by choice, rather than chance, but it is necessary to dispel the idea that the individual's experience of a better life is commensurate with the species also flourishing.

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China: Tang Yueming & Wang Qian, Dalian University of Technology
France: Robert Gianni, Sciences PO
Germany: Philipp Hövel & Lisa Tambornino, EUREC
Greece: Maria Bottis & Efi Apostolou, Ionian University
The Netherlands: Hero van Gein, University of Twente

Poland: Zuzanna Warso, Helsinki Foundation for Human Rights
South Africa: Jantina de Vries & Olivia Matshabane, University of Cape Town
Spain: Francisco Lara, University of Granada
Sweden: Gry Houeland & Heidi Howard, Uppsala University
The United Kingdom: Rowena Rodrigues, Anaïs Resseguier & David Wright, Trilateral Research

Annex 2: Workshop participants

Workshop on Foresight of Human Enhancement Technologies
January 16th–17th, 2019, London, England

Name	Institute
Philip Brey (SIENNA)	University of Twente
Cansu Canca	AI Ethics Lab
Christopher Coenen	KIT (Karlsruhe Institute of Technology)
Lesley-ann Daly	Central Saint Martins
Brian D. Earp	University of Oxford
Oliver Feeney	NUI Galway
Josepine Fernow (SIENNA)	Uppsala University
Stéphanie Gauttier (SIENNA)	University of Twente
Teresa Iuculano	University Paris Descartes
Karim Jebari	Institute for Futures Studies
Philip Jansen (SIENNA)	University of Twente
Sean Jensen (SIENNA)	University of Twente
Karolina Kudlek (SIENNA)	University of Twente
Albena Kuyumdzhieva (SIENNA)	European Commission
Alex McKeown	University of Oxford
Michael Morrison	University of Oxford
Saskia Nagel (SIENNA)	RWTH Aachen
Enno Park	http://www.ennopark.de/
Rowena Rodrigues (SIENNA)	Trilateral Research
Erduana Shala	Deutsche Akademie Der Technikwissenschaften
Patrick Smith	University of Twente
Lisa Tamborino (SIENNA)	EUREC
Karina Vold	University of Cambridge
Zuzanna Warso (SIENNA)	Helsinki Human Rights Foundation

Table 7: Participants of SIENNA London workshop

Workshop on the Analysis of Current and Future Ethical Issues in Human Enhancement
June 13th–14th, 2019, Uppsala University, Sweden

Name	Institute
Imre Bard	NESTA / London School of Economics & Poly-Sci
Jeanett Bjønness	Aarhus University BSS
Jonna Brenninkmeijer	University of Groningen
Lewis Coyne	University of Exeter
John Danaher	National University of Ireland
Farah Focquaert	Universiteit Gent

Name	Institute
Barbro Fröding	KTH Royal Institute of Technology
Pim Haselager	Radboud University Nijmegen
Sean Jensen (SIENNA)	University of Twente
Andy Miah	University of Salford
Emilian Mihailov	University of Bucharest
Ole Martin Moen	University of Oslo & Univ. of South-Eastern Norway
Saskia Nagel (SIENNA)	RWTH Aachen
Thomas Søbirk Petersen	Roskilde University
Johann A. R. Roduit	University of Zurich
Steffen Steinert	TU Delft
Zuzanna Warso (SIENNA)	Helsinki Foundation for Human Rights
Harris Wiseman	University of Birmingham

Table 8: Participants of SIENNA Uppsala workshop

Annex 3: SIENNA Workshop on Foresight of Human Enhancement Programme (London, England)

Introduction: Presentations by Saskia Nagel (20-min introduction to SIENNA, including overview of D3.1 & preliminary work on D3.4), Lisa Tamborino (5-min overview of D3.3) & Zuzanna Warso (5-min overview of D3.2)

Session 1: Group Discussions 1; Chair- Saskia Nagel; Note taker- Lisa

Cognitive enhancement group 1 (Psychopharmaceuticals & cog enhancement in education)
Brian Earp, Michael Morrison, Karina Vold, Teresa Iuculano
Consortium: Josepine Fernow, Lisa Tamborino

Physical enhancement group 1 (Prosthetics & wearables)
Christopher Coenen, Lesley-ann Daly, Enno Park, Cansu Canca
Consortium: Philip Jansen, Philip Brey

Longevity enhancement (Anti-aging technologies, including memory enhancement)
Alex McKeown, Karim Jebari, Patrick Smith
Consortium: Karolina Kudlek, Zuzanna Warso

Enhancement in the workplace
Oliver Feeney, Stéphanie Gauttier, Erduana Shala
Consortium: Albena Kuyumdzhieva, Rowena Rodrigues

