

**A comparative analysis of human mental
functioning in treatments with deep brain
stimulation:
eliminative materialism, Clark's functionalism, and
postphenomenology**

**Master Thesis:
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Introduction

My current professor in applied mathematics introduced me to mathematical neuroscience during a presentation on deep brain stimulation (DBS). I was struck by the fact that patients suffering from Parkinson's disease are often treated by the implementation of an electrode deep inside their brain, where the electrode stimulates the surrounding areas. In order to describe the underlying mechanisms of both Parkinson's disease as well as deep brain stimulation, mathematical models of the brain are developed, simulated, tested against data, and mathematically analyzed. Learning more about deep brain stimulation and the effects on the patient's mental and personal life, I became interested in the dynamics between neuroscientific approaches and technological developments, and the way human mental functioning is explained, described, and understood within the neuroscientific community as well as the general public. Although there may be a prospect of helping desperate patients, the idea of implanting an electrode within the human brain without a full scientific understanding on forehand seems extraordinary and revolutionary, and it is remarkable that while deep brain stimulation since its start in the early 1990s evolved into a widely accepted surgical treatment, its functioning is currently still scientifically relatively poorly understood.

Despite this lack of a full scientific understanding, deep brain stimulation provides an optional treatment for severely suffering patients of Parkinson's disease. Its influence is expanding, because deep brain stimulation is now also experimentally used in other pathologies such as epilepsy, obsessive compulsive disorder, and obesity. At the same time, doctors and neuroscientists are trying to discover how deep brain stimulation exactly works. The main questions that they try to answer are how deep brain stimulation influences the stimulated regions, the surrounding regions, and the functional and behavioral patterns. This becomes particularly relevant in light of side effects that often turn up after the surgery, such as loss of motor control, depression, and severe personality changes. Therefore, by touching upon medical, biological, psychological, technological, political, and ethical areas, deep brain stimulation becomes a complex, interdisciplinary scientific and technological development.

The question that lies at the basis of this thesis is how deep brain stimulation, as a recent technological development in the domain of neuroscience and human mental functioning, can be analyzed and understood from a philosophical perspective. The focus of this thesis is on the dynamics between neuroscience, as a field that consists of a wide variety of methodologies, theories, techniques, books, articles, assumptions, and technological artifacts and the way human behavior and mental functioning is understood. Three different philosophical perspectives will be discussed - a materialist, a functionalist and a postphenomenological - on cognition and human functioning. These theories will be applied to address and then assess

deep brain stimulation. The goal is to examine whether deep brain stimulation enables a new form of mental functioning, and whether these philosophical perspectives need to be refined or dismissed for understanding the relationship between human mental functioning and deep brain stimulation. Since these three theories together represent a dominant spectrum of the philosophical perspectives on human mental functioning, this philosophical discourse may be particularly relevant in light of addressing the problems and complexities that emerge during treatments with deep brain stimulation. This leads to a final question that focuses on how the different perspectives characterize the influence of deep brain stimulation on the concrete practices in the reality of daily life. Although these practices touch upon several different domains, this is mainly a discussion on how deep brain stimulation is approached in practical terms from the philosophical perspectives, since an evaluation of the qualitative state of the concrete situations seems to lie at the basis of a discussion of any further ethical, economic, political, scientific, religious, or societal issue.

The first chapter provides a general introduction to the field of neuroscience and deep brain stimulation, in order to provide an overall background for the subsequent chapters on the three philosophical perspectives. I will argue that the development of the current interdisciplinary neuroscientific methodologies and research is founded upon the materialist assumption that the level of human behavior is connected to the level of neural activity and consequently. I will then go on to discuss the importance of technological developments in neuroscience and the close relation between medical practice and neuroscience. Both connections lie at the core of the discussion of deep brain stimulation. This discussion will reflect the interdisciplinarity within neuroscience and the complexity of the problems and difficulties that arise during deep brain stimulation.

The second chapter is on eliminative materialism (EM). After discussing the main theoretical framework, I will argue eliminative materialism is build upon the underlying presupposition that the biological brain is the only and ultimate source of human mental functioning. This position that the brain *is* the mind, becomes untenable in light of deep brain stimulation, because deep brain stimulation interacts directly at the level of the neurons, and thereby effectively influences neural and neuronal patterns. Since eliminative materialism considers the brain as the ultimate source of human functioning, this also holds for the resulting forms of human functioning that are typically associated with these patterns of neuronal activity. Recent neuroscientific studies on deep brain stimulation include a more functionalist perspective within their overall current neuroscientific approach. This seems to bely the eliminative materialist claim that a strictly materialist neuroscientific approach is the only defensible way to study and understand human mental functioning.

In order to address a functionalist perspective, the third chapter will be on the work of

Andy Clark. Clark's concepts of the parity principle and the extended mind lie at the core of his anthropological understanding of human beings as *natural born cyborgs*. I will argue that Clark's account is ultimately untenable because Clark adheres to a view that contains a fixed understanding of human functioning, namely, he regards human beings as continuously engaging with their external world in order to increase their overall intelligence. Clark argues this process operates on a biological level so that eventually the brain respectively the body engage with new technological interactions in order to compensate its weaknesses and take advantage of cooperating with external objects. The idea of an intelligence-driven human existence becomes problematic because deep brain stimulation actively shapes, transforms, and reconfigures the subject and its subjectivity in radical unprecedented ways, and thereby undermines the existence or continuity of the intelligence-driven motor underlying human beings.

The third perspective is postphenomenology, that starts by looking at the concrete forms of reality and actual practices around deep brain stimulation as the method to obtain philosophical insight in the dynamics between human beings and their actions, their world, and deep brain stimulation. At the core of a postphenomenological philosophy of technology lies the idea that the interdependent relation between human beings and the world they live in - including their experience, actions, and mental activity - is mediated through the engagements with technology and artifacts. By studying several cases of treatments with deep brain stimulation, it will become clear how postphenomenology enables a framework that is able to recognize how deep brain stimulation often gives rise to a specific form of *experience* of experience. Postphenomenology, I will argue, is not vulnerable to the arguments that undermined eliminative materialism or Clark's functionalism, and thereby provides a philosophical perspective on approaching, understanding, and discussing the relation between human beings and deep brain stimulation.

In order to see how the practical complexities associated with deep brain stimulation can be addressed by the different perspectives, the final chapter will be on how these perspectives can characterize the influence of deep brain stimulation on the actual practices in daily life. I will discuss how the three different perspectives enable us to think about the concrete practices and cases of deep brain stimulation and thereby contribute to a more general discussion and interpretation of deep brain stimulation, so that the earlier philosophical discussion is placed in a broader context, and more closely connected to the direct experiences of patients in daily life. Despite the fact that the different perspectives provide different points of departure and might not be actively focused on the practical side of technological developments, I will try to explore where they *might* take us if their philosophical perspective is applied to the concrete practices of deep brain stimulation.

1 Introduction on neuroscience

This chapter introduces neuroscience as an interdisciplinary scientific field, and will show how this interdisciplinarity leads to multi-layered methodologies and an overall materialist assumption concerning the relation between human behavior and functioning and that which happens inside the human body and brain. I will discuss the importance of technological developments for neuroscientific progress, especially in medical practices. I will then go on to discuss how deep brain stimulation creates a complex connection between human behavior and neuroscientific insight.

Neuroscience is the scientific study of the brain and the nervous system. Neuroscience evolved from studying the biology of the nervous system into the current intersection of several sub-disciplines including biology, physics, chemistry, mathematics, engineering, medicine, and psychology. The interdisciplinary nature of neuroscience is arguably due to the brain's apparent immense complexity: the brain consists of billions of interconnected nervous cells, and a wide variety of biological components such as ion channels and neurotransmitters with complex underlying mechanisms and dynamics. Consequently, neuroscience operates on several levels by studying and revealing the molecular, cellular, developmental, anatomical, functional, evolutionary, computational, and medical aspects of the nervous system. Neuroscientific research has led to significant progress in understanding language, cognition, memory, decision making, perception, pattern recognition, dreaming, hallucinations, learning, speech, and emotionality. This wide variety of subjects reflects neuroscience's interdisciplinarity and indicates an important connection between the neuronal level and actual human mental functioning. The overall goal of neuroscience is to understand and describe the overall dynamics and mechanisms within the nervous system that are responsible for all these forms of human mental functioning. Consequently, neuroscience operates at the level of the single neuron (such as axons and synapses), but also studies the interactions between neuronal ensembles (such as excitatory and inhibitory neurons), entire brain structures (such as the visual cortex and the hippocampus), and ultimately mental functioning and behavior (such as perception and decision making).

Given the observed connection between activity in the nervous system and behavioral responses and mental functioning, the question arises whether this assumption is *always* made in neuroscientific research. In combining the several disciplines and crossing boundaries and levels with such seemingly ease, there seems to be a looming background assumption that which happens at the behavioral level results from activity patterns and interactions inside the brain and therefore, can be described in neurobiological terms. If this is true, neuroscience always needs to establish this connection somehow, whether they are aware of it

or not, whether they want it or not, or whether they do it explicitly or not. To make this claim more substantial, consider the relation between two dominant neuroscientific sub-disciplines: psychophysics and neurophysiology.

Psychophysics is the study of the relation between a stimulus (for example a picture or a sound) that is presented to a human or an animal, and its response or outcome (for example perception or a decision), whereas neurophysiology is the study of the electrical properties of neurons. There is typically a two-sided interaction between these disciplines: observations from psychophysics often lead to a specific hypothetical explanation of the observed result at the neuronal level, that would account for the observed behavior in the psychophysics. Measuring neuronal responses during these psychophysical experiments then allows a statistical or mathematical data-analysis, and the hypothesis will be refuted or confirmed. Although this schematic representation reflects the connection between 'human behavior' and 'neuronal behavior', it is usually a difficult project to successfully bridge this gap in a scientifically convincing way, given the complexity prevailing in the brain.

By connecting activity on a behavioral level to patterns of activity on a neuronal level, neuroscientists imply and suggest there is at least a relation or correlation between the two. That is, they assume there is a biological process or mechanism that is participating in the emerging of an event at the behavioral level. By approaching the relation between the brain and behavior through focusing on the functioning of the brain in all its details, neuroscience actually has an underlying materialist dimension. It is materialist in the sense that from approaching interactions inside and through matter (neurons, synapses, neurotransmitters) mental activities on a behavioral level are regarded as emerging properties (cognition, memory, decision making). A pure materialist perspective on human mental functioning regards the brain as the ultimate condition of possibility of mental activity such as thinking, perception, and intelligence.

Ever since the beginning of neuroscience, technological developments have played an important role in its achievements and developments, especially in the recording, measuring, and visualizing of brain activity. Alan Hodgkin and Andrew Huxley used voltage clamping, an electrophysiological technique developed in the 1940s, in their experiments on giant squid axons in 1952. These revolutionary experiments enabled them to formulate a mathematical description of the activity of a single neuron, the Nobel Prize winning Hodgkin-Huxley model and these type of neurons still lie at the basis of a significant amount of neurocomputational models. A more recent stream of technological developments that has gained a lot of attention in the neuroscientific community is *neuro-imaging*, the use of various techniques to either directly or indirectly image the structure, anatomy, and pharmacology of the brain. By measuring and visualizing neuronal and neural activity, neuro-imaging enables new ways

to study the anatomy, structure, and functioning of the brain. For example, PET-scans have been used to identify several specific receptors and neurotransmitters whereas fMRI is often used in functional studies on perceptual decision making. An important branch of imaging research is situated firmly in medical practices by addressing pathologies and diseases associated with the nervous system, such as strokes, multiple sclerosis, epilepsy, Alzheimer's disease, and Parkinson's disease.

