Evaluating ethical frameworks for assessment of human cognitive enhancement

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Abstract

Human cognitive enhancement (HCE) is a term that signifies applications that are supposed to improve cognitive capacities, such as attention, memory or reasoning. A polarised debate concerning the ethical issues of enhancement has emerged between the champions and opponents of HCE. Taking both this debate and increased feasibility of some applications of HCE into account, it is clear that that those involved in ethical debate on human cognitive enhancement need to find a middle-ground between addressing those issues already here or just on the horizon and those issues that tend to be driven by speculation, hype or abstract philosophical concepts. The aim of this book is to make a reasoned argument for a sound ethical framework that might be used by decision makers to ethically assess HCE. We will focus on ethical frameworks for assessment of specific applications (or generic groups of applications) with a clear decision making focus, for instance, related to decisions as to whether or not to buy, market or to allow marketing of such applications. Appropriate frameworks should facilitate ethical decision making in practice, be usable for non-philosophers and related to evidence that can (at least in principle) be produced in the short or medium term.

Keywords: Human enhancement – human cognitive enhancement- ethical framework - pharmaceutical cognitive enhancers – non invasive brain stimulation

1 Introduction

Human enhancement (HE) is the common denominator for applications or activities that are designed to temporarily or permanently improve human beings in different ways, as opposed to merely repairing damages. Human cognitive enhancement (HCE) is a term that signifies applications that are supposed to improve cognitive capacities, such as attention, memory or reasoning. Such enhancement can be carried out in various ways; through the use of pharmaceuticals, genetic interventions, brain stimulation, sensors, and other tools, such as smart glasses.

The complexity of brain function and its effect on behaviour and cognition is one aspect that perhaps sets cognitive enhancement apart from other physical forms of enhancement (Chan and Harris 2006). There is no agreed-upon range of what may be labelled human cognitive enhancement tools; the category is rather defined by the purpose for which interventions or applications are applied. However, these

diverse applications do have certain characteristics in common (STOA 2009). All HCE tools highlight the issue of distributive justice and bring to the fore questions about fundamental cultural values and what it means to be human, as well as questions regarding the cost of the technologies in question, unintended (side) effects and their societal desirability.

These and other questions are taken up in ethical debate in the area. The debate on human enhancement has centred on a variety of enhancements, ranging from cosmetic surgery to genetic modification (Schermer et al. 2009). An important topic in the discussion has been the therapy-enhancement distinction. Therapy is often defined as "the attempt to restore a certain condition (e.g. normality, sanity, health)" while enhancement is viewed as transcending these boundaries (STOA 2009, p. 10).

'Transhumanists' and 'posthumanists', such as Nick Bostrom or Julian Savulescu are the ones championing HE in principle, adhering to the idea that our given nature is in some sense a restriction. Nature has brought us quite a distance in our evolution, but there are also many flaws in our nature, as well as many potentials that are not fully developed. In their view, human enhancement would be an instrument to rid us of our natural chains, enable us to take a step away from natural evolution, and enter a more controlled and accelerated post-evolutionary, or techno-evolutionary process. In some cases, this step is not framed as merely a positive trigger, but even as a moral duty (Harris 2007).

At the same level, other groups of philosophers (called 'bio-conservatives' by the transhumanists[1]) argue that human dignity is at stake and that human enhancement is unnatural or inauthentic for the human race. For instance, Kass (2003) says: 'Most of the given bestowals of nature have their given species-specified natures: they are each and all of a given *sort*. Cockroaches and humans are equally bestowed but differently natured. To turn a man into a cockroach—as we don't need Kafka to show us—would be dehumanizing. To try to turn a man into more than a man might be so as well. We need more than generalized appreciation for nature's gifts. We need a particular regard and respect for the special gift that is our own given nature' (p. 1). Being similarly concerned by our possibility to change human nature, Fukyama (2002) says: 'Denial of the concept of human dignity – that is, of the idea that there is something unique about the human race that entitles every member of the species to a higher moral status than the rest of the natural world – leads us down a very perilous path. We may be compelled ultimately to take this path, but we should do so only with our eyes open.' (p. 149)

As can be seen, this debate (particularly prominent at the start of the millennium) was quite polarised. As Selgelid (2008) observes, "parties to the debate risk talking past one another" (p. 237). The ethical debate in the area has also been haunted by the lack of empirical basis, while " (…) the meaning, consequences and ethics of enhancement" largely turn on key empirical questions (ibid, p. 238). As Outram (2012) observes, several commentators have argued that ethics is being led into

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[1] Bostrom (2005) includes the following in this category: Leon Kass, Francis Fukuyama, George Annas, Wesley Smith, Jeremy Rifkin, and Bill McKibben.

"unwarranted territory" with little scientific and sociological empirical evidence to support underlying claims regarding efficiency and usage of existing technologies (p.173). A well developed philosophical framework that can deal with conflicting values such as liberty, equality and utility and the need to strike a balance between them is also lacking (Selgelid 2008). Finally, much of the debate centres on "enhancements with a capital E" (Schermer et al. 2009), i.e. those enhancements that go beyond what we currently understand to be "normal" or naturally human. However, as Schermer et al. (2009) argue, there are a number of important ethical and policy questions to be addressed concerning less spectacular kinds of enhancement - or "enhancements with a small e" – that are already feasible or will be in the near future.

Indeed, pharmaceutical and technological advances make the discussion less speculative and closer to the market. For example, transcranial direct current stimulation (tDCS) for cognitive enhancement in healthy individuals is becoming increasingly popular. tDCS devices can be constructed at home using straightforward instructions and cheap parts (Fitz and Reiner 2013). At the same time, the reach of transcranial direct current stimulation is extending beyond home users, with companies selling compact and user-friendly devices (Farah 2015). Similarly, pharmaceutical cognitive enhancers which work to enhance certain cognitive functions are widely said to be used by students and academics (Greely et al. 2008). The Nuffield Council (2011) notes that the number of potential users for the non-therapeutic application of novel neurotechnologies – including tDCS - is inevitably much greater than that for specialised medical applications, thus any ethical or social concerns that do arise warrant attention (p. 163). Moreover, the size and nature of the market for non-therapeutic applications "(…) raises the prospect of direct to consumer (DTC) marketing of devices and services and private use of neurotechnologies unmediated by healthcare professionals" (p. 163). We hold that the same is true for pharmacological enhancers. Off-label prescription[2] of medication for explicit enhancement purposes is likely to expand and the same might be said for the use of enhancing drugs without a prescription (Schermer et al. 2009).

Taking both the entrenched debate and increased feasibility of some applications of HCE into account, it is clear that that those involved in ethical debate on human cognitive enhancement need to find a middle-ground between addressing those issues already here or just on the horizon and those issues that tend to be driven by speculation, hype or abstract philosophical concepts.

There have therefore recently been calls for policy-making in the area of human enhancement (STOA 2009; Zwart 2015). Policies can be developed both with regard to the general concept of HE and with regard to specific applications. Science, technology and innovation (STI) policies may, on the one hand, be developed to support or steer HE technology trajectories in certain directions. This requires soci-

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[2] Off-label use refers to "the prescription of drugs for a purpose that is not included in the drug's approved label" (Schermer et al. 2009 p. 78).

etal deliberation regarding the kind of innovation we, as a society, want to encourage. This is in line with the current focus on Responsible Research and Innovation (RRI) and calls for deliberation on overall societal and ethical issues (Stilgoe et al. 2013). For instance, it could be important to consider whether the technology inherently contributes to or challenges our concepts of agency, autonomy or personhood of other persons. This is the kind of deliberation that Stirling (2008) presents as 'opening up' reflection. One feature in the 'opening up' phase also involves including alternatives, and considering other solutions than the proposed (technological) solution to reach the articulated or agreed upon goal (Rip and Te Kulve 2008).

There may, on the other hand, also be a need for policy-making in the area of specific applications. This kind of policy-making will often have a regulatory or decision-making focus. Risk assessments are commonly applied in the area of pharmaceuticals or medical inventions. Sometimes there are also application focused ethical assessments, such as the ethical assessment that is required for all GMOs in the Norwegian Gene Technology Act. Even when not formally required by legislation, there may be a desire to ethically assess specific applications. For instance, potential consumers or users (such as socially responsible doctors) may want to ethically assess HE applications before they make purchasing-decisions; producers may want to ensure that their products are ethically acceptable; or policy makers may want an ethical assessment when considering policy interventions. This is the kind of deliberation that Stirling (2008) describes as 'closing down'.

These two different levels of policy or decision making are related to different needs for deliberation and assessment.

Societal need for ethical deliberation in HE	Form of deliberation	Aim of assessment
I. STI policies	Societal deliberation processes	Opening up societal deliberation
II. Decision/policy making	Individual/smaller group	Closing down decisions

Table 2. Two levels of policy or decision-making and related needs for deliberation and assessment

The debate between the transhumanists and the bioconservatives may be valuable for informing more general deliberation of HE technologies because they raise general philosophical questions. However, it is not apt as a basis for regulatory or decision oriented policy-making, as these philosophical positions are highly speculative and futuristic, and hard to reconcile with the current paradigm of evidence-based policy making. Moreover, the transhumanist/bioconservative debate does not allow for common ground and in pluralist societies simply picking one favoured philosophical stance is not defensible as a basis for societal decision making (Forsberg 2007). For such policy or decision making, more practical ethical approaches would seem to be required, where there is at least a potential link to evidence to be gathered in the short or medium term and which includes a broader range of value bases that would at least in principle allow convergence on certain judgements. As a basis for policy or decision making Toulmin (1981) argues that

staying at a principled level is likely to cement differences, while operating at a mid-level common morality level is more likely to facilitate a moral dialogue that may agree on important points (in spite of ideological differences). This might be a viable strategy for furthering the discussion on HE beyond the dead-lock of transhumanists and bioconservatives. But how to do this in practice?

2 Ethical tools as vehicles for practical, ethical dialogue

Beekman and Brom (2007) suggest in the biotechnology context the use of "practical instruments that can be used (tools) in order to support debates and deliberative structures for a systematic engagement with ethical issues" (2007, 4).[3] Because of the multitude of ethical and societal debates in emerging technologies, such tools should include all relevant ethical aspects in decision-making and systematic tools should also broaden the debate. This seems to be necessary also in the discussion of HE. Beekman and Brom refer to a FP5 project, Ethical Biotechnology Assessment Tools (the Ethical Bio-TA Tools project), which identified and reviewed a series of ethical tools or frameworks. The Ethical Bio-TA Tools project identified three major types of tools: Food chain value communication tools, public consultation and involvement tools, and decision-making tools. *Food chain value communication* tools were targeted to corporate stakeholder dialogues. *Public consultation* tools designated *process* tools with procedures to elicit information on facts and values from experts, stakeholders or lay people, as well as procedures to deliberate on these. Examples are citizen's panels, Delphi processes, stakeholder workshops, consensus conferences, etc. (see Fixdal 2003 and Rowe and Frewer 2000). These public consultation tools mainly have the purpose of opening up debates. *Decision-making* tools were defined as tools that would aid ethical decision- and policy-making, in other words, assist in closing down decisions. Such tools should not be seen as mechanical decision-processes, but rather as "something that can help you use your judgement" (Seedhouse 2009, p. 107). Public consultation tools fit quite nicely with the STI deliberation level from table 2 and decision making tools are generally appropriate for decision/policy making needs.[4] The food chain value communication tools were targeted to a specific use context and are thus less relevant for ethical assessment (of HE) in general.

For all of these kinds of ethical assessment tools, a crucial concern is to ensure their quality. An ethical assessment tool is of no value if it is of low quality. Ethical assessments should not be biased or misleading, or refer to non-relevant issues. Concerns with quality have led researchers to study what characterises

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[3] In this article, the terms 'tools' and 'frameworks' will be used interchangeably.

[4] However, public deliberation might benefit from a broader variety of tools than the purely procedural ones.

good ethical assessments. In particular there has been a focus on how ethical tools may help to ensure high quality ethical assessment. In the Ethical Bio-TA Tools project, the term 'soundness' was used to indicate a concern for methodological quality of ethical frameworks: 'an ethical framework is ethically sound if [if and only if] its application produces understanding of ethically relevant considerations in such a way that within a given body of knowledge and on condition of its competent use no further considerations would decisively alter the normative conclusions drawn from the framework by the users' (Kaiser et al. 2004 p. 26). Ethical soundness was operationalised as:

1. Inclusion of values at stake;
2. Transparency;
3. Multiplicity of viewpoints;
4. Exposition of case relevant ethically relevant aspects;
5. Inclusion of ethically relevant arguments. (p. 27)

Moula and Sandin (2015) have some objections to Kaiser et al.'s approach, but similarly conclude that all ethical frameworks should be comprehensive. They also stress the need for frameworks to be user-friendly. Even if this context was the biotechnology context, quality in the HE context seems equally important.

Accordingly, in this article 'ethical tools' refers to mid-level decision-aiding tools with the aim of closing down. We are interested in tools that help us go beyond the philosophical debates between transhumanists and bioconservatives in order to assist practical decision makers in concrete ethical deliberation and decision making. We assume that these practical decision makers are seldom learned philosophers and we therefore attach great importance to the criterion of user-friendliness.

This means for instance that we are not so interested in the process tools because the criterion of user friendliness indicates that it would require too much of, for instance, an ordinary consumer or individual bureaucrat to organise such a process.[5] Here we are rather interested in *substantive* tools that help the user to identify and analyse the ethical issues through the provision of information regarding relevant values or principles. Such tools may be used by anyone and may be disseminated by different public or private institutions on the internet or in other written material. Thus, in this article we will focus on systematic methods for identifying relevant ethical values and assessing the impacts of an HCE application on these values, facilitating making judgements on the ethical acceptability or desirability of the application.

