



# a current

need for continuity

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## Abstract

Throughout these last few decades, phenomenology and modern physics have slowly started to approach each other in order to bridge the gap between the subjective and objective. In this thesis I aim to show an approach done with the help of Karen Barad's *agential realism*; a quantum interpretation enabling us to better understand and analyse our complex world, as well as our perception of it.

Taking inspiration from new materialism, phenomenology and physics, I see a need to properly leave discrete dualism behind, in order to be able to describe cultural and material structures as continuous manifolds. Instead of endlessly searching for their binary and changeless parts.

Under de senaste decennierna har fenomenologin och den moderna fysiken sakta men säkert börjat närma sig varandra, för att försöka fylla gapet mellan det subjektiva och det objektiva. I den här uppsatsen vill jag visa på ett av dessa tillvägagångssätt genom att använda mig av Karen Barads *agentisk realism*; en kvantfysisk tolkning som underlättar vår förståelse och förmåga att analysera en komplex värld, samt vår perception av den.

Med inspiration från nymaterialism, fenomenologi och fysik, så ser jag ett behov att lämna en diskret dualism bakom oss, för att istället beskriva kulturella och materialistiska strukturer som en kontinuerlig mångfald. Till skillnad från det ändlösa sökandet efter deras binära och oföränderliga delar.

*the problem posed by physics approaches the problem  
of perception. The duality of the body and the field  
evokes the duality of the perceptual process*

(Merleau-Ponty, 2003, p. 97)

## **Introduction**

Math, physics and philosophy have always gone hand in hand in different ways. One such prevalent discussion is that of continuity versus discreteness, an idea creating tensions from the time of Zeno's paradoxes until today's modern theoretical physics (Hagar, 2014, p. 8). A thorough investigation into these two foundational concepts can be seen in Amit Hagar's book "Discrete or continuous?", where he delves into the history of the two ideas, asking which one can be seen as an adequate description of reality? Or is it both? Hagar also presents several different science theories promoting one or the other as the correct result, with the use of a wide range of old and new mathematical tools.

Instead of here trying to claim one or the other side, I would like to take inspiration from the tools themselves, and the fearlessness that can come with them, as there is a constant possibility of needing to go against one's instinct and previous commitments, to try new approaches and might be proven wrong. One such mathematical idea I find interesting is the concept of complexity. The number of points that connect humans and our society, both with each other and the planet, have been growing exponentially for the last few thousand years. Creating more and more complex structures. Complex not just in the meaning of being difficult, but also in the mathematical sense of having extra dimensions, and where the resulting structures express emergent properties not necessarily belonging to any of their parts. And just as in math, when trying to analyse complex systems with the wrong tools we risk getting faulty results. Especially if those tools are created for a classical view on science, and misses out on all we've learned through the experiments of modern physics. Philosophy needs to be as fearless as the modern mathematicians.

When bringing math and theoretical physics into the picture there are several different interpretations that can be considered, with different impacts on our understanding of our world. Every version comes with different quantum aspects important to their grounding. In this thesis I take the help of one of these interpretations, *agential realism*, and the trail leading to its conclusions. There are plenty of steps on the way, so I will only be able to briefly

mention some of them. I hope it will be enough for this paper, as it is easy to lose oneself in the descriptions of all the strange things we see in the quantum world. The main problem writing has been trying to find a balance between too much and too little information. If further interest on some topics is sparked, I will in a few cases in the footnotes leave a link to a visual presentation, as there always is more to learn. If I haven't left a link, many videos are just a search away. And there are, as mentioned, many different interpretations. None of them necessarily right or wrong, just different ways to interpret the philosophical impact of scientific findings, each with different strengths and weaknesses for what they want to accomplish.

Accompanying these recent advancements in quantum physics, is the development within phenomenology as a philosophy in sync with modern science. What has become the wide field of phenomenology of today can trace its origins back to Edmund Husserl tying together several earlier philosophical strands on consciousness. It became known as the subjective method of a first-person, or an a priori, perspective. As it was trying to do what the sciences at the time were struggling with: coming to grips with our perception of the world. According to Husserl, science was instead a posteriori, or only proceeding from the third-person perspective (Wiltsche & Berghofer, 2020, p. 3). Since Husserl, phenomenology has evolved along with modern science, with new traits emerging and creating a possible bridge between the subjective and the objective. Here I will mostly focus on the later ideas of Maurice Merleau-Ponty, who just before he passed away was working on similar questions to those I will discuss, that of the connection between modern physics and phenomenology. In the end, my hope is that I can show how we need to let go of the rigid system that is empiric binary logic, and instead look to a generalised continuous domain that incorporates all that is in our ever-changing world, subjective and objective.

In the first chapter I will begin by describing another important mathematical idea; *infinitesimal analysis* (calculus), and how it can be seen spread throughout many different areas of academic research. How we can break down our perception of reality into smaller and smaller pieces, to be able to analyse and compare them, and better understand the whole they come from. Using these static pieces of reality, or *snapshots* as I will call them, as grounding for our sciences has made it possible to create an unprecedented global village of trade and communication, and sent people to the moon. But as I will also try and show, with the help of Merleau-Ponty in part two, is a risk of losing the *continuous* perception of reality

by seeing these parts as the whole picture. Losing information that emerges and only exists between the snapshots. It seems like the power of calculus easily can fool us into believing that we indeed see true motion when represented as tiny rectangles, as we can do when watching a movie. When in fact it is discrete in its nature.

As a last note I want to apologise to any mathematicians or physicists for the many simplifications throughout the text. The idea is to use grounding concepts we learnt from math and physics, to help understand how other branches of academia might benefit from the same. My hope is that I haven't distorted the facts too much.

## Part 1

When I started studying mathematics, one of the first things we learnt was the importance of generality. Simply put, for a proof to be a proof it needs to have the ability to be generally applied to anything you need it for; be it construction, virus counts or measuring spacetime. This was the magic of mathematics, its universality, making it possible to find truths in every corner of our existence within this equal, properly defined, mathematical and logical formalism. That was until we started to hit some obstacles with some relatively recent scientific findings. But before we dive into that I believe it to be important with a short discussion on an important mathematical and philosophical issue that I feel is relevant in leading us to where we are today. The idea of infinitesimals.

### Infinitesimal analysis

Going back 2500 years to the ancient philosophers of the Mediterranean, this idea of breaking up reality into tiny pieces was already a hotly debated issue (Glattfelder, 2019, p. 160). Not only with the concept of atoms, but mathematicians at the time had begun to discover and create the existence of things like irrational numbers, something that sort of ruined an imagined perfect world of only the rational whole numbers. When beginning to try and understand these broken up parts of the whole and how they are part of our ontology, along came Zeno with their paradoxes of plurality and motion. The claim was that when perceiving our world, or a phenomenon like motion, as being cut up into snapshots of every position (like how a film sequence is only the combination of many photos after each other), that this claim would create an ontological paradox. Achilles would never catch up with the tortoise and the arrow would always be frozen in space (Huggett, 2019). We needed instead to adhere to the idea of the continuous whole to be able to explain our everyday perception of reality; as everyone can see that motion surely is a real thing. The arrow does indeed reach its target. To stay away from this seemingly obvious paradox, the next couple of millennia European scholars were dominated by the continuous. That is until scientists such as Galileo started to bring back techniques used by Euclid and Archimedes, followed by *calculus of the infinitesimals* appearing in several places, changing the whole future of mathematics (Glattfelder, 2019, p. 163).

Most of our insights into modern physics started from this seemingly simple act of calculus: disassembling difficult-to-analyse geometrical shapes, represented in figure 1 as the area between the red line and x-axis, into the smallest rectangles possible. By doing this we produce a similar enough version of the shape created by the red line, one that is also possible for us to analyse objectively (Sanderson, 2017). These shapes (systems/functions) can correspond to everything from the velocity of a car or the growth rate of bacteria to the social structures of humanity. All corresponding shapes can be broken down into easier-to-analyse geometrical parts, creating the best matching representation possible with smaller and smaller rectangles (as in figure 1), until they become infinitely small and almost perfectly match the original shape. Giving us a good enough approximation of the whole. The creation of calculus made it possible to analyse our world in ways that seemed impossible before.

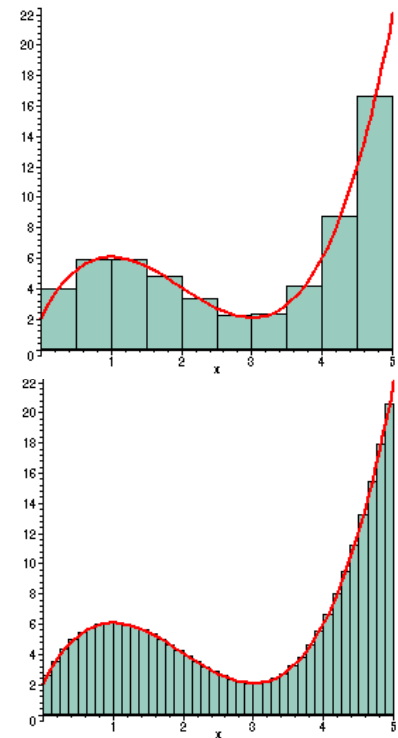


Figure 1

Besides mathematics, I see these smaller and smaller steps of the infinitesimal appear everywhere in our perception of the world around us. To better understand our culture and society we often try to divide an idea into smaller and more detailed parts, comparing them to other parts to be able to make a judgement of the whole therefrom. Take the concept of change as an example, something that is mostly shown in temporal steps: from one point towards another, jumping along the different boxes on the board game of life, slowly adding up into something that can be seen as a whole. One step to the next; one year, day, hour or one second to the next. And just like a classical particle of matter, every piece is seen as discrete in its nature: no two entities can exist in the same space at the same time. Every step becoming a smaller and smaller part of what takes the shape of a whole life. Forcing us to separate our perception into discrete pieces like this brings with it an idea that all things are in fact just impossibly tiny lego pieces, stacked onto each other within a void. An idea that we could call atomistic, or discrete. An idea prevalent in most of our society.

