What is Liberty? Philosophical and interdisciplinary perspectives on Free Will

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Abstract

The concept of free will has been a central topic in philosophy, theology, and science for centuries. However, its understanding remains fraught with complexities, particularly in defining the scope and limitations of freedom in human and non-human beings. This article explores which ontological conditions are required for the emergence of free will, arguing that determinism and reductionism are incompatible both with the existence and understanding of *stricto sensu* free and willed action. By analysing some developments in key areas such as neuroscience, molecular biology and quantum physics, we examine free will in relation to decision-making, consciousness and social context to argue that only anti-reductionist ontologies compatible with some form of possibilism can provide space for free will to exist. Moving beyond traditional notions, we introduce a more specific definition of free will-based actions, distinguishing between general, contingent, and disruptive free will-based actions. Disruptive free will actions lie beyond deterministic and probabilistic laws acting at lower levels of reality, enabling creative and voluntary actions. These actions can be exerted by a variety of entities, including individuals, social groups and even artificial intelligence systems. This interdisciplinary ontology of freedom fosters further inquiry into how agency may operate across different systems and opens new avenues for understanding moral, ethical and political implications of free will and liberty.

Key words

Liberty / Freedom / Free will
Free will based-actions
Disruptive free will
Interdiscipline
Cognition
Decision making
Causal Power

Significance statement

This is an interdisciplinary work that brings together evidence and theoretical approaches from physics, biology, neuroscience, and philosophy to propose the conditions of possibility for free will in decision-making. It raises the epistemological limitations of canonical approaches that are sceptical about the possibility of free will and suggests a non-reductionist methodology for addressing emerging objects from complex systems. It establishes a classification of actions that highlight different degrees of freedom in decisions, stressing the role of context. Finally, as a procedural perspective, it extends the notion of free will to other non-human species and even to complex non-biological systems. Our

perspective would have significant impact on the experimental sciences and philosophy, deepening the study of emerging properties of complex systems.

1-Introduction

The problem of *free will* has been addressed by ancient philosophy, by medieval philosophy and theology, by modern thinkers and nowadays by different philosophical approaches and current scientific disciplines. Part of the challenges related to this notion probably stems from the fact that free will is often seen as a universal property, applied to entities that are considered to be *free from* something, free from certain constraints. But free from which ones?, from body materiality, from external control, from situated (historical, social, cultural) processes, from internal features, as the different dimensions that account for the singularity of personhood (emotions, memories, passions)? If freedom is understood as relying on self-control, what is the *self*? And how can it be *free*? Is it a singularity emerging from a unique set of determinations?

Moreover, here again a series of questions challenges the issue of the subject of free will: is it strictly necessary to think of will in individual terms? Or can it be an emergence of collective organization? The dichotomous tension between the individual and the social arises regarding the philosophical issue of freedom. The discussion about free will generally makes sense in a tradition that considers the problem of freedom in a profoundly individualistic philosophy and metaphysics. Against this tradition, we suggest that, given the fundamental fact that *Homo sapiens* is a social animal, the reality of free will only makes sense in a social metaphysics: "(...) the condition for genuinely free individual action is the embedding of the individual in society."[1].

On the other hand, the concept of *free will* has often been intertwined with other concepts or processes, such as decision-making (DM) and consciousness: do all DM processes involve free will and does free will require the experience of consciousness?

Despite the limits of the conceptualisation of free will, its relevance derives from its implications for the social organization of our species, the agency of our actions, and the responsibility for our actions, and thus has legal and political consequences. These are some of the issues that illustrate the complexity of the problem and will be addressed in this manuscript.

Here we will not deal with the general problem of free will regarding its connection with moral responsibility exclusively. We will offer a philosophical conception of freedom, within metaphysics. We will wonder about the conditions of possibility of free will by appealing to an interdisciplinary approach. We will not offer a notion of freedom that should be empirically tested, because we are not working within the framework of the empirical sciences, in any particular discipline. The ontology of freedom that we develop in this work

will prove fruitful for understanding freedom in various specific scientific domains (i.e. a physical system, a biological species, etc.). We do not intend for our proposal to fall within the framework of empirical science; however, we will provide an ontology of freedom within the framework of a scientifically informed metaphysics.