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[5] We also consider the Ethical Delphi tool as such a process tool, even if it is designed for experts and not for broader public engagement. In the Ethical Bio-TA Tools project, the Ethical Delphi was included among the decision-making tools, but as it is purely procedural it cannot be used by a single individual or a small group of non-expert users without resources for organising a more extensive deliberation process.

It should be clear that there is a need for sound ethical frameworks for both levels of analysis indicated above; for both good ethical deliberation on the STI policies and good ethical assessment that may aid more practical decision- and policy making. An ethical approach to deliberating the overall societal questions (what Brey (2012) calls a generic approach to ethics) regarding human cognitive enhancement has been developed by Hoffman et al (2016). An alternative approach at the same level is the techno-moral scenario approach developed by Boenink et al. (2010). We will therefore not discuss ethical assessment at this level here. We will rather target the decision making level, where no framework yet has been proposed in the field of HE. We will thus focus on ethical frameworks for assessment of specific applications (or generic groups of applications) with a clear decision making focus, for instance related to decisions as to whether or not to buy, market or to allow marketing of such applications. We will take as a starting point the need for such frameworks to facilitate ethical decision making in practice, to be usable for non-philosophers and related to evidence that can (at least in principle) be produced in the short or medium term.

The aim of this article is thus to make a reasoned argument for a sound ethical framework that might be used by decision makers to ethically assess HCE. According to the soundness definition given above, this framework needs to be able to incorporate the values at stake, a multiplicity of viewpoints, exposition of case relevant ethically relevant aspects and inclusion of ethically relevant arguments. This can only be done with regard to specific cases, and we will present below two such generic cases of HCE. The reader should note, though, that the deliberations in this article are not principally different from deliberations in the HE field in general, so the article has broader interest.

In line with the soundness definition, we will first offer a brief overview of the issues that form the core of the ethical debate in HCE, drawing out the various arguments of proponents and opponents for and against HCE. It should be clear that in the ethical discussion about HCE applications we find arguments of a broader scope than the general philosophical positions for and against HE presented above. There is thus much to build upon in an ethical assessment framework for HCE. After presenting these arguments we will identify different candidate frameworks for ethical assessment in HCE and evaluate the ways in which these frameworks are able to address these ethical issues while being user-friendly and facilitating transparency. After discussing some of our assumptions, we will be in a position to make recommendations about an ethical assessment framework that will aid users to draw conclusions in a sound way.

In the following section, we will offer a description of the two main applications of focus here, i.e. pharmaceutical enhancers and non-invasive brain stimulation techniques. These two cases have been chosen because they are already available on the market and will be increasingly available, as we have already described in the introduction. We will list and briefly describe the general ethical issues that are discussed in relation to the two areas. We focus specifically on non-therapeutic applications and refer only to therapeutic applications where ethical

issues touch on both kinds of application or where they are mentioned in accounts about non-therapeutic applications.

3 Ethical concerns: cognitive enhancing drugs and non- invasive brain stimulation

3.1 Methodology

In the mapping of ethical issues regarding human cognitive enhancement, we used a two-tiered approach in which we first carried out a systematic search, followed by the addition of references from these searches. The first round search provided a range of topics, but also many new references that we saw fit to include. We adopted Kjølberg and Wickson's (2007) explorative approach to conducting literature searches on new and emerging technologies.

In the first search, we used Thompson-Reuter's Web of Science using very open search terms: "ethics" and "cognitive enhancement". We found 87 articles that we scrutinised. We removed entries that were clearly off topic or that were in some sense incomplete, for example, abstracts to conferences and non-peer reviewed articles. 30 papers remained. After having read through these articles, we added references that addressed arguments that the first set of articles either supported or tried to refute. This left us with a total of 67 papers.

The ethical issues that are discussed in the context of the two applications discussed here fall under two main categories. The first category concerns health issues and includes items such as safety and efficacy. The second category concerns the individual or societal consequences of the use of these forms of cognitive enhancement and centres in on issues such as fairness and personal achievement, distributive justice and coercion. While authenticity and naturalness are key issues within the overall enhancement debate, many of the papers we reviewed either did not engage with these concepts or considered them as part of another argument. However, given the general importance of this topic to the broader enhancement debate, we include it here. Another ethical issue that is frequently discussed in the context of non - invasive brain stimulation techniques is the issue of autonomy and consent, particularly with regard to the use of these techniques on children – we also discuss this issue here. Privacy is an important issue for some HCE applications (such as smart glasses), but not for the two applications discussed here. An ethical framework should be able to address also such an issue.

Before we discuss these issues, we first provide a brief overview of cognitive enhancing drugs and their purported use and effects.

Cognitive enhancing drugs

Cognitive enhancing drugs, also called smart drugs or "nootropics" – from the Greek roots *noo-*, mind and *-tropo*, turn, change (Cakic 2009) – are used to treat cognitive disabilities and improve the quality of life for patients with neuropsychiatric disorders and brain injury (Sahakian and Morein-Zamir 2011). Such drugs are used in treating cognitive impairment in disorders including Alzheimer's disease, schizophrenia and Attention Deficit Hyperactivity Disorder (ADHD) (ibid). Many of these same drugs have also been used by healthy individuals in an attempt to gain "better than normal" cognitive ability (Farah et al. 2014; Hall 2004; Racine and Forlini 2010). Enhancing effects of cognition can only be shown on the level of distinct functions such as concentration, alertness, working memory, long-term memory and so on (Schermer et al. 2009).[6] The most commonly used drugs for cognitive enhancement are stimulants, namely Ritalin (methylphenidate) and Adderall (mixed amphetamine salts) and are prescribed primarily for the treatment of ADHD (Greely et al. 2008). A modest degree of memory enhancement is possible with these ADHD medications (ibid). A newer drug, Modafinil – approved for the treatment of fatigue caused by narcolepsy, sleep apnoea and shift-work sleep disorder – has also shown enhancement potential and has been tried on healthy people who need to stay alert and awake when sleep deprived, such as doctors on night duty (ibid). [7] Academics are reported to make use of Modafinil to counteract the effects of jetlag, to enhance productivity and to deal with demanding intellectual challenges (Sahakian and Morein-Zamir 2007). The advantages and disadvantages of the use of pharmaceutical enhancers for both *individuals* and *society* have been discussed (Mohamed 2014; Chan and Harris 2006) and will be discussed in more detail here. Survey numbers indicate that the use of cognitive enhancers by students in the United States is likely to be in the range of 5-15% (Ragan et al. 2013) and such use appears to occur primarily at prestigious universities. Studies investigating students' motivations and reasons for the use of HCE have unearthed a variety of motivations. Reasons for use range from overcoming tiredness and sleepiness (Castaldi et al. 2012), to 'getting ahead' and maintaining a high level of academic achievement or, conversely, as a method of "keeping up" or coping with stressful tasks, such as exams (Partridge et al. 2013) and to improve concentration (Mache et al. 2012). There are a few studies which have investigated the prevalence

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[6] The 'intelligence' trait is too complex and multi-faceted to be enhanced by one single intervention (Schermer et al. 2009)

[7] A variety of practices of medication use for enhancement purposes may exist and develop further in future. These include occasional boosts for special occasions; continuous use to improve performance in high-pressure competitive environments; experimentation for curiosity or fun; substance abuse; and auto-medication of mental problems (Schermer et al. 2009).

of, attitude to and rationale for the use of cognitive enhancers by university students in Europe, specifically in Switzerland (Ott and Biller-Andorno 2013), Germany (Sattler et al. 2013; Hildt et al. 2014) and in the United Kingdom and Ireland (Singh et al. 2014). A study by Forlini et al. (2014) regarding the prevalence, views and knowledge of a large sample of German students from three different universities has shown that while neuroenhancement is a well-known phenomenon among German students, only 2.2% of their sample of 1,026 reported having used a prescription medicine for enhancement. The predominant motivations for use included exams and competitive situations. However, on the whole, students were unenthusiastic and critical of the use of neuroenhancers in an academic context.

Given the ageing population in many countries and the attendant extended lifespan of individuals, it is also highly likely that cognitive-enhancing drugs that can improve memory in healthy elderly people and will thus be sought after (Hall 2004; Sahakian and Morein-Zamir 2011).

3.2 Risk and efficacy

The main ethical argument for HCE is that improved cognitive skills will lead to better lives. Sandberg and Bostrom state that low intelligence "increases the risk for accidents, negative life events, and low income" (2006, 201), while higher intelligence is related to improved health and greater wealth. Increased cognitive capacities will then, according to Sandberg and Bostrom, reduce the likelihood of harm and increase the likelihood of benefits. Their argument rests on the notion that different types of HCE actually increase cognitive functions and that the increase in cognitive functions is not offset by other negative consequences.

Notwithstanding the view above, concern about safety is a major issue in ethical discussion of cognitive enhancement. While safety is a concern for all medications and procedures, our tolerance for risk is smallest when the treatment is purely elective (Farah et al. 2004). In comparison to other comparably elective treatments such as cosmetic surgery, cognitive enhancement involves intervention into a far more complex system (the brain) and an associated greater risk of unanticipated problems (ibid). Moreover, the trade-off between side effects and improvements may be less clear if healthy individuals use pharmaceutical enhancers to improve their mental performance (Hall 2004). Crucially, and in opposition to the argument advanced by Sandberg and Bostrom above, some scholars observe that "more" may not always be "better" in terms of memory or attentiveness as unanticipated problems could arise (Whetstine 2015). Altering the selective process of memory could have associated effects whereby gains in one area may lead to diminishments in another area (ibid). For example, some studies have shown that Adderall may increase focus and attention while reducing creativity. Another concern is that "it may not be possible to simply amplify

memory or cognition without having profound effects on our identity" (Whetstine 2015, p. 174).

The medical safety of PCEs varies among substances and side effects relate both to the direct pharmacological effects and broader physical and physiological changes (Maslen et al. 2014, p. 4). The risk of dependence has been highlighted (Farah et al. 2014) as the risk to individuals using these medications specifically for cognitive enhancement is unknown. Indeed, a number of commentators have called for data to inform the discussion on cognitive enhancement. Some authors argue for data regarding the safety and efficacy of the use of these drugs in healthy individuals in order to strengthen the empirical foundation of the ethical debate (Boot et al. 2012; Maslen et al. 2014), while others call for data concerning the attitudes of people regarding cognitive enhancers (Lucke 2012; Nadler and Reiner 2010) in order to inform policy and practice (in general practitioners' offices, schools, universities and workplaces).

Notwithstanding the huge interest in PCE from philosophers and scientists, evidence as to their effectiveness is still inconclusive (Maslen et al. 2014). While all three classes of medication have been reported to enhance performance in certain laboratory cognitive tasks for at least some normal healthy subjects, the true reliability and size of these effects, and their usefulness for real-world cognitive enhancement have not been definitively established (Farah et al. 2014). Moreover, most PCEs are only effective in the case of decreased conditions such as sleep deprivation. While such uses are non-therapeutic, the conditions in question are more like conditions requiring treatment than to a state of normal functioning (STOA 2009). Difficulties in assessing efficacy may very likely mean that many products with unproven claims will enter the market (Hall 2004). Experience with purported 'natural' forms of enhancement such as nutraceuticals, functional foods and dietary supplements demonstrates that protecting consumers from new technologies with doubtful efficacy will be a challenge (ibid). Given these observations, major scholars in the field have argued that the term "cognitive enhancement" itself is debatable in so far as it implies efficacy that has not been established (Forlini et al. 2013; Hall and Lucke 2010; Racine and Forlini 2009).

3.3 Authenticity and naturalness

The debates involving the topics of authenticity and naturalness highlight disagreement regarding the meaning of these two terms. A key disagreement is where to draw the line between natural and unnatural enhancement. Whereas some enhancements, such a yoga, are seen as natural and unproblematic, other enhancements, such as genetically engineering fertilised eggs, are seen as highly unnatural and problematic. When using the notion of naturalness as an argument against HCE, the main challenge is to defend an understanding of this term that

allows one to draw a line between permissible and impermissible applications between these extremes.

Maslen et al. (2014) distinguish between the concern about authenticity and naturalness. One concern regarding authenticity is of a purely philosophical nature, concerning numerical personal identity (DeGrazia 2005). Other rather philosophical concerns that are also noted as ethical issues are what it is for an individual to become more or less his "real" self and similar existential issues (The President's Council of Bioethics 2003 and Kass 2003).

According to Maslen et al., Kass (2003) offers an understanding of naturalness as 'intelligibility in human terms': coffee or alcohol is intelligible to humans in a different way than pills are. Such an objection to pharmacological HE is refuted by Maslen et al. These authors seem to agree that pills that produce completely new cognitive abilities might have a relevant novelty, and as such may be seen as unnatural. They recommend further research into such novel abilities, but still claim that the question of naturalness as non-novelty is ultimately a normative question. They claim that pharmacological HEs at present are 'more of the same' and do not change human beings in a novel way.

Kass recognizes the potential difference-reducing potentials of pharmaceutic enhancers. However, he holds that there is "a sense that the 'naturalness' of means matters" (Kass 2003, 22). Kass focuses on the meaning and the contexts that immerse the different means that humans use in order to strive for a given end. Kass claims that humans cannot understand the meaning of biomedical interventions' effects on the human body and mind in human terms since they are removed from their previous meaning-providing contexts that typically characterize coffee, cigarettes, training, education etc. Kass holds that "The lack of 'authenticity' sometimes complained of in these discussions is not so much a matter of 'playing false' or of not expressing one's 'true self', as it is a departure from 'genuine,' unmediated, and (in principle) self-transparent human activity" (2003, 23).

Maslen et al. claim that the authenticity questions fundamentally refer to an assumption that human beings are most authentic when they are in a "natural" state (p. 5), an assumption they argue against. Rather, they see authenticity as autonomy, where the individual is free to improve themselves. They claim that if pharmacological enhancers 'can, for example, help an individual to concentrate better so that he or she can achieve the goals he or she values, this acts in service of authenticity rather than undermines it' (p. 4).