Calculus being something discrete is not a common viewpoint. On the contrary, it is often seen as continuous (Hagar, 2014, p. 7), but this is because it is only seen together with the systems it is used upon. We use calculus to analyse continuous systems, or functions, yes.



But the tool itself is based on discrete steps, only ever approximating the continuous function it imitates. And it might not be capturing the whole picture that is movement and change. As I will show with the help of agential realism, the infinitesimal might be the only objective possibility for us to measure our world (Ryckman, 2020, p. 180). But capturing reality in frozen snapshots can also be seen as a paradox in itself (Merleau-Ponty, 1964, p. 185). With the risk of losing information that are in between the discrete steps. Something I will discuss more in the second part of this essay.

Coming back to the science side of it all, the first really exciting hurdle towards understanding our world in universally discrete pieces came in the 1800s, when there was an experiment that gave thrilling results. Following the European scientific revolution, the ideas of a scientific logic were pretty rigorous: with enough scientific research we would always be able to find the 'true state' about everything; an absolute universal science was there waiting to be found through objective experiments in what we call empiricism. But that, I would say, started to change with the *double slit experiment*. In simple terms, the experiment was meant to tell us if light behaves like a wave or a particle; the two, supposedly, separate intrinsic states of our universe. Instead we found out that not only light, but also matter, could be seen as both waves and particles at the same time. A result causing a lot of confusion, as how is it possible for anything to be these two fundamental things at once?<sup>1</sup> This was, I would say, the first experimental result that started showing the cracks of the objectivism that had been so dominating. Slowly over the course of the next century, the new fields of quantum and relativistic physics started emerging, showing increasingly significant differences from the logic of the newtonian and cartesian inspired physics that came before.

### **Quantum interpretation**

If we for a moment focus on the quantum side of things we can find many different interpretations on what the experimental results from modern physics actually tells us, and what they mean for an understanding of our being; questions of ontology. Questions like what are the fundamentals of our existence, both in a physical and metaphysical sense? Physical as in can we explain the most general features of what there is and how everything relates to each other? And the meta-physical question of how we interpret both the question

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<sup>1</sup> This experiment and its results could fill several papers like this. A visual representation can make it a lot easier to understand its significance. Jim Al-Khalili does a great job here: <https://youtu.be/A9tKncAdlHQ>

and the possible answer (Hofweber, 2021). This idea of modernising our ontology within the framework of quantum (and relativistic) physics has been around since its beginning in the early 1900s. Niels Bohr and Erwin Schrödinger were two of the earliest science philosophers describing an idea to bring the mathematical results of modern physics into the realm of philosophical thought about our being. For example trying to translate the notion of a system that can be at two (or all its possible) states at once into less abstract imagery. The most famous paraphrase of this is that of Schrödinger's cat: if we can't observe the boxed cat as being alive or dead then the cat could be seen as existing in both states at the same time. For Schrödinger this was an example of the absurdity that he thought could be seen in the *Copenhagen interpretation* of quantum physics. An interpretation that seems to inspire many different meanings, as can be seen in the entry on the subject to Stanford Encyclopedia of Philosophy by Jan Faye (Faye, 2019). His article focuses mostly on the actual writings of Niels Bohr, as well as Faye's own research, stating that there are a lot of misunderstandings regarding the interpretation, and that Bohr never lost faith in the foundation of classical particles, whatever the results of the Copenhagen interpretation are (ibid.). If we instead look to other sources, such as the director of the Niels Bohr archive Finn Aaserud's entry in the encyclopedia Britannica, we can see a different version of the Copenhagen interpretation (Aaserud, 2009). Aaserud writes that several people, such as Werner Heisenberg, also influenced and evolved the interpretation to take in new accounts and discoveries that have been made. The common theme being the *complimentary principle*; stating that "on the atomic level a physical phenomenon expresses itself differently depending on the experimental setup used to observe it. Thus, light appears sometimes as waves and sometimes as particles. For a complete explanation, both aspects, which according to classical physics are contradictory, need to be taken into account" (ibid.). In a way telling us that things can indeed be regarded as being in two different states at the same time. And what that would mean in a metaphysical sense is what I believe to be the interesting part of the Copenhagen interpretation.

The question of Schrödinger's cat shows the irrationality of things in a thought experiment that still is being discussed today, where many variations have been made to try and remove the absurdity and instead show how quantum findings really do affect the way we see and approach the macro world we perceive. It is not a question about whether the cat knows if it is alive or dead, it is instead about how we, as observers, analyse and understand our world (French, 2020, pp. 207-208). If there are things that can exist in every possible state until we

observe them, how do we then know that there exists a universally objective state that always can be referenced? According to agential realism we can take neither the subjects nor the objects of knowledge practices for granted (Barad, 2007, p. 27). Can this help us in the metaphysical discussion within philosophy?

These past few decades many academic fields have tried to incorporate different quantum interpretations into a range of social and artistic areas of academia. Trying to understand new concepts such as uncertainty and entanglement brings with it ideas that goes against much of the logic of for instance the cartesian and newtonian models we are mostly grounded in. The smallest units we can measure and observe nowadays are not things that obey the logic we are accustomed to (Schaffer & Lemos, 2021, p. 7). In their article “Obliterating Thingness: An Introduction to the “What” and the “So What” of Quantum Physics”, physicists Kathryn Schaffer and Gabriela Barreto Lemos try to bridge this gap between our grasp of the world in a classical sense of individual things and their relations, and how that differs after adding our new quantum understandings.

When writing about a quantum approach to ontology there is always the decision on how much of a physics introduction is needed. Schaffer and Lemos leave out most of the thought experiments commonly brought up, such as the double slit experiment or entanglement, leaving the reader to look these up themselves if needed. I mostly agree with this, as it is important to remember that there is far from only one way to interpret the mathematical and experimental results we call quantum physics. These results that seem to be breaking some of the classical laws of physics has got everyone scratching their heads, trying to come up with explanations on why and how entities behave the way they do in their tiniest states. I will still briefly discuss the concepts of entanglement and quantum field theory, as they are both important parts of agential realism.

A main difference we see between modern and classical physics, is that in the latter you only know the state of a system when knowing its individual parts. These parts can be its mass, velocity, position, size, time reference and so on. So knowing the state of a classical system entails knowing its parts. In quantum physics however we can have knowledge about a composite system, while the individual properties of its parts are undefined and we only know the statistical probability of a particles properties (such as what we call momentum or position). In other words; we can know the *entangled* state between the parts without knowing the individual state of the parts. Quantum entanglement, in very simple terms, have furthermore two interesting observations. First it is the connection over distance, that we can

know the state of the entangled particle's system even if the parts are separated by light years. Secondly it is the constant connection, the entangled particles have an iterating and constant connection between them, *instantly* 'knowing' the other's 'behaviour'<sup>2</sup>. What is really confusing here is the part of knowing; how the particles instantly communicate with each other. Doing so breaks the discreteness and ordering of time, in a similar fashion as in the relativistic physics where time is relative<sup>3</sup>. This is because the quantum particle world has in some ways strict relations to account for, a minimum and maximum energy level one can say. And at the moment we can't see how it would even be possible to send information faster than the speed of light. But results show that the particles 'talk' to each other instantly, knowing each other's states before the light waves of information have time to reach them. They seem to be permanently connected through something else, like the void in-between them, or as some call it, the *quantum field*. Quantum field theory (QFT) differs from quantum physics in that the latter is about the single discrete particle and what we can learn from these individual pieces of universe, while the former is about the universal field where those pieces are part of. All material and non-material entities in the universe can be seen as produced by an *oscillation* within a quantum field (Glattfelder, 2019, p. 350), in contrast to the previous common idea of an empty void in between the smallest pre-existing entities (as with classical atomism). Quantum fields can be seen as both our mutual embodiment through entanglement, as well as what creates actual matter. A universal connection helping us move into some of the newer ideas going around nowadays.

Several different philosophical aspects of quantum interpretations are often nowadays categorised as *new materialism*. In their introduction to the subject authors Gamble, Hanan and Nail bring us from the atomism of the ancient philosophers through to the materialistic discourse of our modern day. (Gamble, Hanan, & Nail, 2019, p. 116). Before arriving at what we today call new materialism, we can both in physics and philosophy still see a clinging to the idea of a uniqueness of humanity; our rational minds and perception, as well as our culture and performative language. What is “new”, according to Gamble, Hanan and Nail, is problematising “human exceptionalism at every level” (Gamble, Hanan, & Nail, 2019, p.

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<sup>2</sup> I am using an anthropomorphic language as it can be easier to comprehend. It is important to remember though that this is very oversimplified and can be problematic, especially when discussing other areas connected to quantum interpretations, such as consciousness and intelligence.