In fact, there is a strong connection between neuroscientific research and clinical medicine. Neuroscientific research plays an important role in the practice of medical specialties of neurology, psychiatry, and neurosurgery. At the same time, these clinical practices often provide valuable information and data about the pathologies from the patients, and the practical expertise of the doctors and surgeons can provide valuable additional information on the functioning and malfunctioning of the brain. The boundaries between the several medical specialties have been blurring recently as they are all influenced by research in neuroscience and this is arguable fastened by progress in neuro-imaging: since brain imaging typically enables biological insights into mental pathologies, this often leads to faster diagnoses, more accurate prognoses, and better assessments of the patient's progress over time.

Despite the combined effort of neuroscientists and medical specialists, neurological diseases such as epilepsy and Parkinson's disease remain difficult to fully understand, explain, and treat. The abnormal patterns of activity in the brain during epileptic seizures are particularly hard to describe and predict, and the causes are unknown. For Parkinson's disease the systematic lack of the neurotransmitter dopamine is causing symptoms such as tremor, rigidity, and problems with walking and gait, but the mechanism that causes this lack of dopamine is unknown. It is particularly hard to find a satisfactory medical treatment for these pathologies and furthermore, both diseases are not easy to diagnose, since seizures do not ultimately imply epilepsy, and the symptoms in Parkinson's disease also arise in various other neurological diseases. In fact, Parkinson's disease is often diagnosed through observing the patient's response to L-DOPA, which is a medication that is typically used to diminish the motor symptoms *caused by* Parkinson's disease. The use of L-DOPA and other dopamine antagonists can not effectively treat the disease, often leads to unwanted side effects, and patients eventually become insensitive after years of intensive intake.

A more intrusive treatment is deep brain stimulation (DBS), a surgical method developed in the 1990s. Since deep brain stimulation is an expensive and extensive treatment it is generally only considered for treating the most severe cases of Parkinson's disease. During deep brain stimulation an electrode is placed deep inside the brain, that is wired to a battery that is placed under the collarbone. The electrode electrically stimulates the surrounding brain regions that are typically associated with the observed symptoms, such as the areas

involved in the processing of motor control signals. The overall treatment has a trial-and-error nature, since both deep brain stimulation and Parkinson's disease are not (yet) fully understood. Doctors and surgeons engage in a hit-or-miss process in order to find a desired configuration that influences the patient's symptoms. In practice it is impossible to predict whether deep brain stimulation will work for the particular patient, and finding a suitable configuration is particularly difficult when unexpected side effects, such as loss of motor control and speech, depression, and changes in personality [18]. Deep brain stimulation is not a structural cure or treatment of Parkinson's disease because the symptoms return instantaneously if the device is turned off - and the same seems to hold for the physical, emotional, and psychological changes that might turn up during deep brain stimulation.

The resulting relation between the patient and deep brain stimulation is often difficult and complex, and may even be highly ambiguous. There are several examples of treatments with deep brain stimulation where the treatment lead to unwanted side effects and these new configurations often present the patients and doctors with complicated problems. For example, a woman suffering from obsessive compulsive disorder was treated with deep brain stimulation in order to diminish her obsessive patterns and symptoms. The doctors tried to find a configuration that would effectively diminish the symptoms, and stumbled upon a configuration that did not affect the symptoms while the patient suddenly felt happy. In fact, the happiness experienced by the patient was not influenced by the symptoms and the patient claimed she did not feel bothered or affected by the symptoms while the deep brain stimulation was on and consequently, the patient wanted to keep the device. However, despite the patient's desire the doctors decided to terminate the treatment because the symptoms were unaffected by the treatment. Another example deals with a man that received deep brain stimulation in order to treat his severe Parkinson's disease. The treatment was very successful with regard to the patient's symptoms, but with the drawback of several physical and psychological negative side effects. These changes in personality and character were so severe and dramatic in his personal life, that the patient ultimately decided to be hospitalized in a closed institution with the device turned on [18, 27].

When deep brain stimulation is accompanied with negative psychological side effects, the patient's psychological and emotional functioning may dramatically change, influencing the patient's overall functioning and behavior. This often leads to unwanted behavior with possibly dramatic consequences such as divorce, financial problems or addiction [18, 27]. The brain stimulation then somehow functions as a dynamic switch between different configurations of symptoms, directly determining the regime of the patient's mental functioning and behavior. Since the negative side effects might turn out to be untreatable with additional medication, patients typically face the decision to live a life with the device on, possibly leading to physical

or psychological side effects, or with the full-blown symptoms of Parkinson's disease.

In order to address the emerging connection between neuroscientific research and the understanding of human mental functioning during deep brain stimulation, we will start this examination with materialism, since this is the most dominant undertow within neuroscience. Eliminative materialism anticipates a materialist neuroscientific approach is indispensable for the project of understanding mental activity. I will discuss the basic philosophy of eliminative materialism and then critically assess that their materialist perspective reduces the influence of deep brain stimulation to an instrumentalistic input, and therefore is too narrow and limited to recognize that deep brain stimulation directly alters the state of affairs in the brain.

2 Eliminative materialism

In this chapter I will discuss eliminative materialism, a dominant philosophical perspective that directly connects to the materialist dimension within neuroscience. Eliminative materialism provides a specific perspective on human mental functioning and behavior, in light of neuroscientific progress and its technological developments. I will first describe the main philosophical ideas and assumptions, then apply the overall framework to the case of deep brain stimulation, and eventually critically assess that the eliminative materialist perspective is too narrow and limited to describe human mental functioning during deep brain stimulation. The content of this chapter mostly relies on the early work of Paul Churchland, especially *Eliminative Materialism And The Propositional Attitudes* [1].

Paul M. Churchland (1942) is the founder and arguably the most dedicated advocate of eliminative materialism (EM).¹ He has a background in philosophy of mind, philosophy of science, epistemology, philosophy of neuroscience, and philosophy of cognitive science. Eliminative materialism is the belief that some day neuroscientists will be able to take their theories to an ultimate level and present a final explanation of human mentality, by means of their scientific and materialist methodologies. The ultimate and completed neuroscientific theory will then eliminate all earlier and other - inherently false - accounts of human mental functioning. Eliminative materialists disqualify any non-materialist and non-neuroscientific method, and much of Churchland's work is to show the false theoretical underpinnings of *folk psychology*. Commonsense or folk psychology can roughly be understood as combining a person's attitudes (hoping, fearing, dreaming) with propositions, to describe or explain the underlying inner aspects of human actions or behavior. When I am watching a movie with friends and at some point during the film and one of my friends suddenly starts to cry, I assume the scene touched my friend so deeply that her emotions became so powerful and overwhelming she could not hold her tears back, and started crying. A specific action or type of behavior (in this case: the tears) is explained as the outcome of an interaction between something that is perceived (in this case: the movie scene) and a mental state (in this case: her emotions). The question arises how folk psychology is able to systematically derive such explanations and seemingly effortless can combine mental and non-mental activities.

Churchland explains folk psychology's success by pointing at underlying common-sense laws that constitute folk psychology's main theoretical part. Laws properly connect circumstances with the observed behavior: it is because of these laws that I am able to connect

¹Paul's wife and fellow neurophilosopher Patricia is also a well-established advocate of eliminative materialism in the field of neurophilosophy. In general *Churchland* will refer to Paul Churchland and I will explicitly mention *Patricia* Churchland when referring to her work or philosophy.

my friend's tears with her deep emotions instead of connecting her tears with the fact that it was a Tuesday. Churchland argues that in order to explain or predict anything by folk psychology, a network of common-sense laws exists as the underlying theoretical framework. And this network of laws explains folk psychology's success: the laws are transparent, simple, open, and remarkably successful when everybody uses them. This '*body of lore*' concerning the law-like relations holding among external circumstances, internal states, and behavior is what Churchland ultimately defines as folk psychology (Churchland, 1981, 69). By arguing folk psychology is a theory, Churchland can attack it as such, and show how common-sense folk psychology is at its core an inherently flawed and incorrect theoretical perspective for explaining mental functioning. After regarding folk psychology as a theory, its elements are directly attacked by showing the problems with the theory itself: mental discourse such as beliefs and desires become fragile when the conceptual framework itself in which they function is flawed. Even though folk psychology is remarkably successful in quite some aspects, it will always remain a hypothetical framework that only gains its power in proving to be approximately right in hindsight. Churchland argues folk psychology should be rejected since it is an inherently non-scientific methodology, and he furthermore anticipates that these old, naive, and flawed folk psychological attitudes will eventually be substituted, displaced, or reduced by a *completed* version of materialist neuroscience.

Churchland's philosophical project is an intersection of the philosophy of mind, cognitive science and the philosophy of neuroscience. The starting point is materialism; the general belief that truth lies in matter. In order to find out how things work, one has to find out how matter is structured, organized, interacting, and functioning. This materialism disqualifies any non-material disconnected entity a priori and provides an explanation for Churchland's project against the intentional or propositional attitude psychological framework. Remember the invisible connection between tears, emotions, and a scene from a movie: eliminative materialists regard such connections as inherently unscientific mumbo jumbo and search for a neuroscientific explanation. A neuroscientific explanation would approach the tears in neural terms, for example, by pointing at specific brain areas and showing relevant sequences of activity patterns. Although their final conclusion might be similar, neuroscientists employ their methodologies to obtain proof and evidence in a fundamental, profound, and strictly scientifically convincing fashion. For Churchland, science is, and has been, the only successful path towards finding out how things work in general and as such, he is convinced science will explain more and more about the nature of things. This roughly constitutes a belief in a linearly growing body of knowledge with a never decreasing strength. The task of neuroscientists and eliminative materialists is to critically address these questions and the results. Eliminative materialists focus on the nature of things, and try to validate whether

the concepts that are associated with the phenomenon in question truly apply. An example from Patricia Churchland may explain how neuroscience and eliminative materialism can cooperate to achieve a hypothetical framework for describing human mental functioning.

In a radio-interview, Patricia Churchland discussed recent neurophysiological research, and speaks of evidence that during the perception of a perceptual stimulus, higher areas of the brain are projecting back to the early visual cortex to attach a specific value signal that favors a certain perceptual signal instead over other signals [2]. Before any consciously awareness of any form of visual perception, the perception itself seems to have a certain valance, and is consequently far from value-free. For Patricia Churchland, this puts the relation between facts and values in perspective, because the separation between them is not made internally nor biologically, and since behavior emerges from the interactions of the brain, there is no clear evidence for this distinction in general. That is, the distinction between fact and value is introduced or constructed in a later stage in our lives, possibly through education or tutoring, because there is no inherent evidence for a biological distinction between the two. According to Patricia Churchland, this seems to have, or *should* have, implications for any domain that draws upon this distinction or uses the idea of judgments. Since the argument is that the materialist neuroscientific method and eliminative materialism discover and determine the real nature of human mental functioning and their behavior, they endorse the idea that in such a way the real mechanisms and processes will be revealed, and the false accounts eliminated theoretically as well as in the practice of daily life.

Currently, there seems to be no evidence for a completed version of neuroscience of any form. There is no definitive account of our mentality, of human mental functioning and activities, that can satisfactory present a scientific framework describing and explaining human mental functioning and behavior. Neuroscientists and eliminative materialists have not claimed yet they have found the ultimate or definite answers and they contend the current status of their research and results is not yet in a final phase. This is not at all a critique on neuroscience nor on eliminative materialism as a philosophy, for their effort and philosophy is focused on establishing this ultimate version *in the future*. Without a current completed version, they regard progress and developments within the field as an argument for their convicted expectation that a completed version eventually will arise.