Sandberg and Bostrom's (2006) core claim is that HCE is a means to increase the likelihood of a good life. The scholars who see authenticity and naturalness as arguments against the desirability of HCE see it as a poor means for a good life (McKibben 2004, Ida 2008, Agar 2014). The Commission of the Bishops' Conferences of the European Community made a statement about the limits of the human condition (Comece 2009, p. 6). Elliott 2003 and Sandel 2004 also take different strategies in this direction, but at a more general level than simply about pharmacological HEs.

3.4 Fairness and personal achievement

Another frequently discussed issue concerns the question as to whether the use of cognitive enhancers – in exams or at work, for example - constitutes cheating, conferring an unfair advantage over others in competitive situations, resulting in an "unlevel playing field" (Cakic 2009; Sahakian and Morein-Zamir 2011).[8] A related ethical issue noted by Maslen et al. (2014) goes beyond "fairness in competitive contexts to ask whether personal achievement facilitated by PCEs are devalued for this reason" (p.8). A number of scholars, however, posit arguments which undermine concerns regarding cheating. One argument counters that, given widespread biological and environmental inequalities already in existence, the validity of the level playing field concept can be questioned (Cakic 2009; Dresler et al. 2013). Cakic (2009) makes this argument with respect to genes and the socioeconomic background of one's parents which also have an impact on conferring advantage over others. Another argument introduces the relevance to the debate of the particular neural systems affected by different substances and their disparate effects (Maslen et al. 2014); in other words, "whether a substance improves creativity or rote learning may matter for some possible conceptions of what constitutes cheating" (p.8). Goodman (2010) argues that the use of cognitive enhancing drugs does not cheapen accomplishments achieved under their influence; cognitive enhancement can, rather, be seen as being in line with well-established conceptions of collaborative authorship, in which the locus of praise and blame can be shifted from individual creators to the ultimate products of their efforts. Schermer (2008) highlights the importance of understanding education and other arenas of activity such as sport as "practices" with their own internal goods and standards of excellence, the understanding of which can facilitate the articulation of potential problems of enhancement.

The likelihood of cognitive trade-offs adds another dimension to the cheating debate (Maslen et al. 2014): evidence suggesting that enhancement in some domains comes at the cost of impairments in other domains challenges the view that achievements enabled by PCE do not involve sufficient personal sacrifice [which is a factor in the judgement of whether something is cheating]. Biedermann (2010) mentions the possibility for a future where efforts are seen as unnecessary striving, and technological or pharmaceutical measures take the role of hard work. This resonates with Forlini and Racine's (2009) study on the use of Ritalin in academic settings where all stakeholders agreed that Ritalin was an "easy way out" and that such use connoted dishonesty.

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[8] Interestingly, while universities have academic codes of conduct that prohibit cheating and plagiarism, they have yet to directly address the use of cognitive enhancers as violations of academic integrity, as they "are regarded in a moral gray zone" (Whetstine 2015, p. 175).

3.5 Distributive justice

Society-level debates about PCE-related inequality consider distributive justice and the issue as to whether PCEs will worsen existing socio-economic inequality, particularly if only the wealthy can access them[9] (Biedermann 2010; Maslen et al. 2014). Proponents of human enhancement counter this argument with two responses. First, they argue that this is more a criticism of existing social hierarchies than a convincing objection to enhancement *per se* (Hall 2004). Second, they argue that the problem can be overcome by addressing inequities in access to the new technologies (ibid). For example, all forms of enhancement could be made freely available to everyone through public subsidising of costs. Another argument suggests that such distribution of enhancers would contribute to progress in developing countries or among societal groups (such as elderly people with mild cognitive deficiencies or children in areas of poverty) in the developed world, and would, overall, led to an improvement in the human condition (Nam 2015).

Biederman (2010) notes that it is an open question as to whether HCE should be regarded through the lens of a zero-sum game (see also Buchanan 2008), i.e. there might be collective goods arising from HCE, in addition to collective costs. This issue also touches upon the claimed competitive advantage societies and/or individuals will experience from the use of HCE. Beyer, Staunton and Moodley (2014) argue that PCEs will mainly be used by those who are well-off.[10] Dunlop and Savulescu (2015) suggest giving priority of HCE to persons with an IQ in the lowest range (IQ < 75), arguing that the occurrence of such a low IQ level correlates with a range of social ills such as unemployment, underemployment, poverty, illegitimate children and chronic welfare dependence. An increase in IQ for these people will have both individual benefits since it reduces the mentioned ills, but also a societal benefit since they will be less dependent on welfare as a collective. [11] On a more speculative note, Proust warns us of a potential "cognitive arms-race that can only be detrimental to mankind" (2011, 167) in which

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[9] Alternatively, if some PCEs are affordable, they could be adopted in disadvantaged populations, much like what happened with the mobile phone in the developing world (Sahakian and Morein-Zamir 2011).

[10] They suggest a taxation on PCEs whereby the governmental income should be earmarked for health-initiatives for the worst off. Biederman (2010) claims that the only certain beneficiary of a liberal regime on PCE will be pharmaceutical companies (see also Micoulaud-Franchi et al. 2012).

[11] Dunlop and Savulescu are not committed to any specific enhancer, but mention modafinil and methylphenidate as the stimulants having the greatest potential. They are also open to more conventional methods, including adding iodine to diets, as this can increase IQ by 10 to 15 points for those lacking iodine and costs only 2 to 3 cents per year.

individuals and states would compete with each other in order to achieve the most encompassing HCE. [12]

Another argument concerns whether enhancement interventions might take resources away from more useful medical research targeted at serious diseases that could affect the well-being of the poor majority of the world (Giubilini and Sagar 2015). Such egalitarian concerns can also work to justify the normative significance of the therapy-enhancement distinction (ibid). Thus, it has been argued that, given the limited resources available, therapy has priority over enhancement because making everybody a 'normal competitor' is necessary to maintain fair equality of opportunity for different members of society. Other scholars take a different view and question whether it would be ethical to deny healthy individuals a cognitive enhancer that has been shown to be perfectly safe and reliable (Sahakian and Morein-Zamir 2007). This argument relates to the cognitive liberty argument discussed above.

3.6 Coercion

Coercion, either explicitly or implicitly, to take cognitive enhancers comprises another issue that frequently arises in ethical debate. Coercion can be viewed as a "social consequence" of neuroenhancement (Heinz et al. 2012). Such coercion may occur explicitly by, for example, requiring workers to be alert during a night shift or it may occur more implicitly, such as in establishing a competitive environment in which incentives are offered for best performance (Sahakian and Morein-Zamir 2011). Children represent a special case here as they are unable to make their own decisions (Greely et al. 2008; Gaucher et al. 2013). This concern also extends to students who may experience implicit pressure to take PCEs in order to keep up with their peers (Cakic 2009; Biedermann 2010). However, Cakic lists a number of criteria which he argues need to be fulfilled in order for a student to be indirectly coerced into using PCEs. First, enhancers would have to confer significant improvements in performance such that not taking them would leave students at a distinct academic disadvantage relative to their peers. Second, a sufficiently high proportion of the student's peer body would need to be taking enhancers in order to justify the perception that "everybody else is taking them". Finally, the most successful students would need to be using PCEs so as to "perpetuate the presumption that it is either impossible or prohibitively difficult for a drug-free student to attain high grades" (p. 612). Again, given the lack

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[12] Proust concludes that a "principle of scientific responsibility would argue for selecting the areas where cognitive and emotional enhancement would be fruitfully enhanced, while banning research in which enhancements are predictably conducive to violence, addiction, irrepressible consumerism, submission, and, in general, to behaviors that violate the agent's dignity or autonomy" (Proust 2011, 167).

of data regarding the prevalence and use of PCEs in academia, one can only speculate as to whether this situation actually exists in (some) current academic environments. There is also another element to this coercion argument. Some argue that the approach of banning or restricting the use of neurocognitive enhancement at school or in the workplace is also coercive as it "denies people the freedom to practice a safe means of self-improvement, just to eliminate any negative consequences of the (freely taken) choice not to enhance" (Farah et al. 2004, p. 423). In other words, banning enhancement technologies altogether would just replace one form of coercive control with another (Hall 2004). [13] In an article studying health workers', students' and parents' views regarding Ritalin and coercion, Forlini and Racine found that their respondents converged on the view that the use of CE is seen at once to be a personal choice and a "result of tremendous social pressures to perform and succeed in very competitive environments" (2009, 166). This means that even though there is a strict separation in much normative ethics between coercion and personal choice, these two elements are easily combined by key stakeholders. Forlini and Racine explain this in their observation that "participants advanced the role of autonomy at the normative level. However, at the descriptive level, social pressures were abundantly illustrated by an overwhelming majority of focus group participants" (2009, 174). The coercive aspect is seen as the need to obtain good grades for future success, while the element of free and personal choice is that the students should be free to be who they want. Forlini and Racine interpret the positions discovered in their focus groups as social pressure that limit sthe domain for personal choice.

3.7 Non invasive brain stimulation

Noninvasive[14] brain stimulation (NIBS) techniques such as transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS) are used as investigative tools in cognitive neuroscience and are increasingly being explored as treatments for a variety of neurological and psychiatric conditions (Hamilton et al. 2011). Noninvasive brain stimulation also has the potential to enhance neurological function in cognitive skills, mood and social cognition (ibid).

TMS makes use of electromagnetic induction and involves the generation of a rapid time-varying magnetic field in a coil of wire (Farah et al. 2014). When this

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[13] Beyer, Staunton and Moodley (2014) hold that all regulation and justification of PCEs must take into account autonomy. They further see PCEs as a tool for potentially improving individual autonomy.

[14] We only discuss noninvasive brain stimulation here, as the use of noninvasive brain stimulation faces much lower hurdles for non-therapeutic use than is the case for invasive technology (Heinrichs 2012).

coil is held to the head of a subject, the magnetic field penetrates the scalp and skull, inducing a small current parallel to the plane of the coil that is sufficient to depolarise neuronal membranes and generate action potentials (ibid). Different TMS paradigms use a variety of pulse frequencies, intensities and stimulation locations to achieve specific diagnostic, therapeutic and environmental effects (ibid). In transcranial direct current stimulation (tDCS), weak electrical currents, for example 1mA, are applied for a short duration (approximately 20 minutes) to the head via electrodes that are placed on the scalp (Kadosh et al. 2012). The currents pass through the skull and alter spontaneous neural activity (ibid).

It has been suggested that TMS could be used as a form of cognitive enhancement in the future (de Jongh et al. 2008; STOA 2009). Studies with the explicit objective of inducing cognitive enhancing effects represent only a small fraction of research using noninvasive brain stimulation in healthy participants (Nuffield Council 2013). However, there are many examples reported in the scientific literature reporting effects ranging from memory, language skills, vision, mathematical ability and reasoning to emotional processing and mood (ibid). While TMS offers greater spatial and temporal resolution than tDCS, tDCS is less expensive, far more portable, very well-tolerated and associated with fewer safety concerns (Hamilton et al. 2011). Indeed, the low cost of buying or building one's own personal tDCS device has garnered much interest within the DIY community (Fitz and Reiner 2013). One only needs a 9V battery and other inexpensive and easy-to-source electronic parts and basic instructions (ibid; Lapenta et al. 2014). Conversely, the social penetration of TMS as a *product* is likely to remain low given the high costs, while the use of TMS as a *service* might have a moderate level of social penetration (Dubljević 2015).

3.8 Ethical issues specific to transcranial direct current stimulation

Kadosh et al (2012) list the issues of cognitive enhancement using tDCS that raise special ethical issues that differ from those raised by pharmacological interventions. First, the relative inexpense and portability of tDCS means that its use is not limited to laboratories or clinics; we have already mentioned the DIY community that has emerged around this technique and some companies already offer the device for personal use by adults at home. Second, unlike PCEs, tDCS is not ingested into the body. People may perceive a moral difference between 'external' enhancements, such as education or computing, and 'internal' enhancements, such as drugs that may have worrisome consequences; "The intuition that tDCS is an external intervention may create the misplaced perception that its use is less problematic than more obviously internal enhancements, and thus lower the threshold for premature use" (Kadosh et al. 2012, p. 108). Finally, tDCS can be applied to any cortical brain area, including areas beyond that for

which its use may be indicated. In addition, tDCS can have enduring effects. While tDCS has been praised for inducing only transient changes in the brain, studies have reported effects lasting for months. The concern here is that users may bring about long-lasting effects in their underlying neurobiology which may be difficult to reverse (Fitz and Reiner 2013). The possibility of long-lasting effects highlights the importance of the impact of value-laden words such as "non-invasive" on safety (or perceptions of safety) (ibid): "although the electrodes do not penetrate the brain, the electrical current must do so, otherwise it would have no effect on neural function. Thus, tCDS is minimally invasive *in some meaningful sense*. Yet the technically correct descriptor 'non-invasive' carries substantial rhetorical power with regard to safety, an issue that is particularly relevant when considering DIY users" (Fitz and Reiner 2013, p. 2)

A particular issue relevant to the use of tDCS or other forms of NIBS methods in children concerns its possible effect on brain development and the degree to which enhancing some capacities may bring about a deterioration in other capacities (Kadosh et al. 2012). While adult brain stimulation is thought to be reasonably safe when used within defined limits, "known unknowns" regarding the unknown effects and side-effects of stimulation, a lack of clear dosing guidelines and a lack of translational studies from adults to children warrant greater investigation into the use of brain stimulation for children (Davis 2014). [15] Moreover, while adults are in a position to decide whether a particular effect, for example, enhancing a child's long-term memory, is sufficiently valuable (to them) to justify bringing about a particular impairment, children are not equipped with the capacity or life experience to make such trade-off decisions (Maslen et al. 2014). Informed consent is a key issue in this regard. The effects of brain stimulation for "enhancement" may have consequences that reach far into a child's future (Maslen et al. 2014). Thus, in order to evaluate the reasons one might have for refusing an enhancement, one must be capable of "meaningful temporal projection" (ibid). This forward-looking capacity is particularly important when making decisions about how to weigh the relative value of different cognitive functions (Maslen et al. 2014). Crucially, younger children do not possess this capacity (ibid). Given an uncertain weighing of benefits, risks and costs, considerations regarding the child's best interests (as judged by the parents) diminish, and the need to protect the child's (future) autonomy becomes more important (Kadosh et al. 2012). [16]

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[15] While Davis discusses brain stimulation in relation to treating neurological disorders in pediatric cases (thus for a therapeutic application), the gaps in knowledge that affect our ability to assess risk in translating brain stimulation procedures to pediatric cases similarly apply to its non-therapeutic use.