<sup>3</sup> This visual representation, in the form of a unique machine, really helps with getting a grip on the relativity of time and motion: <https://youtu.be/Rh0pYtQG5wI>

118). Trying to analyse without any preconceptions gives us a possibility to view the whole of our being in new ways. And to show why this is important is my reason for bringing together phenomenology and agential realism. This is something that has been done before, but only for special cases (Zavota, 2018). But as with a mathematical proof I would like to instead see agential realism as a generalisation, one that gives us tools able to analyse any new entity that we encounter. Something that I think is needed today where we constantly have new extreme and complex global systems acting on each other through for instance politics, consumption or social media. Or all three at once.

Agential realism comes from decades of Barad's intensive work, both as a particle physicist and working on Niels Bohr's science philosophy. Barad expands on Bohr's idea of the intrinsic role of the observer to not just lie within the realm of human action, and that entities never determinately exist apart from the observer; but that all entities instead are indeterminate and un-separable from the observer, whatever they might be (Gamble, Hanan, & Nail, 2019, p. 122). This new interpretation that is agential realism sets the activity of observation on equal grounds with the observer and the observed. An interaction that can be seen as fundamental as we are always interacting with our environment. We are always observing and being observed, or to make it simpler, we are always just being. Because existing as a conscious being means constantly interacting with our world and its particles; breathing, perceiving, feeling, moving, observing, knowing. Establishing an intrinsic connection between the metaphysical discussions on being (ontology) and knowing (epistemology), forming what Barad calls *onto-epistemology*; a "reality in which observations never simply "disclose preexisting values" or properties but, in fact, also always play a role in constituting them" (ibid.). This idea of an onto-epistemology is still new and viewed with somewhat scepticism, as even most strands within new materialism still see these two concepts of knowing and being as a separate duality. However, maybe it is only by leaving that constructed duality behind us that we can reach a true *performative* new materialism. "No property of any discernible thing, that is – whether its physical features, agency, or even its speech or thought – entirely precedes or remains unchanged by its actions or encounters with other things" (ibid. pp. 122-123).

But I am getting ahead of myself. To properly discuss agential realism I will go back a few steps, starting with performativity and how it has influenced several strands of modern philosophy<sup>4</sup>.

### **Performative research**

Many decades ago, language philosopher J.L Austin theorised an idea of speech acts, or performative utterances as they were also called. An act that we could differentiate from the then common idea of binary logic; an empirical concept of being able to break a language down to its smallest underlying semantic parts, and there being able to deduct a truth or false statement. From these binary statements the logical suggestion was that we would be able to additively build fundamental knowledge, from the bottom up so to speak. Instead Austin formalised a type of language that did not fit this mould;

though they may take the form of a typical indicative sentence, performative sentences are not used to describe (or "constate") and are thus not true or false; they have no truth-value. Second, to utter one of these sentences in appropriate circumstances is not just to 'say' something, but rather to perform a certain kind of action. (Austin, 1975)

Several people continued to work with the more continuous act of performativity, and the effect it could have on language and culture, especially Judith Butler in their 1990 book *Gender Trouble: Feminism and the Subversion of Identity*. Butler wrote that identities such as gender couldn't always be constrained within the binary logic of being a static either-or. Instead we could almost see gender as having agency on its own.

gender proves to be performative - that is, constituting the identity it is purported to be. In this sense, gender is always a doing, though not a doing by a subject who might be said to pre-exist the deed (Butler, 1990, p. 34)

Together with Butler, Barad sees similar influence from social constructivist Michel Foucault, who discussed the performative effect of power and knowledge on society. What they also both have in common though, is how agency is still solely in the land of human activity. "That is, both accounts honour the nature-culture binary" (Barad, 2007, pp. 145-

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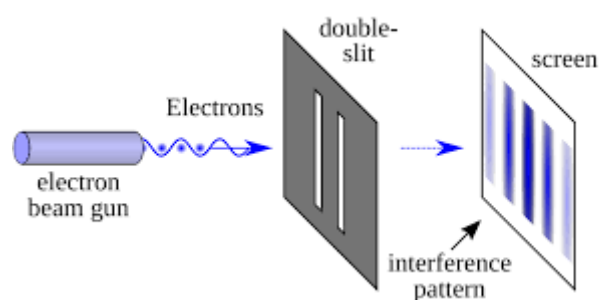
<sup>4</sup> My bachelor thesis was an introduction to agential realism, I have in the following sections reused certain elements from that paper (Svensson, 2021)

146). Barad is critical that so much power has been given to language and culture this past century. This is not because they think it is wrong to give power to our culture and language, but instead that we tend to then miss the power that is the material world. As matter is often seen as “passive and immutable” (Barad, 2007, p. 132).

In contrast to these human centred ideas we see how the Copenhagen interpretation instead, in a way, supplies agency to the actual measurement device. The uncertainty that underlies this quantum interpretation tells us that we can get different results depending on the way we observe and measure. An interaction between the measurement device and the entity measured is performative in itself, creating a certain kind of action, as Austin put it. This uncertainty is a fundamental idea, that is not part of either human action or culture.

While Foucault’s genealogical analysis focuses on the production of human bodies, to the exclusion of nonhuman bodies whose constitution he takes for granted, Bohr is attentive to the production of nonhuman phenomena and takes for granted the prior existence of a human observer. (Barad, 2007, p. 169)

A contrast to performative research can be seen as representationalism, in where we would merely reflect on our world as if it was a mirror (Barad, 2007, p. 133). An idea where we observe a replica of our world by watching from the outside, in a true empirical fashion. Instead Barad uses *diffraction* as a more well-suited metaphor for the role of observation and its entanglement with the quantum world. Diffraction is seen as the fundamental way for waves to behave when they meet, be they fluid or light, and become entangled in each other, becoming one. An example of this is again the double slit experiment, where the procedure is to send separate photons or particles of matter (like electrons) through parallel slits. On the other side of the slits the particles interact, become entangled through diffraction and create interference<sup>5</sup> patterns. Classical physics say that only waves can produce diffraction patterns, while physical matter instead has the state of discrete particles, with the intrinsic property of not being able to occupy the same space at the same time (Barad, 2007, p. 81). But the double slit experiment tells us that particles of matter do indeed,



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<sup>5</sup> There is some discussion in the science community about the difference between interference and diffraction. Barad views them as interchangeable, as will I.

under the right circumstances, show diffraction when meeting on the other side. Matter and non-matter alike becoming, in the words of agential realism, entangled with itself and others through simple performative interaction. Or *intra-action*, as I will explain in this next section

### Phenomena

When Democritus and Leucippus discussed ontology so long ago they described it as being represented by individual atoms situated within an infinite void. Only statically reacting to the presence of each other when meeting in the nothingness. Nowadays we have several interpretations on what this void can be, and plenty more forgotten, with quantum field theory being the one in focus here. If we take all human and non-human parts, every entity from electrons to culture, into the same field; then they all become one single system acting on itself. Without any need for void. Interaction presumes the presence of different systems acting on each-other, while *intra-action* tells us that they all part of the same underlying field. Or phenomena as Barad calls it.

the primary ontological unit is not independent objects with independently determinate boundaries and properties but rather what Bohr terms ‘phenomena’.  
(Barad, 2007, p. 33)

Phenomena is in constant fluctuation, always changing depending on the intra-actions within. When we intra-act and perceive with our surrounding we are part of an ever-ongoing circle of apparatuses. Observer, observation and observed, each their own apparatus, form together an entangled apparatus of measurement. And every apparatus of measurement must itself be possible to be measured by another apparatus of measurement, and so on<sup>6</sup>. Perceiving this act of measurement can in a sense fixate the boundary of the apparatus, creating a possibility for an objective view from a certain perspective. This *rigidification* of apparatuses is something I will come back to in the next chapter on phenomenology. But for now we see phenomena and apparatuses as fundamentally continuous, connected and constantly changing.

For us to be able to perceive our surrounding we need to, as mentioned, be able to form a new apparatus of measurement, as we are also phenomena, part of the world-body in its ongoing

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<sup>6</sup> A theory on why we are having trouble finding a quantum theory of relativity is that there is nothing to measure the whole cosmos, nothing that can observe phenomena itself in order to create a new apparatus of measurement (Barad, 2007, p. 349).



dynamic structuration of boundaries (Barad, 2007, p. 172). Every intra-action is a perceptual measurement, and every measurement is an apparatus. From electrons to culture.

### **Agential cuts**

Agency was formerly seen as only belonging to humans (who also happened to be seen as the only conscious entity in the world), but as with performativity, agency is also spreading towards other categories; animals, culture, history, power, computers making measurements and more. But as soon as we start to try and list something like this it can seem like a daunting task to create a truly satisfying record that includes everything. What agential realism instead tries to do is to shift our idea of agency from being an attribute belonging to an individual entity, to instead see it as the actual intra-action between entities. Agency is doing, and agential cuts are what create the boundaries of our apparatus. When we do - we cut. The cutting of phenomena creates an apparatus of measurement, blurring the usual human/nature separation.

To try and show this diffusion of a commonly static border, Barad takes the help of Lisa Diedrich's article "Breaking down: a phenomenology of disability", based on Nancy Mairs's autobiography and her relationship with the compact electric wheelchair Quicky P100.