Since eliminative materialists hold on to the view that human mental functioning is determined within the biological brain and nervous system, there is an important theoretical presupposition underneath this anticipation of an ultimate neuroscientific theory, namely, that anything that is not a biological component of the nervous system is not intrinsically relevant to the *actual processing* of human mental functioning, and consequently irrelevant for the eliminative materialist neuroscientific methodology. In other words, the view that there

is nothing more to the mind than there is in the human brain and nervous system implies external objects function merely as instrumental stimuli or inputs of the brain. After their presentation these stimuli are 'translated' into patterns of brain activity and become subjected to the mechanisms and rules of the brain. The brain then goes on to process and transmit the inputs and eventually will initiate and generate output, for example, in the form of human behavior or functioning. The eliminative materialist argument is that the only convincing and satisfactory way to obtain an explanation for the connection between the observed input and observed output, is to study the internal processing within the brain. That is, the goal of the eliminative materialist neuroscientific method is to discover and describe the rules that govern the neuronal and neural patterns within the brain - between input and output. Given the fact that Churchland and eliminative materialists are *only* concerned with finding out *how things work*, it is clear why eliminative materialists can consider external objects as irrelevant for the description of human mental functioning, since they expect the influence of any non-biological aspect eventually will induce a neuroscientific mechanism that should be approached with neurobiological terms: for example, the release of a neurotransmitter or the activation of specific ion channel. An eliminative materialist only considers the terms and concepts that turn up during these linear neuroscientific descriptions with regard to human mental functioning and consequently, and refuses to invoke or consider any mental concept or conception that is not rooted in such a neuroscientific explanation.

In order to examine the deeper consequences of this perspective, the earlier movie-example might be helpful in making the materialist neuroscientific scheme more explicit: a materialist neuroscientist typically would conceptualize the movie scene as a form of external input for the nervous system and the tears as the resulting output resulting from the processes within the brain: the light from the screen enters the eye, the optic nerve is stimulated and then transmits the input at the retina to the brain, and the signal will be transmitted from lower level visual areas in the visual cortex to higher areas, transmitting signals to the areas of the brain involved with emotion and consequently these areas will eventually trigger the tear duct, and consequently the tears. The explanation only contains the terms and concepts necessary to describe the linear process between the movie scene towards the tears, and does not invoke the existence of anything that is not essential for the explanation, such as free will or the soul. By regarding the brain and its interactions as sufficient and adequate for understanding human mental functioning and human behavior, the overall eliminative materialist perspective boils down to a view that there is nothing more to the mind than there is in the brain, and that the influence of external objects is regarded as strictly implicit. This means that the influence of any external entity - such as visual or auditory stimuli and technological artifacts - is marginalized as an implicit neutral input that would only be responsible for the onset

of certain brain mechanisms. I will argue that exactly this philosophical conceptualization becomes troublesome during treatments with deep brain stimulation.

As described earlier, deep brain stimulation is a surgical method where patients receive an electrode within a specific brain area, typically the thalamus (VIM), the globus pallidus (GPi), or the subthalamic nucleus (STN). The neurostimulator then generates pulses and consequently interferes with the neural activity at the target area in which it is placed, with the goal to influence the symptoms such as rigidity and tremor. These pulses of current have a certain amplitude, strength and form and these settings can be adjusted by surgeons, doctors, or nurses in order to find a configuration with a maximum effect on the symptoms. Since pulses of current are the main means of communication between neurons, the effect of deep brain stimulation changes the 'diseased' patterns of activity within the brain.² This interfering can not satisfactorily be understood as having a neutral or independent effect on the overall brain mechanisms, because it is the overall goal to structurally change the Parkinsonian activity patterns within the brain. More explicitly, deep brain stimulation is not merely a neutral input to the nervous system, but explicitly influences and changes the nature of the neural and neuronal patterns of activity and consequently, the way the brain functions, processes and operates is fundamentally influenced by the device.

Since the brain and the nervous system is directly influenced at its most basic *biological* level, deep brain stimulation reveals an inconsistency in the theoretical foundations and perspective of eliminative materialism. The position that the brain is adequate and sufficient for understanding the mind - the deeper philosophical underlying presupposition within eliminative materialism - becomes problematic, because deep brain stimulations basically forces neuroscientists to take a more functionalist approach towards the study of deep brain stimulation and the brain. This means they have to come to terms with the fact that external objects can have an explicit and crucial effect on the mechanisms and patterns within the brain, and this is exactly reflected in the research focused on deep brain stimulation [20, 31]. More specifically, the fact that deep brain stimulation directly influences and changes patterns of brain activity and the neural mechanisms is reflected in the observation that current neuroscientific research is trying to find out how deep brain stimulation functions within the brain structures that it stimulates and influences. Although the settings of the device are

²A neuron typically receives inputs from more than 10000 other neurons through the contacts on its *dendritic tree* called *synapses*. The inputs then produce electrical transmembrane currents that change the membrane potential of the neuron. Small synaptic currents produce small changes, called post-synaptic potentials (PSPs). Larger currents produce larger PSPs that could be amplified by voltagesensitive channels and lead to the generation of an *action potential* or *spike* - an abrupt change of membrane voltage that propagates to other neurons via the *axon*. A typical spike has a duration of around 10 ms and the potential changes in the order of 80 mV.

exactly known and controllable, this is not an easy task, since it might be the case that deep brain stimulation forces the brain in an unknown dynamical regime, with new types of mechanisms, dynamics, and rules. In a metaphoric sense, the neuroscientific task is to find out whether an electrode that speaks the alphabet of the nervous system, is changing the grammar or vocabulary of the nervous system.

The observation that neuroscientists went on past the underlying theoretical presuppositions by eliminative materialism and continued towards a more functionalist perspective and framework, is a hard blow for eliminative materialism. As the discussion on deep brain stimulation shows, a dynamic interaction between brain processes, human actions, self-experiences, and technological artifacts arises in the actual interactions between patients, doctors, neuroscientists and the technology of deep brain stimulation. Within this configuration, the brain can not satisfactorily be understood as an isolated constant or essence. In fact, it seems to be situated and functioning within a dynamical structure and configuration. The brain arguably plays a crucial and indetachable role within these configurations, but this does not necessarily mean that it should be regarded as the sole originator of human mental functioning or the linearly achieved end product of the independent processing of the nervous system.

Given the mixture between pure materialism at the core of eliminative materialism and implicit functionalist aspects of current neuroscientific research on deep brain stimulation, it is hard to see how eliminative materialism, that trusts on materialist neuroscientific research to define the terms, concepts, and computational explanations for human mental functioning, can come to terms with the functionalist perspective of neuroscientists. Although this seems to be an argument against eliminative materialism, it can at the same time also be interpreted as an implicit attack against functionalist elements within neuroscience. It stands to reason whether Churchland or any pure eliminativist would regard the more recent domains of psychological and cognitive neuroscience as falling within the materialist neuroscience they support. By making *materialism* an explicitly essential feature of any successful neuroscientific method, one might even argue these newer domains are in fact eliminated by eliminative materialism themselves, and as such, have the same status as folk psychology and are therefore just as vulnerable. By doing so, a softer and more positive side of eliminative materialism is that it supports neuroscientists to exploit the materialist feature for scientific and technological progress. It is debatable whether the functionalist perspective would have emerged without a materialist assumption: the possible philosophical troublesome assertion that truth lies in neurons might turn out to be the great motor underneath neuroscientific developments - perhaps the trouble with eliminative materialism may only emerge because of the fact that eliminative materialism wants to extrapolate outside of their neuroscientific framework, and penetrate and inform all other domains that depend on neuroscientific components.

Along the way, the model of the mind *as* the brain has been proven insufficient because it assumes a certain instrumental dependence on external features, like deep brain stimulation, and thereby not fully recognizes the influence of external objects and environmental components on the brain and the mind. The eliminative materialist claim that what goes on in the brain is enough and sufficient to understand the actual human mechanisms of human cognition, can only be upheld when deep brain stimulation is considered to part of the natural brain. In order to address the relation between human mental functioning and deep brain stimulation, an explicit functionalist account by Andy Clark will be discussed in the following chapter. Clark's perspective recognizes and incorporates the role deep brain stimulation plays within human mental functioning. Clark introduces the *parity principle*; the idea that biological boundaries are insufficient demarcations of mental functioning. From Clark's perspective, human beings engage and participate in interactions with technological artifacts, such as laptops, agendas and calculators, in order to establish more intelligible configurations. Clark develops a functionalist perspective towards human mental functioning and technological and scientific developments and as such, his work is a direct critique and abandoning of eliminative materialism. Clark's work provides a different and new perspective to discuss configurations with deep brain stimulation whereas eliminative materialism failed fully recognize the role and of influence technological objects, such as deep brain stimulation, to mental functioning. I will argue that Clark holds on to a view that relates interactions and engagements with the outside world and external objects with an overall intelligence-driven perspective, and thereby reduces the influence of deep brain stimulation on human behavior.

3 Clark's functionalism

Whereas materialism was found to be too reductionist by regarding the brain as an adequate entity to fully describe mental functioning, the work of cognitive scientist and philosopher Andy Clark presents an alternative evaluation of human mental functioning. Clark presents a broad and elaborate anthropological framework that provides an understanding of what it means to be human in relation with technological artifacts and the 'natural' world. His work is closely connected to recent technological developments and largely driven by his experience in the cognitive sciences. Clark's most radical philosophical concept is arguably the idea of the 'extended mind'; the idea that non-biological objects contribute to human mental activities. This call for a more symmetrical treatment and description of the relation between humans and the world they operate in, addresses the influence of external objects in human mentality. The brain now *enables* the mind, instead of the materialist perspective where the brain *is* the mind. I will argue that although this account does allow a deeper and more satisfactory analysis and description of the difficulties during deep brain stimulation when compared with eliminative materialism, this functionalist account fails to fully recognize the transformative capacity of external components such as deep brain stimulation on human beings and their biological and mental functioning. The content of this chapter mainly relies on Clark's and Chalmer's *the extended mind* and Clark's more recent *natural born cyborgs* and *supersizing the mind* [3, 4, 5].

Before setting out his basic framework, Clark first identifies two different but dominant conceptualizations of the relation between the mind and the world: (1) a view that accepts the demarcation of skin and skull as the ultimate boundaries of identity and mind, so that what is outside the body is necessarily regarded as lying outside the mind, and (2) a view that associates meaning (of words, events) or semantics not entirely with internal processes in the head and accept a certain form of externalism of the mind. Clark wants to bypass both of these views and proposes a different view that is focused on the active role of the environment in driving cognitive processes, and as such, an *active* form of externalism. By regarding the material surrounding context - trees, software, books - as possibly relevant in constituting mental processes, Clark argues the mind is *extended*.

The extension of the mind lies in the active role that external and environmental aspects often play during mental processes. Clark argues that if a certain process - say, a mathematical calculation on a piece of paper, or searching an address in a notebook - would be regarded as cognitive if *it would have been done in the head*, the action itself actually is equally cognitive. This *parity principle* holds, Clark believes, because the only possible difference is the biological boundary by skin and skull, which is exactly questioned, and therefore cannot function as

the justification for the very boundary itself. By spreading cognition over a larger interactive space of bodies, brains, and environmental components and accepting the cognitive role of artifacts and the environment, a new understanding towards mental processes and the mind is articulated, since technology and artifacts are placed inside the loop of mental functioning. Human beings are coupled cognitive systems: all the components within the cognitive action play an explicit and active causal role, and jointly govern behavior in the same sort of way cognition usually does. Coupled processes count equally as well as a cognitive process, no matter the biological status or location. Active externalism opens a more natural explanation of all sorts of actions. Actions in the world can be part of mental thought and cognition is continuous with its environment instead of discrete: simplicity is power, so what makes some information count as a certain mental process is the role it plays, not whether it fits in an abstract idealistic framework that structures the explanation a priori.

The extension of the mind is not merely a coincidental circumstance, but lies at the basis of what Clark understand as an essential feature of human existence. According to Clark, human beings are essentially cyborgs, and always have been *natural born cyborgs*. Although 'cyborg' is far from a value-free concept, Clark purposely hijacks the term and redefines it as a thinking and reasoning system, that is constituted within a network of a body, brains, and non-biological entities. This means, that if there is anything as the mind or the self, it is spread out over the entire network and cognition should consequently be understood as a hybrid process. In the most negative sense, Clark's anthropology rejects a perspective that constrains or restricts mentality, cognition, the self, the mind, and any other mental activity solely to the brain, the body, or any other strictly physical or biological border. For Clark human functioning takes place in an intersection of artifacts, bodies, thoughts and actions, and hence is not solely the brain's end product and neither can neuroscience provide a full description of human mentality if it is not taking external factors into account by blindly focusing on the brain and the nervous system.