[16] Conversely, if treatments such as tDCS are shown to be in a child's best interests, without detrimental effects on other cognitive functions, the technique might

Proust (2011) views the introduction and use of both invasive and non-invasive brain stimulants as a promising method for providing children with different learning needs with different learning methods. She further views different forms of HCE as a suitable means for providing those from poor backgrounds with both cognitive and emotional development support.

3.9 Further arguments in favour of cognitive enhancement

The arguments presented above are generated by a literature search explicitly focusing on 'ethics'. However, this strategy leaves some potentially ethically relevant arguments out. We saw in the introduction of the two technology cases the kinds of benefits these technologies may yield for the individuals using them. In liberalist capitalist societies there is no need for products to demonstrate benefits other than those demonstrated by the fact that there is a market. Therefore, these benefits are usually not presented as ethical arguments. However, without these benefits, - and thus a market for such applications - there would not even be any discussion about HCE. These benefits should therefore be included in an ethical assessment framework. Moreover, the evidence base for these claimed benefits should be assessed, in the same way as the evidence for the risks and costs of the enhancement applications.

Moreover, several scholars argue that it would be a restriction to personal freedom if we do not allow for individual choice vis a vis the shaping of one's nature (Buchanan et al. 2000, Sandberg 2013): if we allow for plastic surgery – also carrying along risk to health – why would we ban the non-therapeutic use of cognitive enhancement technology? If we allow for high altitude training for sportsmen to increase the level of oxygen in the blood, why do we ban doping? And if we applaud the use of meditation techniques to reduce stress, why do we frown upon relaxants that perform the same function? This freedom to choose revolves around the fundamental value of individual's autonomy. There are also specific issues relating to the choice not to enhance (Fenton 2009). Given the speculative nature of much of the debate on PCE / HCE (Ferrari et al. 2012), an early exit from the possibility of enhancing humans could hinder future positive developments:

"Non-traditional cognitive enhancement might be able to produce a solution to this problem, by generating more adept scientists who can figure out ways to

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become mandatory as a treatment for developmental disorders or even in basic education (e.g. if tDCS were shown to significantly improve the acquisition of core skills in normal children) (Kadosh et al. 2012).

reverse the effects of carbon, or invent more efficient forms of transport, or more adept economists who can sell alternative energy to brighter politicians" (Fenton 2009, 150). Fenton then argues that the immediacy of climate change calls for a speeding up of testing of non-traditional HCE.

There are also other ethical issues that will be relevant for certain HCE applications, even if they have not been relevant for the two technologies that have been reviewed here. Privacy is one such concern, for instance related to smart glasses (Hoffman et al. 2016).

With this thorough review of ethically relevant concerns and arguments related to the two key cases of HCE, we are now in a position to present and review potential ethical tools systematizing this into decision guidance.

Summary: Ethical concerns identified in the literature search on ethics and HCE:

- Safety
- Efficacy
- Fairness
- Personal achievement
- Distributive justice
- Coercion
- Authenticity/naturalness
- Autonomy and consent

4 Frameworks relevant for assessing HCE applications

As there are no specific frameworks proposed for addressing ethical issues at the decision-making level in HCE, we have been forced to search for relevant frameworks in neighbouring fields. As can be seen in table 1 above, many applications that can be used for HCE purposes are from the biomedical field: pharmaceuticals, surgery based applications and sensors. The biomedical field is therefore a closely adjacent field in which ethical frameworks may be found. HCE applications may also be related to biotechnology (again, see table 1). Biotechnology ethics is thus also a relevant field in which to look for ethical frameworks. Finally, HCE applications may be related to ICT based applications, providing relevant frameworks. In the following we will describe one framework from each of these fields.

We do not include here the large number of technology assessment (TA) approaches that have been developed for societal deliberation on (new) technologies (e.g. Guston and Sarewitz 2002, Fisher and Mahajan 2006, Grin and Grunwald 2002, Rip

and te Kulve 2008, etc.). Such approaches generally describe procedures for societal deliberation. An ethical framework explicitly refers to ethical principles or theories. There are hybrid forms of ethics and TA approaches, like the Ethical Technology Assessment approach developed by Palm and Hanson (2006). These have been included here in order to increase comprehensiveness.

We also do not include substantive theories of the good; theories that provide a soft or hard form of moral algorithm. An example is the John Rawls' theory of justice [REF] or Amartya Sen's Capability Approach [REF]. These approaches provide substantive advice on a decision based on a certain prioritisation of values. Here we assume that an ethical framework that is to be useful for a variety of decision makers in liberal societies should not require the user to subscribe to any particular conception of the highest good.

After these have been presented, we will assess their respective pros and cons for the purpose of facilitating an ethical assessment of HCE applications as a basis for decision-making by non-philosophers/ethicists.

4.1 Principle based ethics

The clearly most established ethical framework in the biomedical field is Beauchamp and Childress' four principles framework, presented in the classic work Principles of Biomedical Ethics, originally published in 1979 and with the, until now, 7th revised edition published in 2012. In this book they present, justify and apply their framework.

Beauchamp and Childress claim that principles provide the most general and comprehensive norms, but also acknowledge other kinds of norms: rules, rights, virtues and moral ideals. Rules are similar to principles, only 'more specific in content and more restricted in scope' (p. 13). Principles, on the other hand, 'are general norms that leave considerable room for judgment in many cases. Principles therefore do not function as precise action guides that inform us in each circumstance how to act in the way that more detailed rules and judgments do.' (ibid). They say that the four principles 'derive from considered judgments in the common morality and medical traditions, both of which form our starting point in this volume' (p. 23). The four principles (or rather: 'clusters of moral principles') the authors propose as basic in this field are:

> '(1) respect for autonomy (a norm of respecting the decision-making capacities of autonomous persons), (2) nonmaleficence (a norm of avoiding the causation of harm), (3) beneficence (a group of norms for providing benefits and balancing benefits against risks and costs), and (4) justice (a group of norms for distributing benefits, risks, and costs fairly).' (p.12)

The principles are starting points that can be *specified* into rules and/or *balanced* to solve a problem. They are prima facie: 'W. D. Ross's distinction between *prima facie* and *actual* obligations is basic for our analysis. A *prima facie* obligation must

be fulfilled *unless* it conflicts on a particular occasion with an equal or stronger obligation. This type of obligation is always binding unless a competing moral obligation overrides or outweighs it in a particular circumstance.' (p. 14) If an act is both prima facie right and prima facie wrong a balance must be struck between these principles, by determining 'the relative weights of all competing prima facie norms' (pp. 14-15).

Specification 'is a process of reducing the indeterminateness of abstract norms and providing them with action-guiding content.' (p.16), i.e. giving them a specific range or scope. In this way concrete cases can be subsumed under the norm. Specification can eliminate an apparent dilemma without either applying or balancing norms. Beauchamp and Childress give several examples of specification, for instance specification of the rule that 'Doctors should put their patients first' (which is again a specification of the beneficence principle). An example they give that shows how specification can solve an apparent conflict is the following: In the US patients might receive better medical treatment if the doctors manipulate the information they give insurance companies. However, this specification of the beneficence principle conflicts with the rule against deception. [17] A specification of the rule to put patients first that would, according to Beauchamp and Childress, solve this apparent conflict would be: In the information they give insurance companies, doctors should describe the medical situation so that the patient will receive the most benefits, as long as it is not outright deception (pp. 16 -17).

Specification can thus be a way of (dis)solving moral conflict, by finding a norm adequately determinate in content to indicate a solution. Still, it is not certain that any particular specification is the morally best *justified*, even if it provides a solution to a conflict between norms. For instance, insurance companies might complain that this rule is unfair to them. So, the authors say that '[s]pecification is an attractive strategy for hard cases of moral conflict as long as the specification can be justified' (p.17). So specifying principles in itself is never enough; one must always also evaluate the specification in a broader light. Thus they say: 'Nothing in the model of specification suggests that we can avoid judgments that balance different principles or rules in the very act of specifying them. [...] We therefore must connect specification as a method with a larger model of justification that will support some specifications over others.' (pp. 17-18).[18] They describe the relation between specification and balancing:

> Principles, rules and rights require *balancing* no less than *specification*. We need both methods because each addresses a dimension of moral principles and rules: *range and scope*, in the case of specification, and *weight or strength*, in the case of balancing. Specification entails a substantive refinement of the range and scope of norms, whereas balancing consists of deliberation and judgment about the relative weights or strength of

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[17] Strictly speaking, there cannot be *conflict* between prima facie principles, they only 'pull' in different directions.

[18] This 'larger model' is coherentism.

> norms. Balancing is especially important for reaching judgments in individual cases, and specification is especially useful for policy development. (p. 18)

Beauchamp and Childress describe in more detail how balancing should be understood: 'The metaphor of larger and smaller weights moving a scale up and down graphically depicts the balancing process, but it may also obscure what happens in the process of balancing by suggesting a purely intuitive or subjective assessment. Justified acts of balancing entail that good reasons be provided, not merely that an agent is intuitively satisfied.' (ibid) Specification and balancing are interconnected, but not in a systematic way: 'Balancing does often eventuate in specification, but it need not; and specification often involves balancing, but it also might only add details or fill out the commitments of a principle' (p. 19). They also claim that substituting balancing with specification in some cases would be pointless, unduly complicated or even perilous (in cases too unique for any generalization into prima facie norms).

In accordance with their focus on justified balancing, Beauchamp and Childress have specified some conditions for balancing. These 'conditions must be met to justify infringing one prima facie norm in order to adhere to another' (ibid):

1. 'Better reasons can be offered to act on the overriding norm than on the infringed norm (e.g., if persons have a *right*, their interests generally deserve a special place when balancing those interests against the interests of persons who have no comparable right).
2. The moral objective justifying the infringement must have a realistic prospect of achievement.
3. The infringement is necessary in that no morally preferable alternative actions can be substituted.
4. The infringement selected must be the least possible infringement, commensurate with achieving the primary goal of the action.
5. The agent must seek to minimize any negative effects of the infringement.
6. The agent must act impartially in regard to all affected parties; that is, the agent's decision must not be influenced by morally irrelevant information about any party.' (pp. 19-20)

They explain that '[t]o the extent these conditions themselves incorporate norms, the norms are also prima facie, not absolute' (p. 19). If these conditions are conjoined with 'requirements of coherence […] they should help us achieve a reasonable measure of protection against purely intuitive or subjective judgments.' (p. 21) Finally, they admit that in some cases it will not be possible to determine which principle should be overriding, but claim (quite plausibly, in our opinion) that this is a fact of ethics that no theory can mend.

4.2 The ethical matrix

In the biotechnological field, several frameworks were explored in the European Commission 5th Framework project Ethical Biotechnology Assessment Tools (see Beekman et al. 2006 and table 2).

Decision-making framework
Casuistry
COGEM framework
Critical systems heuristics
Delphi method
Discourse ethics
Ethical codes/guidelines
Ethical matrix
Multi-criteria mapping
Precautionary principle
Principle based ethics
Risk analysis
Stakeholder analysis
Value-tree analysis
Public consultation and involvement
Citizen's Forum
Consensus conference
Focus group
Future workshop
Public hearing
PubliForum
Referendum
Scenario workshop
Technology Delphi studies/technology foresight
Food chain value communication
Benchmarking
Ethical accounting
Ethical audits
Ethical codes
ISO 9000
Normative standards
Stakeholder dialogue
Stepwise dilemma-solving
Total quality management
Value clarification
Weston's toolbox

Table 2. List of frameworks discussed in the Ethical Bio TA Tools project.

In this project, several tools were scrutinised, but the identified tools were of very different character. Some were purely procedural, such as consensus conferences and the Ethical Delphi. Though interesting working methods for established advisory committees (such as ethics committees), such methods do not offer guidance on identifying specific ethical issues. Likewise, risk analysis or multi-criteria mapping are general approaches that do not target ethical analysis in particular. Some presuppose a particular normative stance; such as applying the precautionary principle, which in our opinion cannot be assumed by decision makers in the HCE area.

However, the project also considered a substantive ethical framework that had been proposed in the early 1990s for ethical assessment of animal biotechnology, namely the so-called ethical matrix. The ethical matrix method was developed by Professor Ben Mepham at the Centre for Applied Bioethics (CAB) at the University of Nottingham for ethical assessment of biotechnologies, for instance issues related to technology development in the dairy sector and for evaluation of gene modified foods. In Mepham's words '[t]he aim was to establish a methodology that was versatile in terms of subject matter, user group and form of user engagement' (2004, p. 271). The aim of the ethical matrix method is to 'facilitate, but not to determine, ethical decision-making, and in "committee use" to identify areas of agreement and disagreement by promoting transparency' (p. 272). Although Mepham was the 'father' of the ethical matrix, others have taken similar approaches, for instance Kymlicka (1996) and Hermerén (1996). Moreover, some groups have appropriated variants of the ethical matrix method, for instance The National Committees for Research Ethics in Norway (cf. Kaiser and Forsberg 2001).