[Quickie P100] is not only an extension of her body or "a bodily auxiliary," as Merleau-Ponty calls a blind person's cane, but has become incorporated, made part of her body – so much so that when the Quickie P100 breaks down, it is the breakdown not simply of an instrument employed by the body but of Mairs's very self. According to Mairs, "the wheelchair I experience is not 'out there' for me to observe, any more than the rest of my body, and I'm invariably shocked at the sight of myself hunched in its black framework of aluminum and plastic". In her Quickie P100, Mairs is at one and the same time positioned and situated in the world (Diedrich, 2001, pp. 218-219)

Being fully dependent on something like a custom-made wheelchair creates a bond I think most people would have difficulty to understand. Mairs participation in this world is not really viable without it. The chair is part of her embodiment, intrinsic to her life<sup>7</sup>. And not

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<sup>7</sup> As this story tells us, it truly can be a life-or-death matter:  
<https://www.forbes.com/sites/lakenbrooks/2021/11/08/disability-advocate-engracia-figueroa-died-after-an-airline-damaged-her-wheelchair/>

just being part of her physical self, Mairs' wheelchair is part of her perception of the world, part of her knowledge-gathering. Mairs' experience of perceiving the world is in the embodiment that is both her and Quickie P100. Not only her own world, Mairs also gets a unique insight into the world of the upright, as her existence is outside this 'normal'.

"I am literally diminished by my disability," Mairs writes, "reduced to a height of about 4'8", consigned to gazing at navels (generally shrouded) other than my own. But diminution is not the whole of it. 'Waist-high' also resonates with 'knee-deep.' This is no piteously deprived state I'm in down here but a rich, complicated, and utterly absorbing process of immersion in whatever the world has to offer" (Diedrich, 2001, p. 218).

All of Mairs' embodiment and apparatus are again intra-actions of the phenomena; oscillations in the field. Creating a foundation where we can't differentiate between the human and the nonhuman, or between nature and culture (Barad, 2011, p. 124). The complexity of the apparatus that is Mairs is instead what becomes in focus. Its level of intricacy results in an apparatus' ability to mark other apparatuses, generating *marks of measurement* as Barad calls it. In every intra-action, the apparatuses involved leaves marks on each other. The more intricate and complex the apparatus is, the bigger the mark it leaves. In a sense this can be seen "as part of the universe making itself intelligible to another part in its ongoing differentiating intelligibility and materialization" (Barad, 2007, p. 176).

Either way, what is important about causal intra-actions is that "marks are left on bodies": bodies differentially materialize as particular patterns of the world as a result of the specific cuts and reconfigurings that are enacted. Cause and effect emerge through intra-actions. Agential intra-actions are causal enactments (ibid.)

Agential cuts are what enact agency, with the cuts themselves not being enacted from the outside; it is in the intra-action between apparatuses that the cuts appear. This way, agency and causality no longer can be seen as it usually does, in a binary fashion going from one individual entity to the next. If we take Bohr's scientific philosophy seriously, we need to rethink the foundation that causation lies upon (Barad, 2007, p. 23). We most importantly need to rethink our idea of responsibility.

A concern that often comes up in critiques against agential realism is that of responsibility, such as in Andreas Malm's book *The progress of this storm - nature and society in a warming world*. In a section dedicated to new materialism, and in some matter Karen Barad,

Malm sees the possibility of a shift in agency as a troubling concern when considering blame and responsibility.

a theory that partitions agency so that unintended consequences are seen as the outcome of some material actant is also a theory that evacuates the world of recklessness, improvidence, liability, responsibility and a whole range of other moral parameters. The parents of the dead infant would be asked to vent their anger on the wind (Malm, 2018, p. 95)

This discussion of responsibility is a very important one, and not something that will fit in a thesis like this. What I do want to say is that I see Malm still clinging to the idea of causality and agency as binary. That we always should be able to backwards trace the cause, and consequently fault, in a simple line from one individual to another. But the complexity involved in real causation chains is beyond this simple binary model. If there is a need to identify a culprit we need to, and are able to, identify the more intricate apparatuses leaving more impactful marks. And in the case of the dead infant, it most certainly is not the wind that would be seen as responsible. There are no fundamental individual things that possess agency and can be single-handedly blamed, or praised. No one acts on their own.

the primary ontological units are not “things” but phenomena ... And the primary semantic units are not “words” but material-discursive practices through which (ontic and semantic) boundaries are constituted. This dynamism is agency. Agency is not an attribute but the ongoing reconfigurings of the world (Barad, 2007, p. 141)

Agency cannot be designated as an attribute of subjects or objects as these categories do not pre-exist as such; they are all an entangled part of the phenomena (Barad, 2007, p. 178). Agential cuts create boundaries that become apparatuses, simultaneously causing both exclusion and inclusion, making it possible for us to observe and measure. The boundaries created by intra-action is what makes it possible for us to objectively measure the snapshots we take. Telling us what is part of the apparatus and what is not.

Within the creation of apparatuses there is no difference between inaction or action (this can instead be expressed as in/action). Whatever we do or don't do, we still mark the apparatuses we constantly intra-act with. If I vote or don't vote, buy fair-trade products or not, or never leave the house; it all leaves marks either way. It is impossible to not be a part of the becoming of the world. We are not the ones re/enacting the cuts and creation, agency is the

cut itself, but we are still a deeply involved part of that agential cut. “We are responsible for the cuts we help enact not because we do the choosing ... but because we are an agential part of the material becoming of the universe” (Barad, 2007, p. 178). So our responsibility is only limited to what we choose it to be limited too, as we are always part of the becoming of our entire world. In one way we are responsible for everything our apparatus intra-acts with. As my existence and identity is dependent on intra-actions. I see Mairs and Quickie P100 in a certain way because I see myself in a certain way. My own body and its presumed able-ness is not an idea of universal normalcy. We have instead built our society around an idea of a specific embodiment. Something I will get back to in the end discussion, as there are a lot of perspectives to shift before that.

Luckily this next chapter is about phenomenology, an idea that has been around for much longer than agential realism. Phenomenology has tried to understand the subjective through several new models and methods. Trying to open our horizons, as Husserl might've put it. With the help of his successor Merleau-Ponty, I will try to show how the more well-known ideas of phenomenology can help us to see what agential realism is trying to achieve.

## Part 2

### Phenomenology and the quantum world

To help us on this path towards phenomenology and science philosophy, I'll be referencing several segments from the book *Phenomenological Approaches to Physics* by editors Harald Wiltsche and Philipp Berghofer. The first chapter is an introduction to the subject written by the editor pair; discussing among other things Husserl, Heidegger and Merleau-Ponty's different views on science. In a later chapter Marcel Bitbol writes about the possibility of a big shift in our mutual understanding of knowledge, with the help of a rapid succession of new quantum interpretations. In his article there is a search for a participatory realism that neither interprets nor pragmatizes the ontology of quantum physics (Bitbol, 2020). Thomas Ryckman writes a technical piece about the gauge principle (Ryckman, 2020), an interesting concept I won't have time to explain here unfortunately<sup>8</sup>, but the article also discusses a couple of important concepts about infinitesimals and coordinate systems that I think are pertinent. Last from the collection is Steven French's article on how a phenomenological approach might benefit from recent quantum interpretations (French, 2020). Before heading into those though, I will begin with a more general article by Komarine Romdenh-Romluc, author of the *Routledge Guide Book to Merleau-Ponty and the Phenomenology of Perception*. Their article "Science in Merleau-Ponty's Phenomenology" holds a "provocative and interesting line of thought" (Romdenh-Romluc, 2018, p. 342), in which phenomenology and science are brought together, even though they seem to be investigating different things using different methods; one subjective and one objective.

when viewed at a certain level of generality, *what* it is they are discovering and *how* they are doing so, is the same. Moreover, Merleau-Ponty holds that the different concepts they employ and the different object they investigate are not essential differences between science and phenomenology. Let us say, therefore, that for Merleau-Ponty, science and phenomenology are "continuous" (ibid.)

At this level of generality we are no longer only problematising human exceptionalism at every level in order to avoid duality, as I wrote in the last part. We need to put all kinds of dualism aside, and search for what Merleau-Ponty, following Husserl, would call *the essence*: our world's essential structures, "meaningful forms taken by the experience of the world, and are inseparable from it" (Romdenh-Romluc, 2018, p. 351). Forms constantly intra-connecting

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<sup>8</sup> See this Wikipedia article for more information: [https://en.wikipedia.org/wiki/Introduction\\_to\\_gauge\\_theory](https://en.wikipedia.org/wiki/Introduction_to_gauge_theory)

with experience, always changing and impossible to be universally objective. As Merleau-Ponty also writes in his lectures published as *The World of Perception*:

physics of relativity confirms that absolute and final objectivity is a mere dream by showing *how each particular observation is strictly linked to the location of observer and cannot be abstracted from this particular situation; it also rejects the notion of an absolute observer* (Merleau-Ponty, 2004, as quoted in Romdenh-Romluc, 2018, p.344).

I think this rejection of the absolute observer can be seen already in the later Husserl. He was critical of the idea that the world could be assessed solely through objectivism; a debatable idea he traced back to Galileo Galilei. Husserl saw this notion of empirical universality as a problematic mathematisation of the sciences (Wiltsche & Berghofer, 2020, p. 21).

A mathematisation of the world can be represented as a coordinate system, with an endless amount of variables. A rigid and static system, like a snapshot of reality. The idea of a universal rigidification though, clashes with the findings of Einstein in his theory of relativity, where the math actually shows us it is impossible to be universally objective about time, for instance. A phenomena we usually see as rigid and universal, is instead being proven to be relative. Meaning that time is experienced differently on a fundamental level depending on the observers position and momentum. The only way to be (locally) objective about (space)time according to relativity is when we have decidedly strictly linked and rigidified the location of the observer within the system they are observing, something that can be done with a spacetime coordinate system<sup>9</sup>.