Foresight of ELSI &; Chair- Philip Brey; Note taker- Philip Jansen

Session 2: Military Enhancement; Chair- Patrick Smith; Note taker- Josepine

Session 3: Group Discussions 2; Chair- Sean Jensen & Saskia Nagle; Note taker- Zuzanna

Cognitive enhancement group 2 (Neurostimulation & BCI)

Karina Vold, Alex McKeown, Teresa Iuculano, Stéphanie Gauttier
Consortium: Philip Brey, Albena Kuyumdzhieva

Physical enhancement group 2 (Gene-editing)
Christopher Coenen, Oliver Feeney, Cansu Canca
Consortium: Zuzanna Warso, Josepine Fernow

Moral enhancement (Enhancement of socially undesirable/criminal behavior)
Brian Earp, Erduana Shala, Patrick Smith
Consortium: Karolina Kudlek, Philip Jansen

Affective & emotion enhancement (Enhancement of personal relationships)
Michael Morrison, Lesley-Ann Daly, Enno Park, Karim Jebari
Consortium: Lisa Tamborino, Rowena Rodrigues

Session 4: Scenario Discussion; Chair- Josepine Fernow; Note taker- Karolina Kudlek

General Discussion (Conclusion); Chair- Rowena, Note taker- not needed

Annex 4: SIENNA Workshop on Ethics of Human Enhancement Programme (Uppsala, Sweden)

sienna.

[http://www.sienna-project.eu]

Workshop on the Analysis of Current and Future Ethical Issues in Human Enhancement

June 13th–14th, 2019
Uppsala University, Sweden

OBJECTIVE: To make steps towards a broad ethical analysis of human enhancement technologies—one which further clarifies, provides details about nuances, and contextualises the present and potential future ethical issues (within the next 20 years) that have previously been identified by the SIENNA project.

AGENDA DAY 1 (June 13th)

08:30–09:00	Coffee & Registration
09:00–09:45	Introduction to the SIENNA project, aims of the workshop
09:45-12:30	**Session 1: Discussion Groups for (1) Freedom to be Imperfect, (2) Autonomy & Enhancement, and (3) Authenticity & Enhancement**
	Introductory Presentation: Harris Wiseman (10 min max) This session will begin with a short presentation and introduction to group work in plenary, followed by break-out discussions in three pre-assigned groups from 10:00-11:45 (approx. 1.5hr for discussion). Groups are encouraged to take a short break when needed during the discussion; coffee will be available. At 11:45, groups will reconvene for reporting on discussions in plenary (45min). This will be the format for all three Thursday discussion group sessions, with different, assigned topics per session.
12:30-13:30	Lunch
13:30–15:45	**Session 2: Discussion Groups for (4) Human Nature, (5) Dual-use & misuse, and (6) Safety, security and liability (with an ethics focus)**
	Introductory Presentation: John Danaher (10 min max) Same format as Session 1, please see above. Intro + discussions from 13:30-15:00, plenary reporting from 15:00-15:45.
15:45–18:00	**Session 3: Discussion Groups for (7) Accessibility & Inequality, (8) Justice issues for enhancement, and (9) Normality & Enhancement**
	Introductory Presentation: Ole Martin Moen (10 min max) Same format as Session 1, please see above. Intro + discussions from 15:45-17:15, plenary reporting from 17:15-18:00.
18:00	Workshop day 1 ends
19:15	Workshop dinner

AGENDA DAY 2 (June 14th)

8:30–9:00	Coffee & Registration

9:00–10:30	**Session 4: Ethical issues in defence applications of AI, robotics and human enhancement technologies**
	Presentations: Peter Asaro, Imre Bard (additional presenters TBA) (15 min. each) In this plenary session, together with the semi-parallel SIENNA workshop on AI & Robotics, we will collectively analyse the most important present and potential future ethical issues in the domain of defence applications of artificial intelligence, robotics and human enhancement technologies.
10:30–11:00	Break
11:00–12:30	**Session 5: Parallel sessions**
	In two parallel sessions, we will have groups discuss important practical issues for SIENNA Human Enhancement: 1. "Missing issues": what do *you* want to see in SIENNA Human Enhancement reports that is rarely/never addressed? What are key topics / new angles that need to be considered? 2. The value of public involvement and stakeholder engagement in multinational projects, i.e. strategies to best include participation from various stakeholders (discuss potential and limits)
12:30–13:30	Lunch
13:30	Workshop ends

Follow us on Twitter: @SiennaEthics & #ethicsofenhancement

The SIENNA Project – *Stakeholder-informed ethics for new technologies with high socio-economic and human rights impact* – has received funding under the European Union's H2020 research and innovation programme under grant agreement No 741716.