An example of an ethical matrix is the following one, developed for the ethical assessment of bovine growth hormone in dairy cows (Mepham 2005):

	Well-Being	Autonomy	Fairness
Dairy Farmers	Satisfactory income and working conditions	Managerial freedom of action	Fair trade laws and practices
Consumers	Food safety and acceptability Quality of life	Democratic, informed choice, e.g. of food	Availability of affordable food
Dairy Cows	Animal welfare	Behavioural freedom	Intrinsic value
The Biota	Conservation	Biodiversity	Sustainability

Table 3 An ethical matrix for assessment of bovine growth hormone in dairy farming

The ethical matrix method is a further development of Beauchamp and Childress' method, but adapted to the field of animal biotechnology. In Mepham's view, the difference between beneficence and non-maleficence was not as acute in animal

biotechnologies and could therefore be combined into a principle of well-being. Mepham also showed that specifying the principles according to each affected party relevant for the topic would provide a useful overview of the concerns at stake.

The ethical matrix has been widely applied in the context of biotechnology and in other fields, such as radiation protection, natural management, etc. (Kaiser and Forsberg 2001, Oughton et al. 2004, Jensen et al. 2011, Cotton 2009) and would prima facie appear as a candidate for an ethical framework also in the HCE field.

4.3 The ETICA framework '

Many HCE applications are related to ICTs, for instance different kinds of brain/computer interfaces (see table 1). In the European Commission 7th Framework Programme ETICA project, an ethical framework for ICTs was proposed by Stahl (2011):
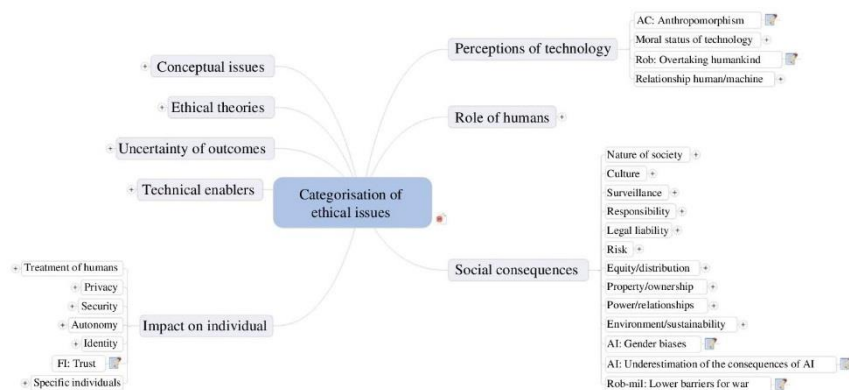

Figure 1. The ETICA framework: Categories of ethical issues of emerging ICTs. (Stahl 2011, 149)

The ETICA framework is not primarily presented as a practical framework for ethical assessment, but it might still amount to a promising avenue for this. The ETICA project identified emerging technologies by employing a distributed discourse analysis of publications on emerging ICTs (Stahl 2011). These publications included governmental/funding sources or publications from research institutions. These sources were "well placed" to assess the kinds of ICT research underway and the medium-term outlook. The identification of ethical issues of the emerging technologies was achieved through several interrelated steps. First, a bibliometric analysis was undertaken of the discourse on computer and information ethics from 2003 to 2009. The bibliometric analysis functioned as a heuristic starting point for potential ethical issues. The analysis then used the descriptions of the technologies as compiled in the earlier steps in order to explore whether any of the defining fea-

tures of the technologies were likely to raise ethical issues. The application examples were also investigated with respect to their ethical relevance. The ethical analysis led to the identification of numerous ethical issues (see figure above). A mind map was created that detailed all of the technologies, with one branch for each of the ethical issues identified. The full description of the ethical issue was added in a "comment" to the branch. The mind map tool enabled the grouping of different ethical issues into more general categories, allowing for the development of a more abstract view of the ethical issues that emerging ICTS are, on the whole, likely to bring to the fore.

4.4 Anticipatory ethics for emerging technologies

Brey (2012) presents an ethical framework that is especially targeted to emergent science and technologies. The defining feature of such technologies is that they are not yet in wide societal use so there exist high uncertainty about their consequences and moral implications. According to Brey there is therefore a need to apply anticipatory methods embedded in ethics assessment; and his anticipatory ethics for emerging technologies (ATE) is a proposal for such an approach. Brey distinguishes between several stages in technology development. The first stage, the Research stage (R) is characterised by large uncertainties. At the Development stage (D) there is slightly less uncertainty, but still uncertainties abound. ATE operates at the R and D stage and includes forecasting as a central element.

ATE distinguishes three levels of ethical analysis: the technology, artefact and application level. Various *objects of ethical analysis* are defined at each of these levels. The technology level is the level at which a particular technology is defined, independent of any artefacts or applications that may result from it. An artifact refers to a physical configuration that, when operated in the correct manner and environment, produces a desired result. An application is defined as the concrete use of a technology artifact or procedure for a particular purpose or in a particular context, or a specific configuration of an artifact to enable it to be used in a particular way (p.8).

Ethical analysis at the technology level centres in on the general features of the technology, particular subclasses of it, or techniques within it. It then considers general ethical issues associated with these features: "These are either ethical issues inherent to the character of the technology, issues that pertain to consequences that are likely to manifest themselves in any or nearly any artefact or application of the technology, or issues pertaining to risks that the technology will result in artifacts or applications that are morally problematic" (p.8). Ethical analysis at the artifact level focuses on types of artifacts and processes that have resulted, or are likely to result, from a particular technology and the associated features that present moral issues. Such moral issues may arise as a result of the inherent character of the artifact, because the artifact has particular unavoidable consequences in many of its

uses, or because certain potential applications of the artifact are so risky or morally controversial that reflection on the ethical justification of manufacture is necessary. Ethical analysis at the application level is concerned with particular ways of using an artifact or procedure, or on particular ways of configuring it for use. Ethical issues at the application level fall into three groups. The first group consists of moral issues relating to the intended use of the artifact. Such issues concern the morality of the particular purposes for which an artifact or procedure may be used. A second group is made up of moral issues concerning side-effects or unintended consequences for users. These include consequences that arise in certain uses, in certain contexts of use, or for certain users groups. A third group consists of moral issues concerning the rights and interests of non-user stakeholders who may be affected by a particular use of an artifact. To sum up, at the technology level, fundamental ethical issues concerning the technology are investigated, while more specific and contingent issues are studied at the artifact and application levels.

Knowledge of these objects of analysis can be gained through different forecasting methods, including the use of existing forecasting studies, expert panels and surveys, and self-performed futures studies. Finally, ethical analysis is performed at two initial stages, i.e. the identification and evaluation stages. During the identification stage, moral values and principles are operationalised and cross-referenced with technology descriptions derived from the forecasting stage. The values and issues are derived form an ethical checklist, in addition to identification of ethical issues in the technology ethics literature and bottom-up ethical analyses of the various artefacts and applications. The ethical checklist is structured around four categories of ethical principles that are widely recognised in ethics, i.e. those relating to the prevention of harms, the protection of rights, the pursuit of justice, and the promotion of well-being and the common good (see table 5). The potential importance of ethical issues identified is evaluated during the evaluation stage and these issues are elaborated. Evaluations may subsequently be used for improving technology development or for enhanced governance of technology.

Main category	Sub-category	Specifics
Harms and risks		
	Health and bodily harm	
	Pain and suffering	
	Psychological harm	
	Harm to human capabilities	
	Environmental harm	
	Harms to society	
Rights		
	Freedom	

		Freedom of movement
		Freedom of speech and expression
		Freedom of assembly
	Autonomy	
		Ability to think one's own thoughts and form one's own opinions
		Ability to make one's own choices
		Responsibility and accountability
		Informed consent
	Human dignity	
	Privacy	
		Information privacy
		Bodily privacy
		Relational privacy
	Property	
		Right to property
		Intellectual property rights
	Other basic human rights as specified in human rights declarations (e.g., to life, to have a fair trial, to vote, to receive an education, to pursue happiness, to seek asylum, to engage in peaceful protest, to practice one's religion, to work for anyone, to have a family, etc.)	
	Animal rights and animal welfare	
Justice (distributive)		
	Just distribution of primary goods, capabilities, risks and hazards	
	Nondiscrimination and equal treatment relative to age, gender, sexual orientation, social class, race, ethnicity, religion, disability, etc.	
	North–south justice	
	Intergenerational justice	
	Social inclusion	
Well-being and the common good		
	Supportive of happiness, health, knowledge, wisdom, virtue, friendship, trust, achievement, desire-fulfillment, and transcendent meaning	
	Supportive of vital social institutions and structures	
	Supportive of democracy and democratic institutions	
	Supportive of culture and cultural diversity	

Table 5. Brey's ethical checklist

4.5 Ethical Technology Assessment

Ethical Technology Assessment (ethical TA) refers to an ethical assessment framework for new and emerging technologies that can be used to explore the soft impacts of such technologies. The idea behind Ethical TA is to render conflicts and differences in opinion on new technologies more explicit rather than evening them out (Palm et al. 2006). Ethical TA aims to identify the ethical aspects of an emerging technology to inform and steer design process to avoid, *ex ante*, the emergence of

ethical controversies. Reaching consensus should, however, not be the pre-set goal of this approach. It focuses on rendering accessible negative aspects of new and emerging technologies on topics such as human relations, values and identities through the discussion of specific scenarios. Ethical TA operationalises the following ethical check list:

1. Dissemination and use of information
2. Control, influence and power
3. Impact on social contact patterns
4. Privacy
5. Sustainability
6. Human reproduction
7. Gender, minorities and justice
8. International relations
9. Impact on human values.

In operationalising this checklist, ethical TA aims to further the science-society dialogue and thus enable public participation with technology developers as well as with political decision-makers.

4.6 Ethical Constructive Technology Assessment

Kiran et al. continue the effort initiated by ethical TA (Palm, & Hanson): to fill in the gaps left by regular TA. They believe one should proceed beyond evaluating a list of pre-defined ethical issues, the checklist approach. In their paper they define principles for an ethical-constructive technology assessment approach (eCTA) that builds onto the philosophy of technology and Science and Technology Studies (STS). Kiran et al. criticise a supposed gap between man and technology in many TA approaches. The extent to which this gap is indeed embraced remains up for debate, but in the tradition of STS the authors continue by claiming the area in which technologies can be studied as mediator between humans. They do so on the basis of the postphenomenological approach of Idhe (1983, 1990) who defines our relation to technology fourfold: through the way it embodies us, the way it provides us with ways to interpret the world, through perceiving technology as another subject and through creating a backdrop to our lives. On this basis they develop a framework to assess the way in which novel technologies also affect the microprocesses in our daily lives. Rather than assessment, the authors suggest a technology 'accompaniment' since, our morals and values are continuously shaped by our technologies (Kiran et al. p. 16). To their mind, both design practices and the world in which these will ultimately land will need to be taken into account. This can only be done when design practices "[…] incorporate openness to situatedness, alternative life-worlds and changing moral routines" (Kiran et al., p. 16). According to Kiran et al.

one should take into account the way in which technologies shape subjects as well as the way in which they demand a responsible uptake by subjects. Rather than providing an approach for assessment of technologies, they provide for an account of how technology, society and ethics are co-constituted. Thus, technology, society and ethics coevolve and all three should be taken into account simultaneously.

4.7 Ethical Impact Assessment

Building partly on the work in the Ethical Bio TA Tools project, Wright (2011) proposes a framework for an ethical impact assessment which can be performed in regard to any policy, service, project or programme involving information technology. His ethical impact assessment approach offers a means of ensuring that ethical implications are adequately investigated by stakeholders prior to the deployment of a new technology or project in order that mitigating measures can be taken as necessary. An EIA is a process that comprises a number of steps. The first steps include 1) determining whether an EIA is necessary; 2) identifying the EIA team and setting the team's terms of reference, budget and timeframe; 3) preparing an EIA plan; 4) describing the proposed project to be assessed; 5) identifying stakeholders; and 6) consulting with stakeholders and analysing the ethical impacts. Remaining steps include checking that the project or technology development complies with legislation, preparing and publishing the EIA report and implementing the recommendations.

The EIA framework is partly based on Beauchamp and Childress's four principles, along with a separate part on privacy and data protection. More specific values or issues, explanations and questions for consideration are included for each principle. See table 6 for an overview of values and issues.

Respect for autonomy (right to liberty)	
	Does the technology or project curtail a person's right to liberty and security in any way? If so, what measures could be taken to avoid such curtailment?
	Does the project recognise and respect the right of persons with disabilities to benefit from measures designed to ensure their independence, social and occupational integration and participation in the life of the community?
	Will the project use a technology to constrain a person or curtail their freedom of movement or association? If so, what is the justification?
	Does the person have a meaningful choice, i.e., are some alternatives so costly that they are not really viable alternatives? If not, what could be done to provide real choice?
* Dignity	
	Will the technology or project be developed and implemented in a way that recognises and respects the right of citizens to lead a life of dignity and independence and to participate in social and cultural life? If not, what changes can be made?