So through rigidification we can actually include an objective observer, as it is brought into the symbolic structure of math through the axes of the coordinate system that both “determine the physicist’s orientation in space” and their “zero point of orientation” (Wiltsche & Berghofer, 2020, p. 37). This was the idea of mathematician Hermann Weyl, an idea also discussed by Husserl (ibid.). Because even though *absolute* and *final* objectivity seems like a dream, as Merleau-Ponty claims, I believe it to be important to note that we do have this ability to be ‘locally’ objective with the act of observation through rigidification and determining a zero point of orientation. Or taking a snapshot. We can analyse the apparatuses created within the phenomena by simply observing them, becoming part of the measuring apparatus that is formed between us. My subjective creating a decipherable snapshot by

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<sup>9</sup> See foot note 3

setting it into a coordinate system with me as the zero point. A point from where I can observe and compare.

For me it is easier to see this if we regard the zero-point mentioned as the actual centre of a coordinate system, the coordinates  $(\mathbf{0},\mathbf{0})$ <sup>10</sup>. The zero point of orientation in a mathematical coordinate system. As I've mentioned earlier we can use the coordinate system to analyse almost anything we want, and get good enough results. This is how we've sent rockets to the moon and built skyscrapers. But to get results we always need to determine or identify the centre; the origin of the coordinate system, as expressed in the point (0,0). Whenever we make a comparison, transformation or analysis; we need to refer to the origin in order for us to get results we can use. And I don't think it especially provocative to claim that this point does not actually exist. Neither science nor phenomenology claims that there is an actual centre of origin for everything to which we always can make references. There is instead a continuity, or even fluidity, to our world and its essence, where a single universal point of origin would be paradoxical.

Nowadays there are mathematical tools that work on systems without any zero-points, in a way that calculus can't<sup>11</sup>. Ryckman hints on this in his discussion of Weyl's mathematical ideas and suggests that other mathematical resources might be needed when seeing this rigid system as a continuous manifold (Ryckman, 2020, p. 184). The objective tools we have in for instance logic and analysis can work great on local binary systems, but if we want to describe apparatuses as complex whole structures, it seems like we might need other tools than the infinitesimal ones usually applied today. "The injunction to comprehend the world from "its behavior in the infinitely small" is a recurrent theme running through Weyl's writings" (ibid.)

Ryckman goes on to introduce Weyl's concept of *symbolic construction*. He describes the idealism of classical science telling us that its objectivity is not given, but constructed; "and that it cannot be constructed absolutely but only in relation to an arbitrarily assumed coordinate system, and in mere symbols" (Weyl, 1927, as quoted in Ryckman, 2020, p. 184). The objectivity that is analysis is grounded in an idea of the infinitesimal as an

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<sup>10</sup> Or depending on the number of dimensions you have:  $(0_1, 0_2, \dots, 0_n)$

<sup>11</sup> Mathematical topology is, I think, a great inspiration for the discussion of new analytical tools, but that is a topic for another paper. To see some other very interesting uses for topology I recommend this mini symposium: <https://youtu.be/1kQMIRVv6R4>

epistemological mandate for an understanding of our world. We comprehend the changes in life "as arising through infinitesimal increments acting in sequence" (Ryckman, 2020, p. 182). And according to Barad, when analysing these changes through the infinitesimals, we are at the same time part of the creation of the apparatus of observation we are analysing. Space (x) and time (y), that actually are relativistic, becomes this rigid sequence, a coordinate system of two axis (x,y), in order for us to be able to fully observe and understand our surrounding. Our perception is rigidified in the system of coordinates that is the sequence of spacetime from our own perspective, with ourselves as the zero-point. Even though we are able to successfully use time as a successful objective tool doesn't mean that this is how time is, or should be, universally represented. For quantum physics time is perceived as an absolute and constant thing, but in the relativistic version time is very much relative and not bound to any specific sequence. Relative time appears different depending on where you are and how you are moving in relation to others. So we know that its quantum counterpart, the discrete particle formalism, does not apply universally.

it becomes clear that quantum theories are not to be understood as an indirect representation of some reality beyond the phenomenal level of experimental information, but as a direct expression of some in-principle bounds of the availability of this information (Bitbol, 2020, p. 230)

As Bitbol says, there is no universal 'truth' to be found in the world of quantum physics. But there are still lessons to be learned, just as there are many lessons within classical and relativistic science as well. The choice of focusing on quantum physics in this paper is not individually mine, it is just what is available to me at this moment, what people before me have made of things. When Einstein, Newton, Bohr and the rest started experimenting with new theories they did not see themselves as inventing new kinds of physics. The categories of classical, quantum and relativistic have instead emerged out of what was only seen as physics, that came from what was seen as science, and so on. It was just a natural progression, part of the fluid motion of humanity. And none of them were alone in their ideas, as it is always the culmination of all that came before, often just symbolically represented in one person. Instead we could see it as our common human apparatus, making achievements and progress as a whole, a manifold of individuals creating a new apparatus. As we are all dependent on each other to succeed, both in an ontological and an epistemological



sense<sup>12</sup>. I believe it hinders us when we often see these instances as an individual and discrete breakthrough. Our need for separating and categorising seeping deep into our culture and knowledge. As can be seen with the question if phenomenology is contained within a realist or anti-realist world view, one that often appears in science philosophy (Wiltsche & Berghofer, 2020, p. 24). This is also a common question for physicists, Barad writing that Einstein is often seen as the realist and Bohr as the anti-realist (Barad, 2007, p. 317). But what do these questions bring to a discussion on generality and universality?

French writes that the interpretations of quantum physics do "not fit neatly into the space defined by the axes of the realism-antirealism debate" (French, 2020, p. 217), reminding us of the rigid axes in a coordinate system that is local objectivity. Neither does phenomenology for that matter, as French takes "the more widely accepted stance that phenomenology sits askew both (traditional) idealism and current forms of realism and anti-realism" (ibid.). Not even Bohr himself seems to have wanted to be identified as either one or the other; instead we only see later philosophers attaching both a realist and an anti-realist label to him (Faye, 2019). The whole idea of needing to label science becomes somewhat confusing for me when no one seems to be able to fully agree on what the labels are doing. This is of course a discussion that would not fit in this thesis, and in some sense I can't really see the need for it. Simply put, going back to the 70's, Putnam, Boyd and others described scientific realism as an idea of an asymptotical convergent truth lying at the end of all scientific trails (Liston, 2022). But when we stop regarding truth as final, static and universal; it's mostly semantics to me. Sometimes excellent and intelligent semantics indeed, but unnecessary when trying to understand the whole. Theory of relativity tells us that the 'truth' of time changes depending on the perspective of the observer; on the spacetime coordinate system. And objectivity, much like spacetime, can be seen as a construct on its own, in its own locally rigid system. Where the matter of objectivity changes depending on the zero point of its system, depending on the observer.

Realism is not an all-or-nothing affair. Furthermore, "objectivity" is not a monolithic notion. "Objectivity" has a history, and there are often multiple extant meanings at any given time (...) there is an important sense in which the entire realism versus antirealism debate is a red herring. Traditional conceptions of both

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<sup>12</sup> It is not only my knowledge that is dependent on others. My being is dependent on global trade, political and production structures and chains, and so on, making sure all my basic needs are satisfied to be able to research and write this paper. An enormous and complex manifold of seemingly endless points.

views are premised on representationalism. Significantly, quantum mechanics challenges the premises of representationalism. (Barad, 2007, p. 318)

I will come back to the idea of scientific realism later, but for now I'll stay with the more general idea of objectivity. In this quantum world even objectivity that comes with rigidification can become problematic in some senses. Yes we can be objective, Barad says, but we always need to understand what that objectivity brings with it, as it is not created in a vacuum. As everything else in existence it has been formed and shaped by other apparatuses, creating marks on its existence that needs to be taken into account. Bitbol talks about this problematic history in the sense of a western cultural obstacle: a "contract" we as a civilisation struck both with the scientific revolution of the late 1500s, as well as with the ancient Greeks, "which has made it an obligation to look for a principle of understanding superficial appearances in the inmost depths of things (Schrödinger, 1954), and to seek there the *changeless source* of any change" (Bitbol, 2020, p. 229, emphasis added). Instead of getting stuck in this search of a changeless source, Bitbol thinks we should look to the new quantum interpretations coming at a fast pace nowadays; seeing several common features between them and the "phenomenological attitude" (Bitbol, 2020, p. 232). A grounding in the idealism of objectivity through infinitesimals can otherwise have some difficult implications, as Merleau-Ponty will hopefully show us in the next chapter with the help of the phenomena that is movement.

### **The description of movement through art**

If we see analysis of the infinitesimal as breaking down reality into smaller and smaller pieces to be able to better analyse, I believe there is a valuable comparison to be made with photography and film. I've claimed that it is through the separation and comparison we call calculus that we can try to objectively perceive our world, much in the same way we see the world moving in front of us at the cinema. Even if the movie is actually just created from frozen snapshots in sequence. And the more parts we have (more frames per second), the more fluid the motion seems. But can it become truly continuous? Or do we perhaps risk losing information every time we create a separation; information that existed in-between the frozen snapshots that make up the motion we perceive? In the same way that we then might lose information in our objective and rigid analysis.