Human intelligence lies at the basis of Clark's anthropological framework [4]. Clark not only situates our human nature as being spread out across the external world in our mental activities; rather, humans constantly engage in two-way interactions with external objects. In fact, Clark argues it is exactly this underlying intelligence-increasing-process that defines our human nature. This means that in order to understand the human condition, Clark argues one has to come to terms with the fact that humans have an inherent and fundamental drive to change, design, re-design, build, rebuild, structure, and restructure the network in which they are constituted. There is no autonomous brain, body, or artifact that could be conceptualized outside of the surrounding 'natural' world he lives in. For Clark it is essentially human to engage in extending or overcoming the status of mental capacities and activities by interacting

with new structures and configurations.

Although this double-sided interaction between human actors and their environment becomes explicitly visible at a behavioral level, the biological brain plays a vital role in the generation and processing of these interactions. Nevertheless, Clark's functionalism does not regard the brain as an adequate entity to reveal the entire story of cognition and human mental functioning, instead, the biological brain is a part of the larger functioning constitution that is responsible for the intelligent and cognitive processes: *'in fact, the true power and beauty of the brain's role was that it acted as a mediating factor in a wide variety of complex and iterated processes, which continually looped between brain, body, and technological environment, and it is this larger system that solved the system'* (Natural Born Cyborgs, p.76). Clark argues there is a biological driving force which contributes to the overall intelligence-driven engagements with external objects: the biological brain is constantly striving to streamline, chunk, compile, and automate, and it does so by attending to repeated patterns of activity and use. Clark even goes a step further, by regarding this driving force as a general strategy, developed by the brain, in order to optimize the brain's key features, that is, by maximizing its strengths and at minimize its weaknesses: *'we have been designed, by Mother Nature, to exploit deep neural plasticity in order to becomes one with our best and most reliable tools'* (Natural Born Cyborgs, p.6).

Clark characterizes human beings and their functioning within their world as problem-solving organizations with an inherent drive to find more intelligent engagements and interactions, regardless of the biological status of the components within the problem-solving loops. It is important to note this process does not assume the existence of central agent that is explicitly aware of the very process; it is exactly that the problem-solving organizations *emerge* from the intelligence-driven flow that underlies human engagements and interactions in relation to the resources and components that together make up the organizations. This view culminates in Clark's notion of the *Principle of Ecological Assembly*, that states that the overall agent uses and employs *'whatever mix of problem-solving resources will yield an acceptable result with a minimum of effort'* (Supersizing The Mind, p.13). Clark's functionalism then translates into the view that components should only be distinguished on the basis of the larger effect they bear on the overall problem-solving project, and not on basis of their position - outside or inside the body - or their biological status. In Clark's earlier work, such as the extended mind, these arguments would be mainly philosophical and he would argue that their power lies in their ability to explain and simplify the problems surrounding mental and intelligent behavior, but it is interesting to note that in *supersizing the mind* Clark supports his views with results from cognitive and psychological neuroscience. This is not an easy project, for it is not an easy task to show how an agent does not discriminate between

inhomogeneous components, but the fact of the matter is that there seems to be at least a growing amount of experimental evidence that support his hypothetical framework [5].

Whereas Churchland’s framework failed (or refused) to connect to the current functionalist neuroscientific developments, Clark embraces these results and links them with the understanding of human mental functioning, and often supports his framework with examples of various technological developments. By doing so, Clark’s perspective is firmly based in the concrete reality of scientific and technological practices and is an effort to symmetrically understand the engagements within the space where human beings, artifacts, and the external world meet each other. Clark’s functionalist framework therefore also contains a phenomenological character, because it starts and wants to end with the concrete practices within daily life. It is only after approaching this space without any presuppositions that Clark recognizes the silent intelligence-driven flow underneath human functioning. The question arises to what extent this intelligence-driven view relates back to the overall relation of human mental functioning; that is, the question is whether it is the case that Clark is only focusing on a particular type of mental or cognitive behavior. In fact, it is difficult to find a satisfactory answer to this question in the work of Clark, but Engstrom and Selinger recognize that without such insight, Clark’s work explicitly or implicitly - that is exactly the question - extends the problem-solving-framework towards all forms of mental functioning, and thereby actually endorses a view with personal, political, economical, and societal consequences by influencing the way human beings are bound to understand themselves and their actions [23, 24]. Careful analysis of practices of deep brain stimulation will undermine the idea of a successful and smooth extension of his Principle of Ecological Assembly to the configurations that emerge during treatments with deep brain stimulation. By sticking to principles such as the Ecological Assembly, Clark connects technological artifacts to human intelligence according to the logics and rules of the artifacts, without acknowledging or recognizing the fact that this connection itself is not a natural or eternal truth, but is in fact influenced by the technological artifacts and practices themselves [23].

Helmut Dubiel, a German sociologist and philosopher, describes in his own personal experiences with Parkinson’s disease and deep brain stimulation how he literally configures deep brain stimulation and additional medications in order to match external demands: twenty minutes before an academic presentation he puts the device off, which allows him to control his speech [7].³ As soon as the presentation is finished, Dubiel puts the device back on to diminish the motor control symptoms and depression. Dubiel description is one of a dy-

³*Deep In The Brain* is Dubiel’s personal account of his experiences with Parkinson’s disease and deep brain stimulation and mainly focused on his effort to come to terms with the disease, the symptoms, the medical treatments, and the personal implications.

namic engagement with the external world, the self and the medication - it is not sufficient to describe these anthropological accounts with neuroscientific developments with a view that regards the implications from deep brain stimulation as intelligence increasing. It might have been the *goal* of the treatment to increase the intelligence, but the deep brain stimulation influences and frustrates this goal, and even seems to determine the subject, its behavior, and its experience of the self and the world. In a much broader sense, one could even consider a much deeper shaping of human functioning and mentality, when the development of the brain is associated with artifacts that participated in the development of human beings since childhood. The brain and its functioning is then conceptualized in a more historic framework, because the current state of the brain is related to earlier phases throughout its maturation. This historic importance is then closely related to a possible contingent character of brain development and the development of the functioning of the brain, because external factors - such as education - influence and shape the coming into being of the brain and its behavior. It stands to question whether Clark, with the parity principle and the notion of the extended mind, is able to fully appreciate this determinative dimension in the development of human beings and their mental functioning [25, 17, 26].

A young woman suffering from obsessive compulsive disorder (OCD) was treated with deep brain stimulation. Her doctors struggled to find a configuration that would reduce the obsessive symptoms, which is not surprising considering the experimental status of brain stimulation with cases of obsessive compulsive disorder. Surprisingly, a specific configuration left the symptoms unaffected but the woman claimed she felt happiness when the stimulation proceeded. Although the symptoms remained, the happiness obtained during brain stimulation was such that the woman wanted the device to stay on because she claimed the happiness was not touched by her obsessive behavior. The doctors decided to not allow the woman to keep deep brain stimulation, referring to an ethical perspective that is founded on the diminishing of the symptoms. However, the doctors recognized this to be a complicated ethical problem, and find themselves not too comfortable dealing with it, because of the major impact it might have on societal issues, concerning the relationship between a patient's autonomy, doctors, and technological possibilities or developments [27, 18].

Deep brain stimulation seems to enable new forms of neural and behavioral activity, the existence of a constant driving force that would underlie the configurations of humans, their brains and bodies, and the world they live in is questioned. More specifically, by shifting the brain in a seemingly new dynamical regime, deep brain stimulation enables the brain to generate brain patterns that are typically not observed or experienced before, and it is a difficult task for neuroscientists to describe and discover this new dynamical regime. The numerous accounts of side effects, whether they are positive or negative, imply that the effect

of the stimulation on the biological level can bear deep consequences on the behavioral level. It stands to question whether Clark's perspective is *meant* to be used to analyze deep brain stimulation, because it might be the case that this intelligence-fueled framework should only be applied to those particular configurations and forms of mental functioning. The fact of the matter is that deep brain stimulation shows how a technological development reconfigures that what it means to be human; the behavioral and mental capacities are changed, influenced, and restructured due to the implementation of deep brain stimulation. Given this transformative power, it seems that the idea of any algorithmic motor underneath human mental functioning is questioned itself because it might itself turn out to be transformed due to the influence of external components, such as deep brain stimulation. When the brain enables the mind and the inner workings of the brain are transformed by deep brain stimulation, deep brain stimulation also transforms the mind and thus the overall configurations and constitutions between environmental and biological components. And although it might be the case that usually these configurations and interactions can be described and understood in light of cost-functions and an ecological principle, these principles do not make up a perspective that seems to successfully describe the actual influence that technological developments can bear upon the overall configurations.

The direct problems with Clark's perspective in light of deep brain stimulation emerge at the point where the problem-solving-driven understanding of human cognition is assumed to apply to all human mental activities, and therefore, also to patients undergoing deep brain stimulation. Regardless of whether this is the case or not, his perspective does not address the transformative power of technological developments and thereby is ultimately too reductionist to describe and analyze deep brain stimulation. However, since it is only the last functionalist cognition layer on top of the phenomenological focus on actual and concrete practices, the phenomenological elements are not affected by the critique and problems in light of deep brain stimulation. Since it is only this last reductionist step that is problematic, the preliminary phenomenological dimension can still be a useful starting point for a philosophical examination of the relation between human beings and the world they engage with, without assuming any fixed characteristics per se. An alternative understanding of the relation between human beings and their world lies at the core of postphenomenology, a philosophical perspective that is closely related with phenomenology and philosophy of technology, and focuses on the existential and hermeneutical dimensions of the relation between human beings, external objects, and the world they live in. It is important to note that whereas eliminative materialism regards the brain as the mind, and functionalism regards the brain as an enabler of the mind, postphenomenology strictly tries to describe how things manifest or reveal themselves to human beings within their particular environment and rarely tries to

explain why the phenomena are as they are.

4 Postphenomenology

Clark's anthropological perspective assumes a constant and inherent relation between human beings and the world they are engaging in, namely, that human beings are striving to engage in those interactions to increase the strength of their mental and behavioral actions. The biological brain plays a major role within this configuration, where the mental functioning is ascribed to the overall constitution of human actors, their nervous system, and their environment. More specifically, the brain is assumed to be responsible for a large amount of the biological component underneath this strife for intelligence, by interacting with external objects in order to compensate its weaknesses and increase its strengths, possibly by means of algorithmic cost-functions. The resulting relation between human beings and the world, or *subjects* and *objects*, is then thoroughly centered around this natural goal. Through the discussion on deep brain stimulation, it became apparent that the problem with Clark's functionalism is that he does not fully appreciate and comprehend the influence of objects and technological developments on the existential dimension of human beings and their functioning. The central question of how deep brain stimulation can be understood, is now rephrased around the relation between human beings and the world they live in, including artifacts and technological artifacts and developments. Although Clark's framework with the parity principle, the extended mind, natural born cyborgs, and the Principle of Ecological Assembly is highly functionalist, it also contains a phenomenological dimension by taking the actual practices of human beings and their functioning within their particular context and environment as its starting point, but it ultimately reduces this relation to an evolutionary tendency towards more intelligent interactions. Since it is only this last reductionist step that is problematic, the preliminary phenomenological dimension can still be a useful starting point for a philosophical examination of the relation between human beings and the world they engage with, without assuming any fixed characteristics per se. An alternative understanding of the relation between human beings and their world lies at the core of postphenomenology, a philosophical perspective that is closely related with phenomenology and philosophy of technology, and focuses on existential and hermeneutical dimensions of the relation between human beings, external objects, and the world. Much of the postphenomenological content of this chapter relies on the work of Don Ihde and Peter-Paul Verbeek [9, 10, 11, 32, 33].