	Is such a recognition explicitly articulated in statements to those involved in or affected by the project?
	Does the technology compromise or violate human dignity? For example, in the instance of body scanners, can citizens decline to be scanned or, if not, what measures can be put in place to minimise or avoid comprising their dignity?
	Does the project require citizens to use a technology that marks them in some way as cognitively or physically disabled? If so, can the technology be designed in a way so that it does not make them stand out in a crowd?
	Does the project or service or application involve implants? If so, does it accord with the opinion of the European Group on Ethics (EGE)?
* Informed consent	
	Will the project obtain the free and informed consent of those persons to be involved in or affected by the project? If not, why not?
	Will the person be informed of the nature, significance, implications and risks of the project or technology?
	Will such consent be evidenced in writing, dated and signed, or otherwise marked, by that person so as to indicate his consent?
	If the person is unable to sign or to mark a document so as to indicate his consent, can his consent be given orally in the presence of at least one witness and recorded in writing?
	Does the consent outline the use for which data are to be collected, how the data are to be collected, instructions on how to obtain a copy of the data, a description of the mechanism to correct any erroneous data, and details of who will have access to the data?
	If the individual is not able to give informed consent (because, for example, the person suffers from dementia) to participate in a project or to use of a technology, will the project representatives consult with close relatives, a guardian with powers over the person's welfare or professional carers? Will written consent be obtained from the patient's legal representative and his doctor?
	Will the person have an interview with a project representative in which he will be informed of the objectives, risks and inconveniences of the project or research activity and the conditions under which the project is to be conducted?
	Will the person be informed of his right to withdraw from the project or trial at any time, without being subject to any resulting detriment or the foreseeable consequences of declining to participate or withdrawing?
	Will the project ensure that persons involved in the project give their informed consent, not only in relation to the aims of the project, but also in relation to the process of the research, i.e., how data will be collected and by whom, where it will be collected, and what happens to the results?
	Are persons involved in or affected by the project able to withdraw from the project and to withdraw their data at any time right up until publication?
	Does the project or service collect information from children? How are their rights protected?
	Is consent given truly voluntary? For example, does the person need to give consent in order to get a service to which there is no alternative?
	Does the person have to deliberately and consciously opt out in order not to receive the ''service''?
Non-maleficence	
* safety	
	Is there any risk that the technology or project may cause any physical or psychological harm to consumers? If so, what measures can be adopted to avoid or mitigate the risk?

	Have any independent studies already been carried out or, if not, are any planned which will address the safety of the technology or service or trials? If so, will they be made public?
	To what extent is scientific or other objective evidence used in making decisions about specific products, processes or trials?
	Does the technology or project affect consumer protection?
	Will the project take any measures to ensure that persons involved in or affected by the project will be protected from harm in the sense that they will not be exposed to any risks other than those they might meet in normal everyday life?
	Can the information generated by the project be used in such a way as to cause un-warranted harm or disadvantage to a person or a group?
	Does the project comply with the spirit of consumer legislation (e.g., Directive 93/13 on unfair terms in consumer contracts, Directive 97/7 on consumer protection in respect of distance contracts and the Directive on liability for defective products (85/374/EEC))?
* Social solidarity, inclusion and exclusion	
	Has the project taken any steps to reach out to the excluded (i.e., those excluded from use of the Internet)? If not, what steps (if any) could be taken?
	Does the project or policy have any effects on the inclusion or exclusion of any groups?
	Are there offline alternatives to online services?
	Is there a wide range of perspectives and expertise involved in decision-making for the project?
	How many and what kinds of opportunities do stakeholders and citizens have to bring up value concerns?
* Isolation and substitution of human contact	
	Will the project use a technology which could replace or substitute for human con-tact? What will be the impact on those affected?
	Is there a risk that a technology or service may lead to greater social isolation of in-dividuals? If so, what measures could be adopted to avoid that?
	Is there a risk that use of the technology will be seen as stigmatising, e.g., in distin-guishing the user from other people?
* Discrimina-tion and so-cial sorting	
	Does the project or service use profiling technologies?
	Does the project or service facilitate social sorting?
	Could the project be perceived as discriminating against any groups? If so, what measures could be taken to ensure this does not happen?
	Will some groups have to pay more for certain services (e.g., insurance) than other groups?
Beneficence	
	Will the project provide a benefit to individuals? If so,how will individuals benefit from the project (or use of the technology or service)?
	Who benefits from the project and in what way?
	Will the project improve personal safety, increase dignity, independence or a sense of freedom?
	Does the project serve broad community goals and/or values or only the goals of the data collector? What are these, and how are they served?
	Are there alternative, less privacy intrusive or less costly means of achieving the ob-jectives of the project?

	What are the consequences of not proceeding with development of the project?
	Does the project or technology or service facilitate the self-expression of users?
* Universal service	
	Will the project or service be made available to all citizens? When and how will this be done?
	Will training be provided to those who do not (yet) have computer skills or knowledge of the Internet? Who should provide the training and under what conditions?
	Will the service cost the same for users who live in remote or rural areas as for users who live in urban areas? How should a cost differential be paid?
* Accessibility	
	Does the new technology or service or application expect a certain level of knowledge of computers and the Internet that some people may not have?
	Could the technology or service be designed in a way that makes it accessible and easy to use for more people, e.g., senior citizens and/or citizens with disabilities?
	Are some services being transferred to the Internet only,so that a service is effectively no longer available to people who do not (know how to) use computers or the Internet? What alternatives exist for such people?
* Values sensitive design	
	Is the project or technology or service being designed taking into account values such as human well being, dignity, justice, welfare, human rights, trust, autonomy and privacy?
	Have the technologists and engineers discussed their project with ethicists and other experts from the social sciences to ensure value sensitive design?
	Does the new technology, service or application empower users?
* Sustainability	
	Is the project, technology or service economically or socially sustainable? If not, and if the technology or service or project appears to offer benefits, what could be done to make it sustainable?
	Should a service provided by means of a research project continue once the research funding comes to an end?
	Does the technology have obsolescence built in? If so, can it be justified?
	Has the project manager or technology developer discussed their products with environmentalists with a view to determining how their products can be recycled or how their products can be designed to minimize impact on the environment?
Justice	
	Has the project identified all vulnerable groups that may be affected by its undertaking?
	Is the project equitable in its treatment of all groups in society? If not, how could it be made more equitable?
	Does the project confer benefits on some groups but not on others? If so, how is it justified in doing so?
	Do some groups have to pay more than other groups for the same service?
	Is there a fair and just system for addressing project or technology failures with appropriate compensation to affected stakeholders?
* Equality and fairness	

(social jus-tice)	
	Will the service or technology be made widely available or will it be restricted to only the wealthy, powerful or technologically sophisticated?
	Does the project or policy apply to all people or only to those less powerful or unable to resist?
	If there are means of resisting the provision of personal information, are these means equally available or are they restricted to the most privileged?
	Are there negative effects on those beyond the person involved in the project or trials and, if so, can they be adequately mediated?
	If persons are treated differently, is there a rationale for differential applications, which is clear and justifiable?
	Will any information gained be used in a way that could cause harm or disadvantage to the person to whom it pertains? For example, could an insurance company use the information to increase the premiums charged or to refuse cover?

Table 6. Some main categories and questions from EIA, excluding the privacy issues related more specifically to ICT issues.

As an approach to ethics assessment, EIA is aimed at policy makers, technology developers, and other stakeholders including civil society stakeholders, academics and the media. The person who is carrying out the EIA should be responsible for the conduct of an EIA but may require some additional expertise on the EIA team, e.g. ethical expertise.

5 The adequacy of the frameworks for ethical assessment of HCE applications

In the previous section, we have seen that there are several ethical frameworks that can be used to assess HCE applications. We have also seen the kinds of ethical issues raised by HCE applications. We are now in a position to discuss which of the seven above mentioned frameworks seem to fit best for assessing specific HCE applications. In this section, we will evaluate the frameworks based on their ability to incorporate the most important ethical values and concerns (comprehensiveness) and on their user-friendliness. As explained above, there is a need for a user-friendly approach that will guide non-expert users in considering the most important ethical aspects of specific HCE applications. We will thus discuss the proposed frameworks based on two criteria: how well they fit the HCE ethical issues and their user-friendliness.

5.1 Principle based ethics

All the ethical issues identified above can be sorted under the four principles:

- Beneficence: Efficacy
- Non-maleficence: Safety
- Autonomy: Personal achievement, coercion, authenticity
- Fairness: Fairness and distributive justice

A problem with the four principles approach is that it is directed mainly towards health care professionals, such as medical doctors. A doctor is to do good and avoid doing harm. However, in the HCE context there is not necessarily a professional administering the enhancement application.

Another problem with the four principles approach is that it cannot properly deal with the notion of naturalness, but the significance of this problem is up for discussion. Firstly, it is not really clear what the concept of naturalness signifies. It might in fact be more of an aesthetic, than an ethical question. However, sometimes it is clearly an ethical concept, but then it usually refers to the inherent dignity of man or mankind (Kass 2002). This is a kind of concern that is usually not highlighted in the four principles approach.

One might, however, use the four principles approach and adjust it so that autonomy is replaced with dignity (where the concept of respect for dignity includes the concept of respect for autonomy).

One might also reframe the four principles approach to not target a specific professional's responsibility for considering these principles, but to see them more as general values.

With regard to user friendliness the widespread use of this approach is a solid testament to this. All in all, the four principles approach (principle based ethics) seems a good candidate for an ethical decision making framework in HCE.

5.2 The ethical matrix

The Ethical Bio-TA Tools project identified and described 13 different decision-making frameworks and evaluated these according to user utility, participant satisfaction and whether the tools "capture those arguments, values and principles that various ethical traditions and theories would bring to the fore when dealing with issues of that kind" (Beekman et al 2006, 20–21). From this review, the ethical matrix emerged as a sound framework (Kaiser et al. 2007, 70).

The ethical matrix approach appears to have an advantage over the four principles approach by its ability to distinguish impacts for the different affected parties. However, this also makes this approach a bit more complex (and perhaps therefore a bit less user-friendly).

The workshop phase with practitioners in Ethical Bio-TA Tools demonstrated that the ethical matrix was not an easy tool to use, but it provided a necessary structure for debates, made evaluations of ethical values more transparent, and opened up for a change of mind on ethical issues in biotechnology (Kaiser et al 2007).

From the perspective of technology assessment, Cotton (2014) highlights that the ethical matrix's simplified structure "aids simplification and structuring of ethical discussions but also limits opportunities for creative problem solving outside of the matrix's pre-defined principle and stakeholder categories" (2014, 73). Cotton also calls for further tools to justify the bottom-up principle and stakeholder selection, in addition to an expansion of principles and stakeholders in order to ease potential bias. He argues that the "closing-down phase" (Stirling 2004), the phase from deliberation to conclusion, lacks a deliberative mechanism. Cotton's criticism, however, does not hold for the version of the ethical matrix method advanced by Kaiser and Forsberg. In this version, the matrix must be adjusted in a process of reflective equilibrium so that the structure of principles and stakeholders in fact incorporates all values that are discussed in the field. This must necessarily be done for its application in the HCE field.

If the ethical matrix approach is to be used as an ethical framework for HCE applications, it is clear that well-being needs to be split into separate columns for positive and negative well-being, otherwise the enhancement dimensions is not well captured. This has been done already in a report for the World Organisation for Animal Health (see Kaiser 2005), and does not amount to a theoretical or practical problem. An ethical matrix for HCE should be developed in a participatory process, but may look like this:

	Increase of well-being	Avoidance of decrease of well-being	Dignity	Justice
The user	Efficacy	Safety	Authenticity Naturalness Personal achievement Avoidance of coercion Respect for privacy Autonomy and consent	Fair access to enhancements Fair access to societal goods
Non-users	Positive effect on their well-being because of others' use of HCE	Negative effect on their well-being because of others' use of HCE	Respect for their privacy and right to choose non-HCE	Fair access to societal goods

The society	Progress in soci-ety/improvement of humanity	Negative ef-fect of unin-tended side ef-fects of the use of HCE	Safeguarding of the room for so-cietal decision making, and not only market forces	Increased so-cial differences

Table 4: Proposed ethical matrix for HCE

As the main three stakeholders for HCE are the user, the non-users and society at large, it is not clear to what extent it will be considered more user-friendly to use an ethical matrix of the four principles approach for structuring the ethical issues.

5.3 The ETICA framework

The ETICA framework's strength seems to fit nicely with the HCE discussion as the ethical issues identified in the diagram above are relevant for many, even most, of HCE applications. However, its diversity of categories, makes it hard for a non-expert user to analyse specific applications.

5.4 Anticipatory ethics for emerging technologies

Brey's three levels of ethical analysis – the technology, artefact and application level – are useful for concretely identifying the focus of ethical analysis within dif-fuse HCE discussion. In particular, the application level would seem to be the most relevant for the HCE discussion, as much of the discussion is centred, as we have shown here, on concrete objects such as pharmaceutical enhancers or non-invasive brain stimulation techniques. The ATE framework is a practical and systematic ap-proach that emphasises the importance of knowledge and evidence gathering about the object in question. As already noted, the development of an evidence base for HCE is crucial for ethical deliberation. However, use of the ATE framework re-quires a significant degree of expert input in terms of the use of various forecasting methods in order to gain knowledge of the objects and the two stages of ethical analysis, namely identification and evaluation. Thus, while the ATE is both of high quality and comprehensive, it does not adhere to our criterion of user-friendliness. On the other hand, final expert evaluations may be used by non-experts in order to facilitate policy or other forms of decision-making. This would imply that users would have to have expert resources available to them.

5.5 Ethical Technology Assessment

Ethical TA is relatively reliable but holds a disadvantage with regard to representativeness. In this sense, its evidence base is low. With regard to comprehensiveness, it is merely applicable to technologies in development, and its time horizon is limited. Furthermore, the framework perceives of morality conceived as a stable phenomenon, thus not acknowledging the dynamic nature of the technology-morality interface. And specifically due to its adherence to an ethics checklist, it does not provide for a sufficiently adaptive framework for all cases at hand. It does however enable its users to connect more theoretical notions in ethical assessment with more pragmatic participant-based approaches.

5.6 Ethical Constructive Technology Assessment

eCTA is a framework that provides for tools to go beyond a checklist approach, and departs from the idea that technology, society and ethics coevolve. Their methods suggests a framework for the accompaniment rather than assessment of novel technologies, since one cannot step out of this trifold coevolution to assess moral criteria in isolation. It focuses on local contexts and on process guidance and is thus not targeted to decision-makers, which is the starting point of this analysis.