Merleau-Ponty asks a similar question in his essay "Eye and Mind": "Cinema portrays movement, but *how*?" (Merleau-Ponty, 1964, p. 185). Citing the sculptor Rodin in the same text, he claims that movement only can be given in the artistic representation that "portrays the body in an attitude which it never at any instant really held and which imposes fictive linkages between the parts" (ibid.). While I think we can call the photograph objective, the claim here is that to show continuous movement we need to capture the body in a position that it never would be able to have in a photograph, we need to capture the movement of the parts as it is in-between the snapshots. Otherwise we only have another of Zeno's paradoxes, were we actually never move. The source of the change that is movement would then be changeless in itself, as our contract with the ancient Greeks stipulated. An artist capturing movement tries instead to overcome this, they try to capture the continuity that is the phenomena of movement. As Rodin himself said: "It is the artist who is truthful, while the photograph is mendacious; for, in reality, time never stops cold." (as quoted in Merleau-Ponty, 1964, p. 186). The problem is then, as I see it, that the objective snapshot we analyse does just this; stops time cold in its tracks. Creating a discontinuity that only has the appearance of continuity.

The discontinuous images of the cinema prove nothing with regard to the phenomenal truth of the movement that connects them before the eyes of the spectator (Merleau-Ponty, 1968, p. 157)

A movie is a sequence of photos, each with a limited set of information on them. The motion of the movie can therefore be seen as discrete in its nature, only giving us the illusion of being continuous. Infinitesimal analysis could then also be seen as discrete in its nature, as with the atomistic and cartesian ontology it was born within. Instead of existing as discrete individuals, as soon as we as humans take part in the phenomena (by merely existing) we are part of the creation of other apparatuses, generated by our entangled iterating intra-action. And, as I've mentioned, where agential realism differs from atomism is in between these apparatuses. Barad writes that we need to fill the void in-between for the *possibility of continuity*, and this is where quantum field theory comes into the picture. The entanglement of the quantum field and oscillations within create and connects matter (Barad, 2012, p. 210). These intrinsic and iterating connections between all apparatuses, between the snapshots, might then also be what creates continuous movement, instead of discrete zenoan paradoxes? An iterating connection I see having many similarities with Merleau-Ponty's reversibility of the flesh through our senses. As well as the constant foaming connecting all.

## Embodiment

Using our body and senses, such as touch, as a medium for perceiving our world is something often discussed within phenomenology. In the 2015 collection *Carnal Hermeneutics: From Head to Foot*, a number of author's discuss embodiment, with the editors summing up the book as "Transcending the traditional dualism of rational understanding and embodied sensibility" (Kearney & Treanor, 2015). I will discuss two of the articles that state a phenomenological approach towards our place in the world.

First is Dermot Moran's article "Between Vision and Touch, From Husserl to Merleau-Ponty", where we are brought on a journey through the history of touch and sight in philosophy; Aristotle, Berkeley, Locke, up until Husserl and Merleau-Ponty. Moran writes that Husserl kept an atomistic view in line with those before him; separating the two senses into tactile and visual, maintaining a hierarchical categorisation. Where he did strike out differently from his colleagues and predecessors is that he wondered how our separated senses could perceive the world they embodied as a seamless whole. Touch and vision combined gives us a "single shared space" (Moran, 2015, p. 216). The kept hierarchy can be seen in Husserl's example of the right hand touching the left. Your right hand then sensing the smoothness of the left hand's skin; a quality that is "objectivated" or localised in the left hand. "In other words, I am aware of the left hand *as sensitive to being touched* and this sensitivity possesses its own peculiar kind of sensation complex. Both touching and touched hands have their respective 'touch sensations'" (Moran, 2015, p. 225). This "double sensation" was something that Husserl thought was only seen in the tactile, not visual, giving touch a higher order among the senses, as "touchability" was possible for all things visible, but not all things touchable could be seen (Moran, 2015, pp. 226-227).

Here is then where we see a shift from Husserl to Merleau-Ponty. Instead of a separation of senses and their different qualities, Merleau-Ponty sees a continuity between them. He also states that the sensation stays with us, and does not disappear when for instance the hand stops touching the other hand. Our body remembers the sensations experienced (Moran, 2015, p. 229). In later writings of Merleau-Ponty he goes further into this idea of the "reversibility of flesh". The flesh here symbolising "the archetypal element of our world", according to the philosophy of Merleau-Ponty (Bitbol, 2020, p. 236). The flesh can be seen as something even more than an element of our world; the flesh is our world, and ourselves, all reversible. "Where are we to put the limit between the body and the world, since the world is flesh?" (Merleau-Ponty, 1968, p. 138)

In Merleau-Ponty's example of the hand touching the other there is no separation of senses, or the flesh itself. The touched and the toucher are instead intrinsically in a circle, as is the seer and the seen. They are reversible in their qualities, going back and forth between them. To see is to be seen, to touch is to be touched. The same goes for the flesh that is our living body, and at the same time the world around us. "Moreover, what unifies my body is also that which opens my body to the experience of other's bodies" (Moran, 2015, p. 230). Merleau-Ponty speaks of *intercorporeality*; flesh touching flesh, replacing a traditional subject-object dualism, as it is always imminent and never "realized in fact" (Moran, 2015, p. 231). A similar discussion is had with Bitbol, where he states that Merleau-Ponty's ontology is that of a *radical situatedness*:

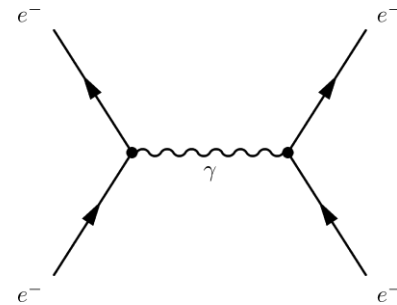
an ontology in which we are not onlookers of a nature given out there, but rather intimately intermingled with nature, somewhere in the midst of it (Merleau-Ponty 1954, p. 152). Here, we cannot be construed as point-like spectators of what is manifest; instead, we are a field of experiences that merges with what appears in a certain region of it (Bitbol, 2020, p. 236)

Touching on subjects, staying in touch, in/appropriate touch are all examples of how touch is an idea used in a range of human activity, and also a subject touched upon by Barad, in their article "On Touching" (Barad, 2012), taking the topic into the realm of physics. When analysed properly, down to its core; what even is touch? The electromagnetic repulsion created between the electrons in the outermost layer of the atoms in our hands actually prevent them from ever truly 'touching'. They are repelled by strong forces at the most basic level. "Atoms are mostly empty space, and electrons, which lie at the farthest reaches of an atom, hinting at its perimeter, cannot bear direct contact" (Barad, 2012, p. 209). This was shown as a fact even with classical field theory, founded in discreteness as a mathematically working, collision-free, atomistic theory. Keeping the individual atoms in a constant separation (Hagar, 2014, p. 15).

It seems like the smallest particles are destined to loneliness, a life without touching. But yet we see something strange happening within the electron cloud, where they seem to be able to create and emit a new particle from nothing. Something that goes against all classical rules of physics. We see *virtual particles* everywhere, a short-living piece of energy filling the void with connecting movement, a void that was previously seen as empty. Virtual particles registering faintly just to disappear almost as fast as they were created, in what is an incomprehensible short timeframe of existence.

In this technical, and yet poetic, text Barad depicts the foundations of quantum field theory, and how one of its key authors, physicist Richard Feynman, described this phenomena of an electron emitting a photon just to absorb it again, as a suggestively immoral act of touching oneself (Barad, 2012, p. 212). This act is often described through a *Feynman diagram*, as shown below in a simple form ( $e^-$  being the electron and  $\gamma$  the photon).

“Instead of going directly from one point to another, the electron goes along for a while and suddenly emits a photon; then (horrors!) it absorbs its own photon. Perhaps there’s something ‘immoral’ about that, but the electron does it!” (Feynman, 1985, as quoted in Barad, 2012, p. 212).



When first discovered the electron was seen as a negatively charged sphere. Nowadays it is described as a so-called point particle. A particle with no surface area whatsoever, just a non-dimensional point carrying a negative charge. Both versions cause significant problems for scientists, mathematical and experimental. The electron has made so many people to scratch their heads in wonder that it is often made the foundation of the discussion between realism and anti-realism, where the dividing question is: does the electron *exist*? (Liston, 2022) A question that at first glance can seem simple, but what does it actually mean to exist? If the electron is a point-particle, with no actual dimensional spread, then how can we ever detect the ‘actual’ electron? As we can only see the effect it has. Belonging to the quantum world we can’t even determine both its position and momentum, due to the uncertainty principle. We can know the statistical chance for it to be somewhere, or where it’s going, but it’s impossible to pinpoint any of them exactly.

With the electron comes a whole lot of mysteries, solved partially through quantum field theory and the existence of virtual particles. There electrons are seen constantly producing these virtual particles, in this case photons, when moving around. This photon is then almost instantly re-absorbed, its constant movement creating what is called quantum foam, or space-time foam. As these fluctuations within the field causes space-time to warp, violating classical physics (Dowden, 2022). The empty void is now filled with constant fluctuating foam, *touching* every particle in existence. For if touch really is just two surfaces coming together, it seems like this foaming dance is the only truly thing experiencing touch.

On the most basic level, in every existing entity's molecular structure, we are touching ourselves. On the smallest level there is no longer room for physical space. It all becomes blurry, entangled energy of uncertain measurement, within the quantum field, or phenomena<sup>13</sup>. And as we are all part of the same phenomena, never separated, we are all constantly touching each other touching ourselves. In the same manner as Merleau-Ponty's circle of simultaneously touching and being touched, or seeing and being seen.