Postphenomenologists argue that the subject and object only *come to be* within the direct interactions within the world they live in, and that neither of them, nor the relationship itself, can be described in fixed or constant terms exactly because they only emerge in the concrete interactions within the lifeworld. This mutual space in which the subject and the object, or the human beings and their world, emerge and relate is conceptualized as *experience* or

perception. This space consists not only of material objects, such as the natural environment and external objects, but also includes social and cultural dimensions. The world provides not only a material configuration but also shapes, forms, and influences the way a subject comes into existence, and consequently also how human beings perceive and experience themselves, their world, and their relation. This cultural or social side of experience together with the more direct and embodied side of experience make up a continuum, that is, although they might operate on a different level, they constitute the full experience and can not be reduced to separated areas. A prerequisite for experience or perception is a directedness or intentionality, and as a consequence of this explicit focus within the interwoven and mutually dependent sphere of human engagement with the world, there is no such thing as a 'pure experience'. This is not to say that the relations between human beings and their world can not be studied or analyzed, but rather that this should be a basic assumption while studying the structures of human engagements.

The lack of general features within human beings, their actions, and the world they live in translates into a human-world relation in which the subject only *is* within the interactions and the world only *arises* in the specific contexts in which it is interacted with by human beings. In these encounters, both sides are not only tightly interwoven, but in fact, they co-shape or constitute each other by constraining and enabling a specific and unique configuration. Throughout experience or perception there is a simultaneous *dance* of engagements at the subjective side between bodily actions and more psychological actions, such as calculating, estimating, expecting, and planning. Similar dynamics can be discerned at the object-side, between concrete environmental and material constraints and more social and cultural structures and implications. Although all of these aspects can be recognized, they can not be separated from each other during the experience itself. Human beings can shape their environment, for example by building houses, bridges, and cities, but at the same time they are influenced by how the world is present to them, such as the climate, natural resources and the presence of cultural and social institutions and technological artifacts and techniques. A postphenomenological philosophy of technology takes this interrelatedness as its starting point and analyzes the role of technology in the mutual relation between human beings.

The general line of thought of a postphenomenological philosophy of technology is that technological artifacts *mediate* the interrelated dimension of experience. This means there is an interwoven connection between humans, artifacts and the world: through the use of artifacts the world and the subject come into being into a configuration that can be experienced. This experiencing through engaging with technological artifacts is not necessarily explicitly reflected in a form of conscious awareness for human beings, but it necessarily leads to a uniquely specified configuration of experience. A more explicit form of awareness typically

arises when a configuration that depends on specific technological aspects is perturbed by changes in these artifacts. The world changes at the moment a soldier runs out of ammunition: not only will it be very likely that the soldier's actions will change, but the way the world and his position in it is perceived and approached will probably alter significantly. It is after running out of the ammunition that the dependence on the ammunition itself becomes most apparent and explicit. It is interesting to note the way the technology is experienced itself can change through the engagements itself, and although this is in line with Martin Heidegger's (1889-1976) tool-analysis, these examples indicate a deeper feature that is closely related to a lack of general features within the human-world relation in postphenomenology.

This concept known as *multistability* means that there is no natural and essential way in which technologies mediate perception: the way technology and artifacts operate within the domain of experience can have several stable forms, possibly even with equal plausibility. Through repetitive encounters with a certain artifact or technology, a preference for a certain form of engagement might arise: this process might be influenced by educational forces or the script of the technology, which is the form of engaging that is typically promoted by the artifact itself. But given the lack of general features in human beings, the technological artifacts they engage with, and the world they operate in, the fact remains that any of these forms of 'stabilized' engagements is not intrinsically stable: technologies or technological artifacts often give rise to unprecedented forms of engagements or practices, and consequently to different forms of experiencing reality.

In order to study the role of a technological artifact within the sphere of reality and experience, it is therefore necessary to examine and analyze the configurations of engagements and interactions that constitute the practices around the technological artifact. With this *empirical turn*, Ihde formulates several categories of human-technology within actual practices of a wide variety of different technological artifacts. These categories - the *embodiment*, *hermeneutic*, *alterity* and *background* relation - together make up a framework in which the practices around technological artifacts can be approached for understanding their role within experience. The embodiment relation refers to embodied interactions such as contact lenses, ear tubes, and painkillers. Experience emerges from the intertwined technological constitution between the subject and the technological artifact, and the experience is mediated by these technologies without an explicit focus on the artifact itself: I am not explicitly seeing my contact lenses, but I rather look at the world through my contact lenses so that my view of the world is literally mediated by my lenses. The hermeneutic relation refers to technologies that include interpretation and thereby influence the engagement within the human lifeworld. These technologies, such as maps and speed indicators, typically function on an informative level: when the speed indicator informs me I am driving too fast, I become aware of the fact

that I am speeding and I can start acting upon it, whereas without the indicator I would have great difficulty in estimating my speed *at all*. The alterity relation refers to interactions with artifacts where these engagements coincide with the experience of the lifeworld. When I am texting a friend with my phone, I directly engage with the mobile through the buttons whereas the underlying components and mechanisms, such as the electronic data processing, subside somewhere in the background. The background relation refers to interactions with artifacts that are not really explicit or conscious interactions after all, since the technological artifact operates somewhere in the background. Regardless of what I might be doing, my mobile phone is continuously on stand by for incoming messages and phone calls at the background.

Since the evolution of the relation between human beings and their world, through technology, is historic and contingent, these categories can not be regarded as ultimately sufficient for understanding technological developments. When there are no general features that underlie human functioning, human interactions with technological artifacts, or human engagements with the world they engage with, new technological developments hold the potential to initiate radically new configurations of interactions that do not fall within Ihde's categories.

A postphenomenological study of the role deep brain stimulation thus focuses on actual practices in order to examine the specific relation between the patients and the world they engage in, mediated by deep brain stimulation. Since deep brain stimulation is used for several diseases and consequently implemented in various brain areas, we consider the general surgical treatment where a person receives an electrode within the brain that electrically stimulates the surrounding areas, without taking into account specific targeted brain areas or symptoms. Since the electrode is placed deep within the brain and directly stimulates the area with electrical current, the biological circuitry of the stimulated person is directly influenced by the stimulation. In fact, this transforming power seems to be a form of immediate biological mediation, since the biological patterns change under influence of the added currents. Given the fact that the neural and neuronal patterns influence the human mental functioning and thereby often the direct bodily actions, the mediation functions also on the explicit bodily level. And furthermore, concerning the influence of these bodily actions within the engagements in the world, the experience itself will be consequently different, thereby also revealing a mediatory component on the experience of reality, the world, and the self.

Given the fact that the general mediatory dimension of deep brain stimulation is present within biological brain patterns, bodily actions, and the experience of reality and the person's self, we can then ask the question which specific human-technology configurations may occur as a result of deep brain stimulation. This entails examining the effects the treatment can have on the patient. From the earlier discussions on deep brain stimulation it is known that the treatment often is accompanied with several side effects, such as depression, changes in

personality, and difficulty of speech. Interestingly, it is debatable whether the notion of a side effects holds within a postphenomenological framework, since this seems to assume a general characteristic within all treatments with deep brain stimulation from which these side effects can be distinguished. Both points are troublesome from a postphenomenological point of view since these side effects can not be distinguished from the overall configuration, and assuming a general effect of deep brain stimulation would boil down to a reduction of the contingent influence of deep brain stimulation. Moreover, these mentioned physical or psychological effects vary from person to person and thereby reveal the multistable forms of experience deep brain stimulation can generate. That is, deep brain stimulation might hold the potential to successfully diminish the patient's symptoms, though at the same time, this might be at the cost of severe negative elements within the overall configuration. In several cases deep brain stimulation can roughly be understood as a dynamic switch between different 'stable' configurations of experience, and this shows the mediatory capacity of deep brain stimulation on human beings and their functioning. That is, there is no such thing as an originary position during the treatments with deep brain stimulation, and this becomes even more apparent when the possible long-term biological effects within the brain are considered, or the personal consequences that persist throughout the patient's life.

Dubiel's personal account, introduced in the chapter on Clark, is a direct reflection on his experience with Parkinson's disease and deep brain stimulation, and is as such a careful phenomenological study of his practices around deep brain stimulation. The set of dynamic configurations that Dubiel developed, in order to meet life's daily demands, illustrates the postphenomenological multistability of both the technology as well his own functioning and experience of reality. Dubiel engages in a continuous dance between symptoms, behavioral capacities, and additional medication through his interactions with deep brain stimulation. If a technological development is literally a switch between different modes of physical and psychological behavior, the question arises in how far this was already the case before the treatment, due to earlier technological engagements. Consequently, every configuration within the current lifeworld then seems to be a position that is the current form of human existence, and there seems to be no inherently stable originary position that human beings could retreat to. At the same time they can actively shape and configure themselves towards a specific form, and deep brain stimulation enables such a reconfiguration and transformation at the biological and behavioral level. The earlier example describing a woman suffering from obsessive compulsive disorder makes this point explicit, since her treatment led to the unexpected experience of happiness as long as the device was on. Another example illustrated the opposite effect, because in that treatment the device led to severe personality changes that devastated the patient's personal life, and ultimately made him decide to be institutionalized

with deep brain stimulation.

Since the discussed practices show how deep brain stimulation resulted in drastically new forms of human mental functioning that were not anticipated at forehand, these practice of deep brain stimulation show Clark's functionalist perspective is profoundly insufficient. Since postphenomenology takes the dynamic capacity of artifacts on the relation between humans and their world as their philosophical starting point, the postphenomenological understanding of the relation between human beings, artifacts, and their world is a strong starting point for describing the actual practices. Without this explicit recognition of the steering and mediating role of technological artifacts on human functioning and the way reality can be present for them, an understanding of deep brain stimulation seems cumbersome and problematic. The engagements with deep brain stimulation turned out to be unpredictable and show how deep brain stimulation can directly alter the expectations and goals prior to the implementation. Moreover, these new configurations are often so profoundly problematic for the involved participants that these configurations question or even attack existing social and cultural frameworks and perspectives. These practices reveal deep brain stimulation can not be regarded as a neutral means to effectively diminish patient's symptoms, because it holds the potential to influence the patient's character and personality. Consequently, the way the patient's experiences and perceives himself and the world he engages with is directly influenced and this gives rise to philosophical questions concerning autonomy and responsibility. The patient's actions, mediated by deep brain stimulation, directly affect the world he lives in, so a change in personality translates to a change in the interactions with his world; this becomes drastically apparent in statistics that reveal a rather high number of divorces in cases of personality changes [18, 27]. The personality changes also face the doctors and surgeons with a problematic new configuration by questioning what it means to be happy, healthy, or sick. It might very well be the case these current frameworks are insufficient to deal with the new possibilities and configurations that emerge as a result of deep brain stimulation. Since it is merely a flick of the switch that can question these concepts within one person, the influence of deep brain stimulation might even suggest there is no such thing as ordinary behavior or functioning. The question arises how deep brain stimulation influences morality. This is the question of techno-moral change: the ability of technological developments to (re)shape and transform morality.

Since the brain stimulator is placed directly within the brain, it is difficult to distinguish deep brain stimulation and the patient, both at the level of neurons and brain patterns and mental behavior. Although the outcome might be completely determined by deep brain stimulation interacting with the stimulated region, it is practically impossible to determine what the exact influence of the brain stimulation is on the behavior of the brain, and it almost

certainly can not be separated in the concrete experience itself. When I am looking through my contact lenses, the visual mechanisms are scientifically perfectly understood and clear to me, but still the act of seeing is experienced in relation with the lenses, and since I would not be able to see that particular way without my lenses nor experience the lenses as such, and I can not see that way without my lenses, the distinction itself is useless. Similarly, the more fundamental act of movements or personal actions can not be thought without deep brain stimulation or without the patient, but only tightly interwoven and coinciding with each other.