5.7 Ethical Impact Assessment

Many of the ethical issues and values grouped under the four principles on which the EIA framework is based are complementary to those encountered in the HCE ethical debate. Indeed, the EIA framework is very comprehensive in terms of listing the most important ethical issues and concerns. The framework is also useful as a means of analysing and evaluating specific applications. As mentioned already, ethical deliberation concerning HCE focuses on applications as opposed to the associated technologies. Moreover, the process of an EIA is clearly described in a number of steps which can be easily followed –and crucially, adapted - by the user according to requirements. Even if the user does not have ethical expertise, he or she may invite an ethics expert to collaborate on the EIA team. In addition, the step of consultation with stakeholders allows the user to identify and consider issues that they themselves may not have otherwise identified as being relevant. This is an important element for the ethical assessment of a field such as HCE in which a plethora of stakeholders, ranging from parents to university committees and doctors are implicated.

However, the step of stakeholder consultation limits the broad applicability of the approach to institutional decision-makers with a certain amount of resources for organising expert and stakeholder input. This limits the approach slightly. However, the checklist is comprehensive and useful for decision-makers because it is very concrete and comprehensive.

5.8 Summary

Framework	User-friendliness	Comprehensiveness
4 principles approach	The broad range of applications suggest high user-friendliness.	All relevant concerns can be given a place in the approach.
Ethical matrix	The broad range of applications suggest high user-friendliness.	All relevant concerns can be given a place in the approach. The matrix structure demonstrates high comprehensiveness.
ETICA framework	User-friendliness is low as the broad range of ethical categories makes it difficult for a non-expert to utilise.	Very comprehensive categorisation of ethical issues.
Anticipatory technology ethics	Low – requires a high level of expert input	Very comprehensive in terms of focus on different levels of ethical analysis and two stage ethical analysis which allows moral values and principles to be operationalised and cross-referenced with technology descriptions, in addition to an evaluation of the potential importance of ethical issues.
Ethical technology assessment	Limited. Ethical TA has been designed specifically to inform innovators.	Ethical TA is merely applicable to technologies in development, and its time horizon is limited.
Ethical constructive technology assessment	eCTA provide an approach for the understanding of the inter-relation between man and technology, which might be helpful to sociologists in elucidating the effects on the microscale of the introduction of novel technologies, but it cannot provide for ethical criteria beyond the advice that 'user contexts should be taken into account'. The framework suggested needs guidance by experts to	eCTA departs from a classic STS approach in its view of technology, ethics and society coevolving. But seen the fact that it implicitly takes an externalist perspective on ethics, it can only explain emerging forms of ethics, not argue for or against them. eCTA provides material for a qualitative approach to technologies, that takes into account a differentiated view on the nature of technologies.

	be operationalised in specific contexts.	
Ethical impact assessment	High – users can make use of the issues and questions clustered under the four principles (and the principles of data protection and privacy) to guide their assessment and to formulate other questions. EIA also allows for collaboration between non-experts and those with ethical and other forms of expertise.	Very comprehensive – sets out key issues and questions grouped under Beauchamp and Childress's four principles, in addition to issues relating to data protection and privacy.

Table 8: Summary of evaluation of the different approaches

From the summary table, we see that the three principle based approaches (4 principles approach, ethical matrix) appear to come out as most relevant for practical ethical decision-making guidance on HCE applications. The particular version of the principle based approach one prefers can vary, but all seem to have applicability in pluralist governance situations, as described at the beginning of this book.

5.9 Some final reflections

A few reflections on our methodology and findings are in order.

First, for this article, we searched for relevant literature by carrying out a systematic search using open search terms, disregarding those articles that were not relevant or were off topic and using the snowballing method in order to identify other, relevant, articles. We cannot claim that our search is complete, as there may be relevant articles that were not picked up in the search. However, the majority of articles included here have been written by key scholars and experts in the area – both in specific fields such as neuropharmacology and neuroscience – and in areas of ethics (including neuroethics and medical ethics) that take up issues in HCE. For this reason, we are reasonably confident that we have generated a thorough and up-to-date representation of key issues and debates in the field.

Moreover, we have not carried out a comprehensive survey of all possible ethical frameworks in the area of applied ethics, as this would be extremely extensive. The selection of frameworks presented here are key contributions in applied ethics and ethical based TA approaches in closely adjacent fields to HCE.

Secondly, in this book we claim, in accordance with Moula and Sandin (2015), the importance of user-friendliness. This criterion carries with it some ideas of "the user" or "the users". Kaiser et al. engaged both an expert and a lay group for their testing workshops, while Millar et al. (2007) used a stakeholder approach. Likewise, Jensen et al. applied the ethical matrix in workshops comprising only of researchers and in a workshop consisting of stakeholders. From the concrete world of tools, we know that different users might use several different types of tools in order to complete an identical task. Some tools require extensive training and skill while other tools are more integrated in the cultural setting from an early age. Thus, in a selection of possible tools, it is challenging to stand on the outside of a social setting and state the superiority of one tool over another based on criteria concerning "the user". We therefore believe it is reasonable to recommend three different versions of principlist approaches, allowing the specific users to decide according to their own preferences.

6 Conclusion

We believe that it is crucial to have a societal discussion on the overall ethical issues of HCE, as outlined by Hoffman (2016). However, we have argued for the need for more user-friendly decision guiding approaches. More specific frameworks may be understood as approaches closer to a governance approach; assisting policy makers and decision makers in making regulatory or commercial decisions on specific applications.

From our discussion of the ability of seven different frameworks to handle the most urgent HCE related ethical issues, and their user-friendliness, we have proposed the four principles approach, the ethical matrix and ethical impact assessment as the most appropriate approaches within the scope of this study.

This does not mean that better frameworks cannot be found, now or in the future, but it means that of the ones that are commonly used in the biomedical, biotechnology and ICT fields these frameworks appears to fit well to practical ethical decision guidance for HCE applications.

We have briefly shown that these frameworks can incorporate the ethical issues and concerns proposed in the literature on the two selected HCE cases. This suggests that they could fit other HCE cases as well, as many of the ethical issues are generic for the field.

Ideally, a database for learning should be generated as ethically informed decisions are made in this field. This should include information about how the principles and specifications are applied and the kinds of challenges users experience in gathering sufficient evidence. This would also allow for refinement of the frameworks suggested here.

As HCE applications will continue to enter the market, ethical and governance resources should be correspondingly developed in order to build societal capacity for

ethical monitoring and control. This book has been an attempt to contribute to building such capacity.

References

Agar, N. 2014. Truly Human Enhancement. A Philosophical Defense of Limits. MIT Press.

Beekman, V., E. de Bakker, H. Baranzke, O. Baune, M. Deblonde, M., E-M Forsberg, de Graaff. R., Ingensiep, Hans-Werner, Lassen. J., Mepham. B., Prosborg Nielsen, A., Tomkins, S., Thorstensen, E., Millar, K., Skorupinski, B., Brom, F., Kaiser, M. and P. Sandøe. 2006. Ethical bio-technology assessment tools for agriculture and food production: final report ethical bio-TA tools (QLG6-CT-2002-02594). Agricultural Economics Research Institute (LEI). https://www.academia.edu/2838074/Ethical_bio-technology_assessment_tools_for_agriculture_and_food_production. Accessed 1 September 2015.

Beekman, V., and F.W.A. Brom.2007.Ethical Tools to Support Systematic Public Deliberations about the Ethical Aspects of Agricultural Biotechnologies. Journal of Agricultural and Environmental Ethics 20(1): 3–12.

Beyer, C., C. Staunton and K. Moodley. 2014. The Implications of Methylphenidate Use by Healthy Medical Students and Doctors in South Africa. BMC Medical Ethics 15 (1): 20.

Boot, B. P., B. Partridge, and W. Hall. 2012 Letter to the Editor: Better evidence for safety and efficacy is needed before neurologists prescribe drugs for neuroenhancement to healthy people. Neurocase 18(3): 181-184.

Brey, P. A. E. 2012. Anticipatory Ethics for Emerging Technologies. *Nanoethics* 6: 1-13.

Buchanan, A. 2008. Enhancement and the Ethics of Development. *Kennedy Institute of Ethics Journal* 18 (1): 1–34.

Cakic, V. 2009. Smart drugs for cognitive enhancement: ethical and pragmatic considerations in the era of cosmetic neurology. *Journal of Medical Ethics* 35: 611-615.

Castaldi, S., U. Gelatti, G. Orizio, U. Hartung, A.M. Moreno-Londono, M. Nobile and P.J. Schulz, 2012. Use of Cognitive Enhancement Medication Among Northern Italian University Students. *J Addict Medicine* 6(2): 112-117.

Chan, S. and J. Harris, J. 2006. Cognitive regeneration or enhancement: the ethical issues. *Regenerative Medicine* 1(3): 361-366.

Coenen, C., M. Schuijff and M. Smits. 2011. The Politics of Human Enhancement and the European Union. In *Enhancing Human Capacities,* eds. J. Savulescu, R. ter Meulen and G. Kahane, 521-535. Blackwell Publishing Ltd.

COMECE. 2008. Ethical questions raised by nanomedicine. *Science and Ethics. Opinions Elaborated by the Bioethics Reflexion Group* 1: 23–28.

Cotton, M. 2009. Evaluating the 'Ethical Matrix' as a Radioactive Waste Management Deliberative Decision-Support Tool. *Environmental Values* 18: 153-176.

Cotton, M. 2014. Ethical Matrix and Agriculture. In *Encyclopedia of Food and Agricultural Ethics,* eds. P.B. Thompson, P.B. and D.M. Kaplan, 1-10. Springer.

Davis, N. J. 2014. Transcranial stimulation of the developing brain: a plea for extreme caution. *Frontiers in Human Neuroscience* 8: 1-4.

DeGrazia, D. 2005. *Human identity and bioethics*. Cambridge; New York: Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511614484.

Dresler, M., A. Sandberg, K. Ohla, C. Bublitz, C. Trenado, A. Mroczko-Wąsowicz, S. Kühn and D. Repantis. 2013. Non-pharmacological cognitive enhancement. *Neuropharmacology* 64(2013): 529-543.

Dunlop, M. and Savulescu, J. 2014. Distributive justice and cognitive enhancement in lower, normal intelligence. *Monash Bioethics Review* 32 (3): 189-204.

Dubljević, Veljko. 2015.Neurostimulation Devices for Cognitive Enhancement:Towards a Comprehensive Regulatory Framework. *Neuroethics* 8: 115-126.

Elliott, C. 2003. *Better than Well: American Medicine Meets the American Dream*. New York: Norton.

Est, R. van, D. Stemerding, P. Kukk, B. Hüsing, I. van Keulen, M. Schuijff, K. Böhle, C. Coenen, M. Decker, M. Rader, H. Togersen and M. Schmidt. 2012. *Making perfect life: European governance challenges in 21st century bio-engineering*. Brussels: European Parliament.

Farah, M. J., J. Illes, R. Cook-Deegan, H. Gardner, E. Kandel, P. King. E. Parens, B. Sahakian and P.R. Wolpe. 2004. Neurocognitive enhancement: what can we do and what should we do? *Nature Reviews* 5(May 2004: 421-425.

Farah, M. J., M.E. Smith, I. Ilieva and R.H. Hamilton. 2014. Cognitive enhancement. *WIREs Cognitive Science* 5: 95-103.

Farah, M. J. 2015. The unknowns of cognitive enhancement. Can science and policy catch up with practice? *Science* 350(6259): 379-380.

Fenton, A. 2009. Buddhism and neuroethics: The ethics of pharmaceutical cognitive enhancement. *Developing World Bioethics* 9 (2): 47-56.

Ferrari, A. and C. Coenen, C. 2012. Visions and Ethics in Current Discourse on Human Enhancement. *Neuroethics* 6*:* 215-229.

Fisher, E. and R.L. Mahajan, 2006. Midstream Modulation of Technology: Governance From Within.

Bulletin of Science, Technology & Society 26: 6, 485-496

Fitz, N. S., R. Nadler, P. Manogaran, E.W. Chong and P.B. Reiner 2013. Public Attitudes Toward Cognitive Enhancement. *Neuroethics*. doi: 10.1007/s12152-013-9190-z

Fitz, N. S. and P.B. Reiner. 2013. The challenge of crafting policy for do-it-yourself brain stimulation. *Journal of Medical Ethics.* doi: 10.1136/medethics-2013-101458

Fixdal, J. 2003. *Public Participation in Technology Assessment*. PhD thesis. Universitetet i Oslo.

Forlini, C. and E. Racine. 2009. Autonomy and Coercion in Academic 'Cognitive Enhancement' Using Methylphenidate: Perspectives of Key Stakeholders. *Neuroethics* 2 (3): 163–77

Forlini, C., W.Hall, B. Maxwell, S.M. Outram, S. M., P.B. Reiner, D. Repantis, M. Schermer and E. Racine. 2013. Navigating the enhancement landscape. *EMBO reports* 14(2): 123-128.

Forlini, Cynthia, Jan Schildmann, Patrik Roser, Radim Beranek and Jocehn Vollmann. 2014. Knowledge, Experiences and Views of German University Students Toward Neuroenhancement: An Empirical-Ethical Analysis. *Neuroethics.* DOI 10.1007/s12152-014-9218-z

Forsberg, E. M. 2006. *A deliberative ethical matrix method: justification of moral advice on genetic engineering in food production.* (Dr. Art). Faculty of Humanities, University of Oslo, Oslo.

Forsberg, E-M. 2007. Pluralism, the Ethical Matrix and Coming to Conclusions. *Journal of Agricultural and Environmental Ethics* 20 (5): 455-468

Fukuyama, F. 2002. *Our Posthuman Future*. London: Profile.

Gaucher, N, A Payot and E Racine. 2013. Cognitive enhancement in children and adolescents: Is it in their best interests? *Acta Paediatrica* 102: 1118-1124.

Giubilini, A and S. Sagar 2015. The Ethics of Human Enhancement. *Philosophy Compass* 10(4): 233-243.