This also means that without touching others, I cannot touch myself. Or in other words; my own identity is not perceivable as a sole identity, existing as a thing in itself. It only exists in recognition of other's identity. Only by seeing and touching the other is it possible to see and touch myself. As the ubuntu saying goes; *I am because we are*. My ability to be human is only possible by acknowledging other humans and them acknowledging me (Ogude, 2019). Our humanity is not part of the manifested rigid system we use to perceive and analyse. We are not objectifiable systems that can be precisely described and categorised. We are instead always part of the phenomena, entangled and iteratively intra-acting with apparatuses all around, as they are with us. We are embodied and connected to all, constantly touching.

This brings me to the second article from the collection I wanted to discuss, Edward S. Casey's "Skin Deep, Bodies Edging into Place". Here I see a practical use of the continuity between phenomenology and science to describe the embodied bodily situation of solitary confinement. Importantly, that the incarcerated is not just a generalised anonymous example, but "the real victim of solitary confinement is an embodied person - a human being *in his or her own body*" (Casey, 2015, p. 161). To better describe and analyse a person in solitary confinement we have to take in all of their personal being within the spaces, within the walls. And how the iterating intra-action between the prisoner and the walls around them together create a habitual body; what Merleau-Ponty called the "knowing body" (ibid.), or as a more generalised idea; Bitbol's notion of radical situatedness where the prisoner's embodiment is impossible to fully objectify.

When Sartre claimed famously that one remains free even when in prison, he did not mean *as a* body in that prison. He meant something rather more Stoic (...) But

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<sup>13</sup> It is impossible to fully understand the scales of the universe, but there have been a few good tries. If you only follow one link in this paper I hope it to be this one, it is worth every moment: <https://htwins.net/scale2/>

this is an entirely *mental* freedom, and it overlooks the full significance of the physical unfreedom of being a body in a cell (Casey, 2015, p. 163)

While analysing something so complicated and complex as solitary confinement within a country's prison system (as the very problematic American one Casey is a part of), there are a lot of things to take into consideration, things that all are part of the constituting embodiment of the prisoner, their apparatuses.

There are many other dimensions at play, and a more complete analysis would discuss such things as cultural parameters (rendering some places intelligible to those in their midst, others unreadable), historical, and institutional aspects such as humidity or temperature (not a matter of indifference in the case of prison cells), and so on (Casey, 2015, p. 167)

There are indeed a seemingly endless amount of factors that could be discussed here, not only for the prisoner themselves but also for the observer, and their part in the apparatus that is solitary confinement. Something Casey actually mentions as he finishes the article by saying that he will join a protest against mass incarceration (Casey, 2015, p. 172).

Within all these changing factors, can we objectively answer the question on why we see a change in mental and physical conditions of the prisoners when in solitary confinement? Casey gives it a try in his short paper, using the subjective and objective space of the prisoner cell as his rigidification to be able to compare and analyse. In a normal day, Casey writes, the average human has an abundance of space, both physical and mental. We are able to move beyond the space we inhabit at the moment, to change our setting or our prospects. The borders of our embodiment are always shifting, just as agency cuts the borders of an apparatus. This elasticity of our apparatus "is markedly absent in a prison cell" (Casey, 2015, p. 169). In confinement we have no choice of movement, no choice of stretching our boundaries, be them physical or mental.

"Skin" is not just the tissue that covers the body; it is the very medium through which the human person, in and through her living body, relates to her surroundings and most notably to place (...) "Skin deep" signifies the process by which from the depths of our skin-being - from its personal or shared history, including whatever joys and miseries to which it has been subject in the course its life until then - we are able to link up with the surfaces and depths of the places we are in (Casey, 2015, pp. 170-171)



Only by expanding our materialism to momentarily leave the duality of human constructed categories, like the usual border between myself and the rest; between the human body and the world, are we able to describe the phenomena of which we are all part of. With the tools of agential realism it becomes more than just a semantic story to tell us of feelings. It is an ontic relationship impossible to disregard. The realness of our intra-connection with the world has consequences, and they can differ a lot from the results we get from an ontology based in cartesian inspired individualism; a belief in the mind in-itself being able to separately observe the world (Hatfield, 2018). A dualistic idea where our body could be seen as a separate blank slate, an equal fit for everyone. In the coming discussion I will try to show that this is indeed paradoxical, as no such thing exists.

## Discussion

Don't get me wrong, the fact that I am writing this essay on my computer that also has access to all of our society's information, is thanks to the scientific revolutions around the world, where ideas based on binary objectivity have guided us to create amazing things, things that certainly has changed us and the world forever.

However, in trying to keep the thesis at a generalised level I see a need to ground oneself in the ontology of agential realism, and therefore at the moment reject others. Just as when I need to mathematically solve complex functions, I also need to momentarily reject the tools that only can solve for real numbers, or I would get, at best, only partially correct answers about the whole system I am analysing<sup>14</sup>. Sometimes those partially correct answers are good enough, sometimes not. So we need to keep a non-binary (or even queer) perspective (Barad, 2012, p. 209).

Binary can of course mean a lot of things, for many people it is just the fact of using 1s and 0s when programming software. Two opposite states of a system that can represent on and off, or true and false. It can also be used in a sense of seeing the world as binary; analysing a situation with the grounding belief that we can find a pre-existing changeless state. Using the word "find" in this context can also be seen as binary, that there exists an objective truth, hiding from us, pre-existing our observation, waiting to be found. Something that can be seen as going against what we observe in quantum science. Something that instead goes in line with our old "contract" with the ancient Greeks, continued through the scientific revolution of 17<sup>th</sup> century Europe. A useful something that has sent rockets to the moon and created beautiful math, but also a something that inspired a post-colonial society with intended and physically constructed systemic injustice against most (Archer, 2020). This might seem like a provocative move, but as I see it these problems stems from the cartesian inspired grounding in a separate self; our biological body separated from our reasonable and logical mind. That we can "find" the objective truth about ourselves though our logical selves. And when we use binary language like that, it is easy to forget about all the different dimensions that being human actually entails. Instead it becomes possible to view our logic, same as our mind, as something external to the embodiment we actually are part of.

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<sup>14</sup> The world of complex numbers is really a lot more interesting than one might first think. For more on the subject I recommend this excellent series: <https://youtu.be/T647CGsuOVU>

For some time, I had the feeling that this stubborn attitude, this resistance against the radical epistemological lesson of quantum physics, is a constitutive feature of Western ethos (Bitbol, 2020, p. 229)

If we can only blame western ethos and its contract with the ancient Greeks or not is debatable. But even through all of its missed goals, it has also helped to bring us to this step, where we can start to understand the variety of our world. Where we can start to understand what information has been missed between the binary snapshots been made.

An example of this 'missed information' can be seen in the numerous discussions on structural injustice that are occurring, not only in the academic fields but also throughout human society (Zheng, 2018). As it has become easier for people to share their personal story with the world, it gets clearer to us that it seems impossible to capture and understand all of human experience in a snapshot. We are realising that our previous logical tools have been severely lacking in identifying and helping different groups of people, groups that have been displaced and disvalued in society due to their individual factors shifting from the normal model of 'man'.

Philosopher Christopher Ryan Maboloc shows how a Rawlsian theory of justice and its grounding in this idea of man, can be seen as cause for many social problems we face today (Maboloc, 2018). The claim Maboloc make is that Rawls' idea of justice grounds itself in a blank slate of a human; that the logical reasoning for a common justice is for everyone to start on the same basic level, with the only trait of being human. And by doing this Rawls claims we give most respect to everyone.

The Rawlsian starting point asserts that the respect for human autonomy is the guiding principle in the pursuit of the just ends of social cooperation. Rawls employs the veil of ignorance as a methodical device to thwart any undue advantage in society (Maboloc, 2018, p. 1186)

The veil of ignorance as a method claims that we could ignore the facts surrounding an individual in order to give them a "fair" judgement. In the same way Descartes separated the mind from the body, where the human mind could be seen as a representation of this blank slate of a human. But as with the prisoner kept in solitary confinement, there is no such thing as a blank slate, no anonymous or equal examples. We are all intraconnecting embodied individuals, fully dependent and influenced by all the changing apparatuses around us.

Judging humanity from the aspect of an empty body seems paradoxical and, in some cases, just outright bad philosophy.

As I mentioned before, when I for instance view Mairs and Quickie P100, I view them in a certain way because the way I view myself. My own body and its able-bodied embodiment is dependent on Mairs being seen as 'dis-abled', as there would be no able without disable. If there isn't a different state to compare to, then there is no state at all. Nothing to identify against and nothing to strive towards. How we value these states depends mostly on the values of those in power. No-one sees themselves naturally as less than, unless told so. We all have our own embodiment, forced to survive both physically and mentally.