In opposition to the biological effects, the effects of deep brain stimulation on the co-constitution between patient and stimulator, however, are directly experienced. Since the stimulator can create radically different forms of actions, functioning, personality, and self-perception, deep brain stimulation often creates new forms of experience and engaging. Deep brain stimulation actually seems to question the very idea of an originary position of human beings and their mental behavior: when there is no natural state to refer or return, and there seems to be no fixed and ultimate criterion to distinguish between sick and healthy, and there seems to be no criterion to favor one form of personality over the other. The lack of an originary position can be derived through an explicit form of experience after deep brain stimulation - where the patient literally interprets itself as a multistable entity - but also from the broader insight of the historic and contingent dimension of human existence that takes into account the mediatory capacity through the historic development of human beings through several earlier encounters and interactions. These interactions are not necessarily associated with artifacts per se, since education and language can also have such a forming and shaping influence over time on the development and shaping of human beings.

Deep brain stimulation affects and defines human existence and the resulting configuration coincides with the person's functioning and behavior. And although there is no such thing as human existence outside the realm of experience, practices of deep brain stimulation indicate there is a form of *experience of experience*: patients are explicitly aware of their own nature and their often uncontrolled patterns of behavior and modes of existence. By experiencing deep brain stimulation as a dynamic switch between different modes of existence, the patients experience *the relation* of the relation between human beings and the world they live in through technology and artifacts, and furthermore, deep brain stimulation enables them to shape this additional layer of experience through a biological reconfiguration of human existence. Deep brain stimulation may enable them to choose for a specific new form of physical and psychological existence, and actively shape themselves and how they experience the world. The question arises whether this additional layer is not already always present within the interactions in the lifeworld, but the fact that deep brain stimulation enables a

certain form of control on the behavioral configurations through the biological underpinnings of existence seems to indicate deep brain stimulation might be regarded as a particularly explicit articulation of this type of experience. This is not the place for a full anthropological and philosophical comparison of deep brain stimulation against other technological developments, but it should be noted that such a thorough analysis might very well lie at the basis of a full appreciation of deep brain stimulation. However, it stands to question whether such an elaborated description is necessary for a discussion of the practical problems and complexities that emerge during treatments with deep brain stimulation, or that the current postphenomenological understanding could suffice.

Up to this point, Churchland's eliminative materialism, Clark's functionalism, and a postphenomenological philosophy of technology have been discussed to see how deep brain stimulation can be analyzed and understood from a philosophical perspective. The conclusion is that the postphenomenological perspective is able to provide a framework that can fully address the radically new nature of deep brain stimulation, whereas the other perspectives turned out to be troublesome in light of deep brain stimulation, because they failed to recognize the transformative power of devices - such as deep brain stimulation - on human beings and their mental and physical well-being. Since these three theories together represent the dominant spectrum of the philosophical perspectives on human mental functioning, this philosophical discourse is particularly relevant in light of the problems and complexities that emerge during treatments with deep brain stimulation. The following chapter focuses on how the different perspectives characterize the influence of deep brain stimulation on the concrete practices in the reality of daily life. Although these practices touch upon several different domains, this is mainly a discussion on how the practices around deep brain stimulation may be steered and structured, since an evaluation of the qualitative state of the concrete situations seems to lie at the basis of any discussion of economic, political, or societal issues that could emerge within these practices.

5 Practices

Up to this point, the three different perspectives have been applied and related to deep brain stimulation by closely following their line of reasoning in a philosophical sense, and deep brain stimulation was approached with their own specific agenda, concepts, and ideas. They represent a dominant spectrum of the philosophical perspectives on human mental functioning, so this philosophical discourse is also relevant in light of the practical problems and complexities that emerge during treatments with deep brain stimulation. By focusing on how the different perspectives characterize the influence of deep brain stimulation on the concrete practices in the reality of daily life, the three perspectives are now directed towards a more specific practical and moral dimension, as it may solve some of the complexities and problems that arise in specific case. This was not the case in the earlier chapters where the philosophical perspectives were analyzed along their own dynamics. Since the scopes and goals of these perspectives drastically differ, a direct comparison reveals strong differences: eliminative materialists mainly address deep brain stimulation in a purely scientific perspective as a neutral component within mental behavior, Clark connects deep brain stimulation to the larger configurations of the brain, the body, and the environment in which it is placed with an underlying algorithmic drive to minimize a certain cost function in order to increase the intelligence of the human agent supported by neuroscientific insights, and postphenomenology starts with the interactive space where the human agent engage and emerge and experience their world, through technological artifacts and developments. There seem to be large differences between the methods employed by materialist neuroscientists in their laboratories and papers, and the direct experience of a patient with deep brain stimulation. Although this shows that the different perspectives together span up a large spectrum, the question seems to arise in how far the weak and strong points of the perspectives relate to each other.

Despite the fact that there seems to be a continuous line of critique in the earlier analysis - Clark's functionalism is undermined by a postphenomenological philosophy of technology, whereas Clark's perspective undermined Churchland's eliminative materialism - the particular problems emerged by following the flow and dynamics of the views within their own philosophical context, and are therefore philosophical problems. Consequently, when the focus is shifted to the practical question of how these perspectives characterize the influence of deep brain stimulation on the concrete practices in the reality of daily life, it is not sufficient to directly use the earlier philosophical discussion to favor the postphenomenological framework over the others, because it need not necessarily be the case that the problems within their particular frameworks also find their counterpart in the answers to this particular question. More specifically, it should be noted that this question *does not* directly follow the flow and

dynamics of the particular perspectives, but explicitly frames these perspectives towards the specific practical dimension. Although it need not be the case that these frameworks directly apply to explore this dimension, since it might not be part of their goal, scope, or current state of development, the perspectives can still function as a guiding light in exploring the concrete dimension, and thereby contribute to a deeper insight in the *general* discussion of deep brain stimulation.

5.1 Eliminative materialism

Eliminative materialism refutes the idea that conceptual analysis can reveal the essence of mental states; the only way to find out how things work in the mind is to study the material interactions of the brain, so the argument goes. Consequently, philosophers can learn from neuroscience and the conceptual analysis - whether it is folk psychology or cognitive or psychological science - that is not derived from the materialist neuroscientific method is vulnerable to neuroscientific evidence and may face revision or even elimination. Churchland argues that by eliminating the bits of these false accounts that do not map reality in as much detail as scientific descriptions do, the insight in human mental functioning will be enriched. The eliminative part is therefore not only a cleaning tool for false accounts, but also a more positive philosophical project to obtain deeper insight in the underlying nature of human behavior: having a specific understanding of obsessive compulsive disorder allow human beings to engage more compassionately with each other than folk-psychology positions such as 'weird', 'odd', or 'possessed'.

As mentioned before, Patricia Churchland recently discussed neuroscientific research that shows how during the perception of a perceptual stimulus, higher areas of the brain are projecting back to the early visual cortex to attach a specific value signal that favors a certain perceptual signal instead over other signals [2]. Before any consciously awareness of any form of visual perception, the perception itself seems to have a certain valance. For Patricia Churchland, this puts the relation between facts and values in perspective, because the separation is not made internally in the biological brain. If there is no evidence that the biological interactions lead to the separation, eliminative materialists argue that this separation does not exist at *all* and should be eliminated in all their contexts. Any domain that draw upon this distinction should take notice of the neuroscientific evidence and let these results inform their practices. For this particular case, this seems to have, or *should* have, implications for any domain that draws upon this distinction or uses the idea of judgments.

This example shows how eliminative materialism works out in practice and how it relates to the concrete practices around neuroscientific developments. The problem is, however, that eliminative materialism can only enter the dynamics of concrete reality once the materialist

neuroscientific method established convincing results relating to those practices. Since there currently is no full scientific understanding of deep brain stimulation and the way it works, it seems impossible to discern and recognize the possible implications in daily life. However, *once* there is such a theory, the associated concepts of personality and individuality will arguably have to be refined or eliminated, but this currently is nothing more than sophisticated anticipation or even speculation. The only thing to do is to endorse and support the neuroscientific research, discuss the results, formulate new hypothesis, in order to support the joint venture to find out how deep brain stimulation really works. It seems difficult to see how eliminative materialists regard the current practices around deep brain stimulation, since it seems they put themselves off side for as long as they have the scientific evidence to attack the current notions and concepts and replace the false accounts with what they believe to be the truth. Consequently, in that sense eliminative materialism is not a dead end, because it is impossible to falsify their trust in the materialist neuroscientific method: eliminative materialists put themselves on hold for as long as they need to find out how things work.

It is interesting to note how the concrete practices themselves seem to create an opening for the results of neuroscience in their institutions: there is the 'Research Network on Law and Neuroscience' at the Vanderbilt University Law School in Nashville, the ESF-COST Conference 'Law and Neuroscience: our growing understanding of the human brain and its impact on our legal system', and a recent Edge-masterclass on 'Neuroscience and Justice' by neuroscientists Michael Gazzaniga discussed how judges and lawyers engage with neuroscientific research. And although it is difficult to examine how these forms of neuroscience relate to the materialist neuroscientific method supported by Churchland, it shows that the structures around the practices are preparing themselves on the refinement or elimination of the old concepts informed by neuroscientific developments.

5.2 Clark's functionalism

At the core of Clark's philosophical work lies the concept of the extended mind; the idea that the mind lies not only in biological matter but is also depending on environmental and external components. By including the brain, body, technological artifacts, and the external world into a functional loop of mental functioning, Clark's functionalism is a step towards a symmetric treatment between objects and subjects in the process of mental behavior. The mind is spread out through these interactive spaces between the components that together constitute the configurations that are responsible for the cognitive and mental processes. On top of this philosophical foundation Clark builds an anthropological understanding of human beings as *inherently* caught up in these interactive spaces and associates these interactions with the human nature as *cyborgs*. This is not only a philosophical assertion resulting from

the notion of the extended mind, but is also connected to neuroscientific evidence that the brain is engaging in these interactions according to an intelligence-driven algorithmic structure to maximize the intelligence of the resulting behavior and this cost-function analysis operates on a silent level. This silent drive, Clark notes, should be regarded as a dominant motor underneath human beings and their mental functioning. The fact that human beings seem to be inherently focused - whether they are consciously aware of it or not - towards engagements with non-biological components, does not mean that they coincide with this biological drive. The brain enables the mind and the brain might try to find an optimal solution in terms of their cost function within the space of possible engagements, but Clark still sees space for human beings to actively evaluate and shape these interactions. The fact that human beings are cyborgs does not mean that they should engage with *every* technological development or that it is enough to rely on their brain-driven dynamics; they have the ability - perhaps even *task* - to analyze and evaluate the engagements and interactions and then position themselves within these interactive spaces, exactly because they are cyborgs.

Once the distinction between skin and skull is removed, human beings can start to see themselves more truly as dependent creatures *of* the world. Since this is an explicit reconception of human beings and their functioning, Clark argues this will have direct consequences for philosophical views of the mind, the methodologies of research in cognitive sciences, and the moral and social domains [5]. So, the idea of the extended mind flows over into the idea of the human cyborg and eventually leads to the idea that human beings can, to some extent at least, shape the interactions and engagements with their environment and non-biological components in a conscious way. Since the extended mind regards the mind and human beings as spread out over the world, this symmetrical treatment between brains, bodies, and objects should find its reflection in the concrete practices: *'it may be that in some cases interfering with someone's environment will have the same moral significance as interfering with their person'* (Clark, 2008, 232).