Goodman, R. 2010. Cognitive Enhancment, Cheating and Accomplishment. *Kennedy Institute of Ethics Journal* 20(2): 145-160.

Grin, J. and A. Grunwald, eds. 2000. *Vision Assessment: Shaping Technology in 21st Century Society - Towards a Repertoire for Technology Assessment*. Wissenschaftsethik und Technikfolgenbeurteilung, 4, 2000.

Greely, H., B. Sahakian, J. Harris, R.C. Kessler, M. Gazzaniga, P. Campbell, M.J. Farah. 2008. Towards responsible use of cognitive-enhancing drugs by the healthy. *Nature* 456 (11): 702-705.

Guston, D.H. and D. Sarewitz. 2002. Real-time technology assessment. *Technology in Society* 24: 93-109.

Hall, W. 2004. Feeling 'better than well'. *EMBO reports,* 5(12): 1105-1109.

Hall, W. D, and J.C. Lucke 2010. The enhancment use of neuropharmaceuticals: more scepticism and caution needed. *Addiction* 105: 2041-2043.

Hamilton, R., S. Messing and A. Chatterjee. 2011. Rethinking the thinking cap: Ethics of neural enhancement using noninvasive brain stimulation. *Neurology* 76: 187-193.

Harris, J. 2007. *Enhancing Evolution. The Ethical Case for Making Better People*. Princeton University Press.

Heinrichs, J.- H. 2012. The promises and perils of non-invasive brain stimulation. *International Journal of Law and Psychiatry* 35:121-129.

Heinz, A., R. Kipke, H. Heimann, and U. Wiesing 2012. Cognitive neuroenhancement: false assumptions in the ethical debate. *J Med Ethics,* 38: 372-375.

Hermerén, G. 1996. Kunskapens Pris. Forskningsetiska problem och principer i humaniora och samhällsvetenskap, Humanistisk-samhällsvetenskaplige forskningsrådet.

Hildt, E., K. Lieb and A.G. Franke 2014. Life context of pharmacological academic performance enhancement among university students – a qualitative approach. BMC Medical Ethics 15: 23. doi: http://doi.org/10.1186/1472-6939-15-23

Ida, R. 2009. Should We Improve Human Nature? An Interrogation from an Asian Perspective. In Human Enhancment, eds. J. Savulescu and N. Bostrom. Oxford University Press

Ihde, D. 1983. Existential Technics. Albany: State University of New York Press.

Ihde, D. 1990. Technology and the Lifeworld. From Garden to Earth. Bloomington: Indiana University Press.

Jensen, K.K., E-M. Forsberg, C. Gamborg, K. Millar, P. Sandøe 2011. Facilitating Ethical Reflection among Scientists Using the Ethical Matrix as a Tool. Science and Engineering Ethics 17(3): 425-445.

De Jongh, R., I. Bolt, M. Schermer and B. Olivier. 2008. Botox for the brain: enhancement of cognition, mood and pro-social behavior and blunting of unwanted memories. Neuroscience & Biobehavioral Reviews 32, 4 : 760-776.

Kadosh, R. C., N. Levy, J. O'Shea, N. Shea, N., and J. Savulescu. 2012. The neuroethics of non-invasive brain stimulation. Current Biology 22(4): R108-R111.

Kaebnick, G. 2007. Putting concerns about nature in context: the case of agricultural biotechnology. Perspectives in Biology and Medicine 50(4): 572–84.

Kaiser, M. and E-M Forsberg. 2001. Assessing fisheries - Using an ethical matrix in a participatory process. The Journal of Agricultural and Environmental Ethics 14: 191-200.

Kaiser, M., E-M Forsberg, B. Mepham, K. Millar, E. Thorstensen and S. Tomkins. 2004. Decision-Making Frameworks. In Evaluation of Ethical Bio-Technology Assessment Tools for Agriculture and Food Production. First Interim Report. Ethical Bio-TA Tools (QLG6-CT-2002-02594), ed. V. Beekman. http://www.ethicaltools.info/content/Interim_Report_Description.pdf [June 2006]

Kaiser, M., K. Millar, E. Thorstensen, and S. Tomkins 2007. Developing the ethical matrix as a decision support framework: GM fish as a case study. Journal of Agricultural and Environmental Ethics 20(1): 65–80.

Kass, L. R. 2003. Ageless Bodies, Happy Souls. The New Atlantis 1, 9–28.

Kiran, A. H., N- Oudshoorn, and P-P Verbeek. 2015. "Beyond Checklists: Toward an Ethical-Constructive Technology Assessment." *Journal of Responsible Innovation* 2 (1): 5–19. doi:10.1080/23299460.2014.992769.

Kjølberg, K. and F. Wickson 2007. Social and Ethical Interactions with Nano: Mapping the Early Literature. *NanoEthics* 1(2): 89–104.

Kymlicka, W. 1996. Moral Philosophy and Public Policy: The Case of New Reproductive Technologies. In Philosophical Perspectives on Bioethics, eds. L.W. Sumner and J. Boyle, 244-270. University of Toronto Press.

Lapenta, O. M., C.A. Valasek, A.R. Brunoni, and P.S. Boggio 2014. An ethical discussion of the use of transranial direct current stimulation for cognitive enhancement in healthy individuals: a fictional case study. Psychology & Neuroscience 7(2): 175-180.

Lucke, J. C. 2012. Empirical Research on Attitudes Toward Cognitive Enhancement Is Essential to Inform Policy and Practice Guidelines. AJOB Primary Research 3(1): 58-60.

Mache, S., P. Eickenhorst, K. Vitzthum, B.F. Klapp and D.A. Groneberg, D. A. 2012. Cognitive-enhancing substance use at German universities: frequency, reasons and gender differences. Wiener Medizinische Wochenschrift, 162(11): 262-271.

Maslen, H., N. Faulmuller, and J. Savulescu. 2014a. Pharmacological cognitive enhancement - how neuroscientific research could advance ethical debate. Frontiers in Systems Neuroscience 8: 1-12.

Maslen, H., B.D. Earp, R. Cohen Kadosh and J. Savulescu 2014b. Brain stimulation for treament and enhancement in children: an ethical analysis. Frontiers in Human Neuroscience 8: 1-5. doi: 10.3389/fnhum.2014.00953

McKibben, B. 2004. Enough. Staying Human in an Engineered Age. An Owl Book. Henry Holt and Company, New York.

Mepham, T. B. 2004. A decade of the ethical matrix: A response to criticisms. In Science, Ethics & Society. 5th Congress of the European Society for Agricultural and Food Ethics. Preprints, eds. J.D. Tavernier and S. Aerts.

Mepham, T B. 2005. *Bioethics. An Introduction for the Biosciences*. Oxford: Oxford University Press

Micoulaud-Franchi, Jean-A., J. Vion-Dur and C. Lancon. 2012. Peut-on Prescrire Des Psychosti-mulants Chez Un Étudiant Sain ? Exemple D'un Cas Clinique. *Thérapie* 67 (3): 213–21..

Millar, K., E. Thorstensen, S. Tomkins, B. Mepham and M. Kaiser 2007. Developing the Ethical Delphi. *Journal of Agricultural and Environmental Ethics* 20(1): 53–63.

Mohamed, A. D. 2014. Neuroethical issues in pharmacological cognitive enhancement. *WIREs Cognitive Science* 5: 533-549.

Moula, P. and P. Sandin 2015. Evaluating Ethical Tools. *Metaphilosophy* 46(2): 263–279.

Nadler, R. C. and P.B. Reiner. 2010. A call for data to inform discussion on cognitive enhancement. *BioSocieties* 5(4): 481-487.

Ott, R. and N. Biller-Andorno. 2014. Neuroenhancement among Swiss Students – A Comparison of Users and Non-Users. *Pharamcopsychiatry* 47: 22-28.

Oughton, D., E-M. Forsberg, I. Bay, M. Kaiser and B. Howard, B. 2004. An ethical dimension to sustainable restoration and long-term management of contaminated areas. *Journal of Environmental Radioactivity* 74 (1-3), 171-183.

Outram, S.M.2012. Ethical considerations in the framing of the cognitive enhancement debate. *Neuroethics* 5 (2): 173-184.

Nuffield Council on Bioethics. 2013. *Novel neurotechnologies: intervening in the brain*. London: Nuffield Council on Bioethics.

Palm, E. and S.O. Hansson 2006. The case for ethical technology assessment (eTA). *Technological Forecasting and Social Change* 73: 543- 558.

Parens, E. 2005. Authenticity and ambivalence – Toward understanding the enhancement debate (No. 3). Hastings Center. http://www.thehastingscenter.org/uploadedFiles/Publications/HCR/Articles/2005_May-June/Parens%20Article.pdf. Accessed 22 October 2015.

Partridge, B., S. Bell, J. Lucke and W. Hall 2013. Australian university students' attitudes towards the use of prescription stimulants as cognitive enhancers: Perceived patterns of use, efficacy and safety. *Drug and Alcohol Review* 32: 295-302.

The President's Council on Bioethics. 2003. *Beyond Therapy: Biotechnology and the Pursuit of Happiness*. New York: Harper Perennial.

Proust, J. 2011. Cognitive Enhancement, Human Evolution and Bioethics. *Journal International De Bioéthique.* 23 (3-4): 149–170.

Racine, E. and C. Forlini, C. 2009. Expectations regarding cognitive enhancement create substantial challenges. *Journal of Medical Ethics* 35:469-470.

Rawls, J. 1971. *A theory of justice*. Cambridge, Mass: Belknap Press of Harvard University Press.

Rawls, J. 1993. *Political liberalism*. New York: Columbia University Press.

Rip A. and H. te Kulve. 2008. Constructive Technology Assessment and Socio-Technical Scenarios. In *Presenting Futures, Volume 1 of the series The Yearbook of Nanotehnology in Society*, eds. E. Fisher, C. Selin and J.M. Wetmore, 49-70. Springer.

Rowe,G. and L.J. Frewer. 2000. Public Participation Methods: A Framework for Evaluation. *Science, Technology & Human Values* 25: 3-29

Sahakian, B. and S. Morein-Zamir 2007. Professor's little helper. *Nature* 450(20): 1157-1159.

Sahakian, B. J., and S. Morein-Zamir, S. 2011. Neuroethical issues in cognitive enhancement. *Journal of Psychopharmacology* 25(2): 197-204.

Sandberg, A. and N. Bostrom 2006. Converging Cognitive Enhancements. *Annals of the New York Academy of Sciences* 1093(1): 201–227.

Sandel, M. 2004. The Case against Perfection. *Atlantic Monthly* April: 51-62

Sarewitz, D. and T.H. Karas 2012. Policy Implications of Technologies for Cognitive Enhancement. In *Neurotechnology: Premises, Potential, and Problems*, ed. J. Giordano 267–285. Boca Raton, FL: CRC Press.

Sattler, S., C. Sauer, G. Mehlkop and P. Graeff, 2013. The Rationale for Consuming Cognitive Enhancement Drugs in University Students and Teachers. *PLOS ONE* 8,7. e68821

Schelle, K. J., N. Faulmuller, L. Caviola and M. Hewstone 2014. Attitudes towards pharmcological cognitive enhancement - a review. *Frontiers in Systems Neuroscience* 8: 1-14.

Schermer, M. 2008. On the argument that enhancement is "cheating". *Journal of Medical Ethics* 34: 85-88.

Schermer, M., I. Bolt, R. de Jongh and B. Olivier 2009. The Future of Psychopharmalogical Enhancements: Expectations and Policies. *Neuroethics* 2: 75-87.

Seedhouse, D. 2009. *Ethics: the heart of health care*. Chichester, U.K.: Wiley-Blackwell.

Sen, A. 1992. *Inequality reexamined*. Oxford: Clarendon Press.

Sen, A. 2009. *The idea of justice*. Cambridge, Mass.: Belknap Press of Harvard University Press.

Singh, I., I. Bard and J. Jackson, 2014. Robust Resilience and Substantial Interest: A Survey of Pharmacological Cognitive Enhancement among University Students in the UK and Ireland. *PLOS ONE*, 9(10). e105969

Stemerding, D. and T. Swierstra, T. 2006. How might interactive scenariostudies help us to think about the normative implications of genomics and predictive medicine. *In Questions ethiques en medicine predictive,* eds. A. de Bouvet, P. Boite and G. Aiguier. Paris: John Libbey Eurotext.

Stilgoe, J., R. Owen and P. Macnaghten 2013. Developing a framework for responsible innovation. *Research Policy* 42: 1568-80

Stirling, A. (2008. „Opening up" and „closing down": Power, Participation, and Pluralism in the Social Appraisal of Technology. *Science, Technology and Human Values* 33: 262-294

Swierstra, T. and A. Rip. 2007. Nano-ethics as NEST-ethics: Patterns of Moral Argumentation About New and Emerging Science and Technology. *NanoEthics* 1: 3-20.

Science and Technology Options Assessment (STOA). *HUMAN ENHANCEMENT STUDY*. 2009. (IP/A/STOA/FWC/2005-28/SC35, 41 & 45), Coenen. C., Schuijff. M., Smits. M., Klaassen, P., Hennen, L., Rader, M. and Wolbring, G. https://www.itas.kit.edu/downloads/etag_coua09a.pdf. Accessed 22 October 2015.

Toulmin, S. (1981) The Tyranny of Principles. *The Hastings Center Report* 11 (6): 31-39

Whetstine, L. M. 2015. Cognitive Enhancement: Treating or Cheating? *Seminars in Pediatric Neurology* 22: 172-176.

Wright, D. 2011. A framework for the ethical impact assessment of information technology. *Ethics and Information Technology* 13: 199-226

Zwart, H. 2015. Deliverable D3.5 Final Report. 49pp. Neuro-enhancement Responsible Research and Innovation (NERRI). A project funded by the European Commission.