The luxury of taking for granted the nature of the body as it negotiates a world constructed specifically with an image of "normal" embodiment in mind is enabled by the privileges of ableism. It is when the body doesn't work – when the body "breaks down" – that such presuppositions generally surface. It is often only when things stop working that the apparatus is first noticed ... "able-bodiedness" is not a natural state of being but a specific form of embodiment that is co-constituted through the boundary-making practices that distinguish "able-bodied" from "disabled" ... What would it mean to acknowledge that the "able-bodied" depend on the "disabled" for their very existence? What would it mean to take on that responsibility? (Barad, 2019, p. 158)

We are always embodied together with our responsibility, without the ability to reflect at the world from an outside neutral position. Instead all observation is created through diffraction, entangling us with the observation at hand to create an apparatus of measurement. So a model of a single individual person can never be on equal grounding for everyone, claiming such a thing is a paradox, as a model without embodiment is not a human model. Instead this supposedly equal model is always built-in resemblance of the model builder and their embodiment. And the main model builders of our world today are de facto white western men belonging to a heteronormative culture. So the 'normal' model we almost always see is that of a white middle-class able-bodied straight man, with their specific embodiments. These traits become defined in our minds over time; rigid and true as a pattern for the general "man". Mistaken as a universal empty shell. Everything else becomes attributes on top of the (not so) empty slate; different genders, appearance, neurological types, sexuality, language and so on. A normal model of "man" is then different from for instance a woman, an autistic or gay person, or person of colour. And vastly different from a person within all of those categories.

Those attributes falling outside the general rigid case and don't fit the norm become *un-normal*, and the more you differ from the norm the harder you fall. As Maboloc, I also believe that restraining people within this contrived model constrains the growth of human beings as a whole (Maboloc, 2018, p. 1196). We fully are our ever-changing embodiment. When trying to fit within a standard of normal, it shackles us. Bind us to pre-defined categories and we become shackled animals, losing our will to be.

Asking what universally defines human is unnecessary; the concept of what a human is can easily be recognised a priori by other humans. As we become human only in our intraaction with other humans (Ogude, 2019). It is by recognising others that we can recognise ourselves. Instead, our common belief in a binary logic, created for simple systems, has caused a grounding in an individual normalcy that doesn't exist, and certainly doesn't benefit us in the long run. As no one is normal. Everyone falls outside the borders of the frozen snapshot that is the model of man.

Holding on to this binary truth-or-false model means holding on to the contract with the ancient Greeks, trying to find a motionless source of motion; a blank slate of our world. In other words, an impossible mission. If we instead let our grounding evolve to follow new scientific findings, to one that can incorporate all the models out there, binary and otherwise, then we might be able to change the way we perceive the world and each other. And embrace the scientific fact that we are all constantly touching.

### **Ethico-onto-epistemology**

A common question that comes up in these discussions is:

If, on a fundamental level, the properties of entities are indeterminate until interactions occurs, should we give up any normal distinctions between subject and object in every context? (Schaffer & Lemos, 2021, p. 23)

I would say no. Our ability to be objective hangs on the fact on doing such distinctions, being able to take separating snapshots of the apparatus you are analysing. As with calculus and modern film, the dividing of objects into smaller and smaller parts creates the illusion of continuity to such a degree that the results are often as good as we need. When building a bridge we can just use straight lines and triangles from euclidean geometry, even if they are not identical to anything existing in the space where they are working. There are no perfect

triangles or flat surfaces in the “real world”, they just act as an ideal representation of the space we live in. And in their infinitesimal state they really do present the illusion of continuity to a degree more than enough for most of our needs.

But there are situations that need other toolsets than the ones we mistake for universal. We live now in an unprecedented global village of trade and communication, a complex apparatus that’s been growing exponentially for a few thousand years. We are also part of an endlessly more complicated biological network, where photons from the sun or the gravity of our planet supports multiple chains of energy, fully sustaining us and our culture. An apparatus of life that has been growing more and more complex for billions of years. Apparatuses that can’t be analysed through the calculus of infinitesimals. The complexity is beyond what our binary tools can practically handle. Sometimes causing detrimental effects on our ethical standards and practices. As the heading hinted at, I will try to show just how ethics really are a real part of our being.

Going back to the results from the double slit experiment and QFT, if we see diffraction through intraaction as grounding for all matter and discourse; then we can also create an apparatus of ethics by the same entanglement. This apparatus takes different shapes and forms depending on the iterating inclusions and exclusions that are made with its cuts, and not from the standpoint of an individual model builder who thinks themselves as neutrally reflecting from the outside.

Diffraction is an ethico-onto-epistemological matter. We are not merely differently situated in the world; "each of us" is part of the intra-active ongoing articulation of the world in its differential mattering. Diffraction is a material-discursive phenomenon that challenges the presumed inherent separability of subject and object, nature and culture, fact and value, human and nonhuman, organic and inorganic, epistemology and ontology, materiality and discursivity. Diffraction marks the limits of the determinacy and permanency of boundaries (Barad, 2007, p. 381)

Just as the solitary prisoner is impossible to separate from the prison cell, as is the ethical system not separable from the people modelling it. The blank slate of equal justice that is claimed is in fact just the resemblance of a self-portrait. Our ethical and justice systems only befitting a certain kind of living and being; the impossible model of the blank slate man.

Instead, observing and measuring an apparatus from different embodied standpoints, using different toolsets, is critical to understanding the extreme and complex webs of intraconnection that is present in our world. A web starting millennia ago with the trade of goods and people, though rushed to unparalleled heights these last few decades with international production and shipping standards, and of course the wireless connection between us all we call internet. I can talk to anyone, read any book, buy almost any fresh exotic fruit I want from anywhere in the world. Being in this position has a real and material impact on the human apparatus as well as the planet's. My intraactivity impact countless lives around the globe. Our intraaction shaping the apparatus of ethics. All in/actions constantly shape the ethical apparatus around me, and the in/actions of the whole human apparatus shapes human ethics. There is no status quo, no blank slates, no normal model. We are re/acting with our embodiment, the environmental factors around us always being part of our decision making. Our cells re/acting to their environment, creating our individual body-apparatuses, in turn creating new group apparatuses, in turn creating new larger group apparatuses and so on. Be it through language, hobby or an international business. All with their own emergent qualities, not present in their separate parts.

An obsession and belief in the dualism of categorising has caused problems for us all around the planet. Importantly our problem, not a separate problem we as outsiders are trying to 'save the world' from. There is no saving the world from us, we are an intrinsic part of its being, as it is of ours. When discovering something new we always try to place it within an already constructed and separate category, instead of seeing why it is there in the first place. Our fixation with pre-existing categories, our belief in their universality, has caused centuries worth of misidentification and misinterpretation in fields like neuroscience (Arshavsky, 2006), archaeology (Steinmark, 2022), linguistics (Makoni & Pennycook, 2005), politics (Bennett, 2010), taxonomy (Thiele & Yeates, 2002) (Kull, 2003), and many more. All of this, I believe, stems from the idea of seeing agency as something needing a source; a separate conscious mind, not really part of the material world. And that we continue to try and find this source, to find out where it all 'started'. By moving agency away from a subject, we can instead see the world for the ever-changing embodiment it really is. Without our human-constructed categories dominating the discourse.

## Conclusion

What is a conclusion to a subject that can't be concluded, or doesn't even have a start? A complex matter indeed. I'll see this instead as a snapshot of what I would like a reader to take with them. As reading this text will be different for every person doing the reading, and the conclusions they draw will vary. The letters and their combination are objectively the same, but how we engage and relate to the symbolic construct that is a thesis, is highly part of our embodiment. What knowledge and understanding we have coming into it. Our feelings towards certain subjects it brings up along the way. But I hope that this text has managed to give an idea of why we need to rethink our general idea of agency and connection with the world. If we do care about some kind of justice, we need to see us for what we really are; impossible to separate from our embodiment. And to even begin to try understanding our world, we need to perceive it as the continuously entangled apparatus it is.

When interpreting quantum physics and agency this way can we move beyond binary dualities, making it easier to analyse and understand complex structures. Instead of the shortcomings that come from the use of binary logical systems common today. As the belief in a universal blank slate has caused systematic problems for everyone that doesn't fit the mould. Problems for everyone who falls outside the borders of the norm. And in reality, when it comes down to it; everyone is un/normal. No one fits an impossible mould.

With a belief in the individual we have trouble seeing the new entangled apparatuses created daily through the massive intraconnection that is today's society, making analysis problematic for a binary logic that is bound to the classical model we are accustomed to. We are always connected, always documenting, always being documented. The last barrier between private and public is soon long gone. Our options, as well as our restrictions, are greater than they have ever been. And the empty slate of the 'general man' is not applicable to measure and analyse the actuality that we all intrinsically have with us. We need other tools, to fill the gaps where classical empiricism fails us.

Following and pleasing a human eagerness for analysis, I believe the closer we get to true continuity the better our results become. So we maybe need to find ways of including even more variables in our snapshots, and how they intraact. Maybe by including fluid models in our designs. Models that are not applicable to only certain structures, but to humans, non-



human and non-living alike. Human consumption is just as real of an apparatus as a person is, causing detrimental markings on the world. An apparatus with its own embodiment and emergent qualities; qualities that definitely needs some better study. All the smaller cuts enacted by every member of the market economy creates larger cuts, that in turn creates larger cuts until we are all one apparatus. Just as individual cells create individual organs that create individual bodies. Groups then emerge from humans, that become nations and tribes. Just as the cell's needs and wants are different from the organ's or the human's; a group's need is not always the same as the people forming it. My liver doesn't, as an individual, need emotional expressions to function, but I do. And the larger human apparatuses I belong to might have other qualities and needs we have yet to acknowledge properly. But trying to identify those using the wrong tools will give us faulty results.

A last ethical thought; there isn't one or several specific individuals we can blame for the world we live in, with all the problems we face. There are likewise not any sole individuals who are responsible for our success. It is an embodied world, and we all help shape it by our own actions, both those we see as bad and the good. Our actions always present in the marks we make. Which of our actions that are ethically significant and which are not, is up to us. I just need enough information and perspective to be able to be as objective as possible about the effect my markings has on the world I am part of.

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