It is interesting to note how close such a notion of interfering is to the postphenomenological understanding of the transformative power of technological artifacts, but ultimately fails to fully grasp the entire dynamical picture by regarding the interactions too neutral. That is, they are instrumentally weighed according to their overall contribution to the intelligence of the human agent and in that context the interfering takes place: if a certain external object happens to be an optimal candidate from the intelligence-increasing context and its availability is denied, or from the deliberation of a human agent on its desired interactions, Clark would immediately recognize a moral field of tension. This seems to be exactly what is at stake in the example with the woman suffering from obsessive compulsive disorder: the device was taken away by the doctors because the treatment did not affect the clinical pic-

ture, whereas the woman wanted to retain the device because its effects made her feel happy. Clark's understanding of interfering does not apply to the general idea behind deep brain stimulation where the specific configuration of the device - the amplitude, width, and shape of the applied current - directly transforms the patient's neural and behavioral patterns. This problem can not be solved by investigating whether the silent-algorithmic drive is still present within this new dynamical space, because even if this would be the case, the fact that deep brain stimulation *transformed* the brain in a radically new state is still ignored. So even though Clark creates room for practical deliberation, analysis, and discussion in order to position one's self towards their engagements and interactions, Clark's perspective seems to asymmetrically favor the *successful* and *unambiguous* treatments with deep brain stimulation when it is applied to the concrete practices and examples.

5.3 Postphenomenology

Since postphenomenology *starts* with the actual experience between human agents within their world, where the subject and the object arise and engage, and influence each other, it is initially and originally connected to actual practices. The interactive space of experience is mediated through technology and technological artifacts, and human beings are historically and contingently shaped and transformed through these engagements. Recent technological developments, such as deep brain stimulation, enable human beings with new forms of physical and psychological interventions, and a new form of experience becomes explicitly apparent: a conscious awareness of the possibility to transform one's self physically and psychologically to become a new entity, with new capacities and abilities. Since this type of *experience* of experience lies at the core of a postphenomenological analysis of the practices around deep brain stimulation, it is the point of the departure for the shaping of the crossroads around deep brain stimulation.

The observation of blurring borders and boundaries between humans and technology, as revealed by converging developments such as deep brain stimulation, strengthens the view of human beings as inherently technologically mediated. By refusing a dialectic approach, in which humans and technology are divided in separate domains and conceptualized in terms such as victims, liberation, or slavery postphenomenology takes an interpretive hermeneutic approach. Human beings are then understood as continuously shaping themselves in relation with technology and artifacts: it is exactly through the interactions with technological artifacts that human beings become themselves. The implications of this conceptualization of human beings and technology as mutually dependent, influences the understanding of human beings, their functioning, and their relation to the world. Since there is a mediated connection between humans and technology, there is a constant feedback loop. This means that

there does not exist a static or constant factor which could be tied down to be a constant or essential feature of human functioning. What makes someone human, both in the existential sense and in the biological sense, is historic. The human condition is a constantly developing process wherein humans and their world never remain the same: freedom, intentionality, beliefs, emotionality, and morality all change in relation with technology and artifacts.

Postphenomenologist Peter-Paul Verbeek is currently trying to formulate a postphenomenological ethics of technology that explicitly deals with the question of what we - as human beings - want to make of ourselves. In the remainder of this chapter this perspective will be discussed and explored, in relation with deep brain stimulation [33, 34, 35]. Given the postphenomenological understanding of the human condition as human beings with an inherently technologically mediated existence, a postphenomenological ethics of technology is then concerned with finding ethical ways of shaping this technologically mediated reality. Instead of using fear or appraisal as the basis under ethical decisions concerning technology, Verbeek wants to embed technological developments in such a way they can contribute to the quality of life, aware of the structural impact technological artifacts can have on the subjective experience. Ethics is then directed towards the quality of the relationship between humans and technology: *'it means that the aim of the ethics of technology must be to give shape, in a sound and responsible way, to the relationship between people and technology'* (The limits of humanity: on technology, ethics, and human nature, 14). Verbeek is searching for an amodern, non-humanistic ethics of technology, in line with the postphenomenological human condition, that is focused on shaping existence in an ethical way and he finds such a candidate in the work of Michel Foucault (1926-1984).

Foucault developed his ethical discourse at the end of his life, whereas he is arguably most famous for his earlier work on power or power structures. Foucault pointed out the current status of power is one of decentralization, since power is now redistributed over a variety of different social institutions such as schools, prisons, and hospitals. Decentralized power has a disciplining effect on subjects, that is, power disciplines the dealing subject towards certain patterns or types behavior. These power structures practise an implicit tendency and thereby profoundly shape the subject. A subject is situated in a hierarchal power structure and it is exactly in these matrices of disciplining power where the subject becomes what he is. Foucault's idea of power is directly connected with the subject's ability to relate to this disciplining power: the task is then to find out how an agent subjectivate and position itself *given* the specific power structure. For Foucault ethics means engaging in a process of *constantly checking the regulations, procedures and constellations of power that make up our inheritances for identity and commitment* (Scott, 1996, 53) Moreover, his ethics is founded on the possibility of a fundamentally personal choice: *'a very strong structure of existence,*

without any relation with the juridical per se, with an authoritarian system, with a disciplinary structure' (Foucault, 1983, 348). Critical philosophy then may shed light on human beings as subjects within their environment, and ethics could help the subject to establish a new relationship towards this network.

The question arises whether and how Foucault's ethics of subjectivation can be translated into a postphenomenological ethics of technology. Within Foucault's power structures, all participating actors are in theory subjectivated and disciplined by the power structure, but his ethics is mainly centered around the subject as an individual in opposition *to* the power structure. By shaping one's own position, the power structure changes around the individual. The resulting overall effect on the power structure depends on the position of the individual and since Foucault's ethics regards the ethical project as a personal and individual form of self-shaping, one could argue that Foucault seems to be mainly concerned with the individuals that are only shaping *themselves*, whereas the possible influence of these actions on *others* remains undiscussed. It seems that Foucault's ethics is not so much concerned with the individuals that explicitly shape the power dynamics through their own personal actions, such as politicians and lawmakers. Although these individuals may experience the same disciplining effect from the power structure, their actions would not only shape themselves but also determine and configure *the other*.

In order to sketch how Foucault's ethics might work out in a concrete example, consider again the case where the woman suffering obsessive compulsive disorder that was not allowed to keep the device that would make her feel happy in a certain setting, because the doctors decided their goal was to diminish the symptoms and not to increase her happiness. It seems reasonable that the patient, by applying Foucault's ethics, could decide that she wants to keep the deep brain stimulation, in light of the larger project of her self-constitution and self-shaping. She might argue deep brain stimulation allows her to experience the world and herself in such a happy and enjoyable way, without harming herself or her capacities, that she feels the device enriches the experience of her own life and her actions. Note that the happiness is in fact part of the patient's existence and well-being, and that it is not sufficient to dismiss this reasoning a priori with the argument that she knew she only could keep the device when it would effectively diminish her symptoms. As soon as one of her doctors would practice Foucault's ethics of self-subjectivation, his ethical discourse automatically seems to *invade* the domain of the other, because the way the doctor would structure his relation with deep brain stimulation, the power structure directly influences or even determines the power structure for *all* patients. The ethics of self-shaping then becomes the shaping of the other, and the way the other experiences itself and its environment. ⁴

⁴One could even go as far to argue that because the happiness arose in the woman suffering from obsessive

Since Verbeek formulates his ethical project around the question of what *we* want to make of ourselves, and how *we* can take responsibility for ourselves and deal with these new technological developments, his ethics of technology contains a societal dimension. If Verbeek uses *we* in the sense that everybody should practice Foucault's ethics of subjectivation, there is not a direct problem with Foucault's ethics, but it seems more likely that he suggest a joint societal form of Foucault's ethics. This type of ethics could or should be applied by patients, doctors, surgeons, designers, politicians, tax payers, technicians, neuroscientists, and lawmakers and it stands to question whether Foucault's ethical discourse can be used in such a societal and political way. In order to see how a postphenomenological ethics of technology founded on the ethics of Foucault could work out in practice, it seems vital that Verbeek addresses this possible gap.

compulsive disorder, the possibility disciplined the doctors into a specific ethical dilemma. By forcing the doctors to decide whether she could keep the device, the doctors themselves where disciplined through the configuration of the woman and her device, and forced to shape this configuration. The fact that the doctors regarded themselves as ultimately incapable with this power supports this claim and shows how the woman herself restructured the power structure surrounding herself and the device [27, 18].

6 Conclusion

The question at the basis of this thesis is how deep brain stimulation, as a recent technological development in the domain of neuroscience, is addressed by philosophical perspectives on mental functioning. As neuroscientific research often applies a materialist presupposition within their research, I started with Paul Churchland's eliminative materialism. Eliminative materialists claim that a materialist neuroscientific method is the only and ultimate way to obtain knowledge of the brain, the mind, and mental functioning. Since any other approach or discourse is a priori disqualified by the eliminative part, eliminative materialists regard the materialist neuroscientific study of the biological brain as ultimate and sufficient for understanding mental functioning. Matter that is not part of the brain or the nervous system is therefore regarded as ultimately irrelevant for understanding the internal mechanisms within the brain. That is, non-biological inputs can only trigger, and thereby reveal, the mechanisms that are at work within the brain, but they cannot change or transform them. As deep brain stimulation is entirely non-biological, eliminative materialists would consider deep brain stimulation as merely a neutral input, just as any other non-biological component, and not a candidate for transforming the biological structures and configurations within the biological brain. However, deep brain stimulation seems to do exactly this: it changes and transforms the 'natural' patterns within the brain and thereby seems to bring the brain in an entirely new regime and state, resulting in new forms of behavior. In order to understand the dynamics of this new emerged brain state, the crucial influence of the deep brain stimulation needs to be recognized and this is something that eliminative materialists refuse to do. Furthermore, and this seems to be the final blow for eliminative materialism, neuroscientists themselves have not failed to recognize this transforming capacity of deep brain stimulation and exchanged a purely materialist perspective for a more functionalist approach. From a functionalist perspective, external objects, including deep brain stimulation, might have a transforming influence on the inner workings of the brain, and consequently on the types of behavior that emerge from the new brain dynamics.

All in all, eliminative materialism fails to provide a perspective that can fully address, describe, and understand deep brain stimulation because they strictly adhere to an entirely materialist perspective and their eliminative dimension becomes untenable in light of the functionalist elements in current neuroscientific research on deep brain stimulation. Leaving eliminative materialism and materialism for what they are, the functionalist dimension within neuroscience was then taken as a starting point to discuss and examine the functionalist framework by Andy Clark. At the core of Clark's anthropological and philosophical work lies the insight that it is not the biological status that determines whether something is mental

or not. Instead, it is the role that an object plays within the larger configuration of humans engagements with their world that should be considered as the fundamental criterion for human mental functioning. When a mathematical exercise is solved with the help of a piece of scrap paper, the overall mental process was not entirely in the head but in cooperation with the paper and the pen. Such a symmetrical treatment - the parity principle - leads to the view that the mind is extended beyond the ordinary biological boundaries of the nervous system, and the biological brain is no longer understood as the sole originator of behavior and mental functioning. The brain then enables the mind, instead of defining it.

Given the fact that mental functioning can be supported through bonding with external objects, Clark then goes on to place this in the larger framework of human functioning: it is exactly the fact that human beings engage and interact with external objects to increase their own mentality and intelligence that lies at the basis of Clark's fundamental understanding of what it means to be human. Clark understands human beings as natural born cyborgs: human beings are constantly looking to shape and improve the intelligence of their actions in cooperation with external objects, and being employed with a pair of brains that utilizes its plasticity, their biological nervous system support the influence of these interactions to the fullest. Although Clark replaces materialism with a functionalist perspective by allowing the external world within the loop of the processing of intelligent and mental functioning and behavior, his positive understanding of these interactions in light of their cyborg nature is problematic since it disallows objects to have an influence on human beings that does not fall within this anthropological understanding. Such a functionalist framework thus does not fully consider the possibility that technological interactions might alter and change the brains and mental functioning. As deep brain stimulation directly transforms and changes the biological as well as the functional levels of mentality and intelligence, Clark's perspective is ultimately too limited since it fails to address the defining influence technological and external objects on human beings and their actions.

Negative side effects as a result of deep brain stimulation are not directly an attack on Clark's larger anthropological framework, although they indicate that the actual behavioral patterns do not necessarily coincide with the desired goal of the stimulation. As deep brain stimulation penetrates the biological level and thereby influences the mechanisms prevailing over the brain and the emerging behavior, these mechanisms turn out to be malleable and transformable. Consequently, deep brain stimulation thereby directly challenges the idea that human beings and their brains are continuously focused on intelligible interactions with external objects: deep brain stimulation transforms the mental functioning on the biological as well as the behavioral level and thereby human beings themselves. These changes are not necessarily towards a more intelligible configuration between human beings and the world

and objects they engage with, but actually question the functional separation of subject and object because the experience of the object can crucially depend on the functioning of the external objects. It is not enough to consider external objects as merely participants in mental functioning; if their participation is regarded as essentially intelligence-increasing, the influence these objects and artifacts can bear upon human beings, their functioning and the way the world becomes present to them is ignored.

The problem with Clark's functionalism is that it does not fully appreciate and comprehend the influence of objects and technological developments on the existential dimension of human beings and their functioning. The central question of how deep brain stimulation can be understood, is now rephrased around the relation between human beings and the world they live in, including artifacts and technological artifacts and developments. Although Clark's framework with the parity principle, the extended mind, and natural born cyborgs is highly functionalist, it also contains a phenomenological dimension by taking the actual practices of human beings and their functioning within their particular context and environment as its starting point, but it ultimately reduces this relation to an evolutionary tendency towards more intelligent interactions. Since it is only this last reductionist step that is problematic, the preliminary phenomenological dimension can still be a useful starting point for a philosophical examination of the relation between human beings and the world they engage with, without assuming any fixed characteristics per se. Postphenomenology elaborates on this starting point, and postphenomenologists Don Ihde and Peter-Paul Verbeek then connected this perspective with a philosophy of technology to provide a hermeneutical understanding of the connection between human beings and the world they live through technological artifacts. Such a postphenomenology then does not lead to a reductionist perspective - such as Clark's - but can fully address and comprehend the crucial defining influence of technological artifacts and technology on human beings, their actions and the way they understand and experience themselves.

Postphenomenologists argue that there is no such thing as an objective world or a subject outside this common playground of experience: it is exactly in the very engagements within the lifeworld where the human being and the world arise and emerge, and these engagements are often thoroughly mediated by technology and artifacts. By focusing on the domain of actual practices and experience - the empirical turn - postphenomenology then brings these engagements into focus to discern the influence of technological artifacts and technology on the coming into being of human beings and their world. Human beings can influence the world they live in, the world restricts and shapes these interactions and consequently what it means to be human, and technology can transform and change these interactions. These relations are consequently contingent and a-historic and there is not a definition that can

be formulated around these interactions, and since there is no such thing as human behavior outside of these interactions, the same holds for human functioning, the world or technological artifacts. This does not mean it is impossible to address technological developments and their influence, but rather that this should be taken as the defining starting point of the study itself: a technological development can only be understood by looking at the actual practices. This means that the concrete configurations with the device, the patient and the surrounding medical environment in deep brain stimulation function as the basis of the postphenomenological study of deep brain stimulation.

Several different examples of treatments with deep brain stimulation, especially those with negative effects indicate how patients often dynamically engage with various physical and psychological actions, depending on the settings of the deep brain stimulation and possibly some additional medications. Deep brain stimulation often functions as a dynamic switch between different modes of existence, reflected in different physical patterns and psychological behavior, and this directly connects to the postphenomenological understanding of the mediating influence of technological artifacts on human existence. Such a connection cannot be made from Clark's functionalist perspective, nor from Churchland's eliminative materialism, since they both cannot recognize the transformative capacity of the device on the patient. By presenting such a dynamical shift between different regimes of behavior, deep brain stimulation reveals an additional dimension on top of the direct experience within the lifeworld, namely, the ability to transform the modes of experience explicitly through the deep brain stimulation. This 'experience of experience' is not an easy dimension, since it seems to enable human beings to become aware of their own relation to the relation that they have with the world they live in, through technology. It is difficult to examine in how far this dimension reveals a new form of experience, or whether this is a general description of the connection between technology and human beings. Deep brain stimulation is then perhaps only one of the most explicit articulations of the mediatory capacity of technological artifacts on human beings, their existence and the way they relate to themselves and the world they live in. All in all, deep brain stimulation presents the engaging actors with a dynamic switch between different modes of existence through a technological interference at the biological structure underlying human functioning. To act upon this possibility is not an easy task, and to address the corresponding problems and complexities might be equally difficult.

In conclusion, Clark's functionalism is undermined by a postphenomenological philosophy of technology, whereas Clark's perspective undermined Churchland's eliminative materialism. The particular problems emerged by following the flow and dynamics of the views within their own philosophical context, and are therefore philosophical problems. The three different perspectives have been applied and related to deep brain stimulation by closely following their

own line of reasoning in a philosophical sense, and approach deep brain stimulation with their agenda and concepts. They represent a dominant spectrum of the philosophical perspectives on human mental functioning, so this philosophical discourse is also relevant in light of the practical problems and complexities that emerge during treatments with deep brain stimulation. Since the scopes and goals of these perspectives drastically differ, a direct comparison reveals strong differences: eliminative materialists mainly address deep brain stimulation instrumentally as a neutral component within mental behavior, Clark addresses deep brain stimulation to the interactive spaces where the brain, the body, and the environment meet. Clark argues there is neuroscientific evidence that these spaces depend on an underlying algorithmic drive to minimize a certain cost function in order to increase the intelligence of the human agent and postphenomenology starts with the interactive space where the human agent engage and emerge and experience their world, through technological artifacts and developments. Consequently, when the focus is shifted to the practical question of how these perspectives characterize the influence of deep brain stimulation on the concrete practices in the reality of daily life, it is not sufficient to use the earlier philosophical discussion to favor the postphenomenological framework over the others, because it need not be the case that the problems within their particular frameworks also find their equivalent in the answers to this particular question. More specifically, this question is explicitly directed towards the practical dimension in these perspectives and thereby contribute to a more general discussion and interpretation of deep brain stimulation.

Eliminative materialism enters the dynamics of concrete reality once the materialist neuroscientific method established convincing results relating to those practices. Since there currently is no full materialist neuroscientific understanding of deep brain stimulation, it seems impossible to discern and recognize the possible implications in daily life from the perspective of eliminative materialism. However, *once* there is such a theory, the concepts that are currently applied in the cases and practices will arguably have to be refined or eliminated. Consequently, the project is then to analyze and support the materialist neuroscientific research instead of these inherently false accounts, discuss the results, and formulate new theories around deep brain stimulation. Eliminative materialists put themselves voluntary off side for as long as they have the scientific evidence to attack the current notions and concepts and replace the false accounts with what they believe to be the truth. Since it is impossible to falsify the trust in the materialist neuroscientific method, eliminative materialists may put themselves on hold for as long as they need to find out how things work. At the same time it is interesting to see how the concrete practices themselves seem to create an opening for the results of neuroscience in their institutions and a specific discipline of *neurolaw* seems to emerge. And although it is difficult to examine how these forms of neuroscience relate to

the materialist neuroscientific method supported by Churchland, it shows that the structures around the practices are preparing themselves on the refinement or elimination of the old concepts informed by neuroscientific developments.

Clark's functionalism provides a more explicit connection to concrete practices and cases of technological developments. If his theoretical understanding of the extended mind and human beings as cyborgs are accepted and the false distinction between skin and skull is removed, Clark argues human beings can start to regard themselves and their intelligence as the result of their specific environmental context. Since this is an explicit reconception of human beings and their functioning, Clark argues this will have direct consequences for philosophical views of the mind, neuroscientific research, and the moral and social domains. The idea of the extended mind flows over into the idea of the human cyborg and eventually leads to the idea that human beings can, to some extent at least, shape the interactions and engagements with their environment and non-biological components in a conscious way. Since the extended mind regards the mind and human beings as spread out over the world, this should find its reflection in the concrete practices, and Clark even goes as far to recognize the possibility that environmental interference can boil down to personal interference. Although Clark's understanding of this interfering is close to the postphenomenological understanding of the transformative power of technological artifacts, it ultimately regards the influence of external objects as too instrumental and neutral. These objects are weighed according to their overall contribution to the intelligence of the human agent. The fact that deep brain stimulation *transforms* the brain into a radically new state is ignored. Although Clark actively supports practical deliberation, analysis, and discussion in order to position one's self towards their engagements and interactions, Clark's perspective seems to favor the *successful* and *unambiguous* treatments with deep brain stimulation over the less successful and more troublesome cases when it is applied to concrete practices.

Since postphenomenology starts with actual experience within the concrete practices in the lifeworld, it is closely connected to the practices by definition from the very beginning. The interactive space of experience is mediated through technology and technological artifacts, and human beings are historically and contingently shaped and transformed through these engagements. Recent technological developments, such as deep brain stimulation, enable human beings with new forms of physical and psychological interventions, and a new form of experience comes to light: a conscious awareness of the possibility to transform one's self physically and psychologically to become a new entity, with new capacities and abilities. Since this type of *experience* of experience lies at the core of a postphenomenological analysis of the practices around deep brain stimulation, it is the point of the departure for the shaping of the crossroads around deep brain stimulation. If human beings are who they are through their

engagements with the world and technology, and if there is a space in which they can configure and shape these engagements and the relation, philosophical discourse and deliberation on this space might turn out to be vitally important for the future configurations. In order to meet the practical urgency of deep brain stimulation, a postphenomenological perspective could actively focus on the development of an ethics of technology that is founded on a more thoroughly developed anthropological understanding of technological developments such as deep brain stimulation seems a promising starting point.

Whereas eliminative materialism and Clark's functionalism do not contain extensive treatments on the shaping of the practices in daily life around technological developments such as deep brain stimulation, postphenomenologist Peter-Paul Verbeek is currently working on a postphenomenological ethics of technology that explicitly deals with the question of how beings can position themselves towards the technological developments. Given the general postphenomenological understanding of the human condition as human beings with an inherently technologically mediated existence, a postphenomenological ethics of technology is then concerned with finding responsible and ethical ways of shaping this technologically mediated reality. Verbeek wants to structure and embed technological developments in practices in such a way they can contribute to the overall quality of the relationship between humans and technology, and regards Foucault's work on the good life as a possible candidate.

Within Foucault's power structures, all the participating human actors are subjectivated and disciplined by the power structure, but he mainly focuses on the subject as an individual in opposition to the power structure. By shaping one's own position, the power structure changes around the individual. However, the resulting overall effect on the power structure depends on the position of the individual and since Foucault's ethics regards the ethical project as a personal and individual form of self-shaping, Foucault seems to be concerned with the individuals that are shaping *themselves*, whereas the possible influence of these actions on *others* remains undiscussed. Consequently, it seems that Foucault's ethics is not so much concerned with the individuals that explicitly shape the power dynamics through their own personal actions and thereby not only shape themselves but also determine and configure *the other*. Since Verbeek formulates his ethical project around the question of what we want to make of ourselves, and how we can take responsibility for ourselves and deal with these new technological developments, his ethics of technology contains a communal dimension. Since Verbeek seems to focus on common form of Foucault's ethics, this type of ethics could or should be applied by the patients and doctors and the politicians and lawmakers. It stands to question whether Foucault's ethical discourse can be used in such a societal and political way, because he asymmetrically seemed to focus on the 'powerless'. In order to see how a postphenomenological ethics of technology founded on the ethics of Foucault could work out

in practice, it seems vital that Verbeek addresses this possible gap.

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