To summarize, the goal of this work is twofold. Firstly, we want to establish the minimal conditions that an ontology must satisfy in order to give place to agents capable of taking free and willed actions. Secondly, we want to propose a general definition of this type of actions that is useful to go beyond individual persons, and can be applied to more general complex systems such as social collectives, animal colonies, and even artificial intelligence systems. The work is organized as follows. In section 2 we start reviewing some of the main philosophical positions and definitions of free will. There we will delimitate the notion of freedom which will be the focus of this work, namely, that which is based in what we call *disruptive free will based actions*. In section 3, we argue that in a fully deterministic world, it is not possible to have *disruptive free will based actions*, the strong version of free will. We also show that no relevant definition of free will can be given for systems whose behaviour is fully governed by probabilistic mathematical laws, such as those of quantum theory. We argue that quantum physics can only provide the material basis for real chances to exist, but on its own, this is not enough for granting the emergence of free will. Next, in section 4, we analyse reductionist approaches, and claim that if the properties of complex systems can be fully explained using an ontology based on simple aggregates of interacting atoms and molecules, no genuine notion of will can emerge. Thus, we conclude that only pluralist or anti reductionist monist ontologies can accommodate actions based on free will. From the point of view of anti-reductionistic ontologies, the arguments used in section 3 against free will do not apply, since the laws of physics as we know them have a limited domain of applicability, leaving room for free will to appear. In section 5 we discuss the problem of free will from the perspective of neurosciences, analysing different experiments that are used to both support and reject free will. We conclude that multilayered pluralist or anti reductionist monist ontologies, in which possibilities are real, are compatible with current accepted models in behavioral sciences. In section 6 we review the discussions of the possibility of finding free will in the animal kingdom, and contrast our anti-reductionist approach with the more traditional reductionist positions in which free will is considered an illusion of the agent. In section 7, we use the findings of the previous sections to argue that possibilities are necessary for free will, by analyzing the Aristotelian notion of potentiality and exploring possibilism. Finally, in section 8, we draw some conclusions.

2- Definitions of free will

In western philosophy, the classical problem of free will can be identified with the issue of human control over one's actions. This definition relates freedom to a peculiar power, i. e., the power *to do or not to do*[2]. It is also related to justice[3] and virtues[2]. Freedom seems to be the possibility of doing otherwise or being able to have done otherwise. Despite

the discussions over his work, in the Medieval era, St. Augustine established that the will, as a self-determining power, is the basis of freedom. John Duns Scoto defended a strongly libertarian conception of the will: there is always the possibility to will otherwise; alternative possibilities are preserved[4]. Free will in ethics is associated with responsibility, rewards and punishment and, therefore, with the possibility of acting morally. Some authors consider that without free will there is no responsibility, therefore there is no place for ethics, for critical reflection on morality. But that is not a universally accepted thesis. In the Modern period, besides the moral concern, it was widely accepted that it is difficult to account for freedom, as well as contingency, in a determined world. This issue can be addressed within a metaphysical or a scientific framework.

Compatibilism is the position that assesses that free will is compatible with determinism, i. e., determinism is innocuous to free will. Some philosophers also assess that free will is not only compatible with determinism but also requires it. Determinism is the idea that every possible world with the same past and the same laws of nature has the same future[5]. According to classical compatibilism, it is not determinism that opposes freedom, but external constraints on doing what one wants to do. A person is free just if it has the freedom to do otherwise. Critics to compatibilism argue that it is not a sufficient account of free will. Freedom to do otherwise demands not only: "...that an agent could have *acted* differently if he had *willed* differently, but also that he could have willed differently. Free will requires more than free action"[6]. The thesis that free will is incompatible with determinism –incompatibilism–, supports the assumption that a deterministic world leaves no room for responsibility.

An alternative view to the position that links free will to the possibility of doing otherwise, is the idea that free will is defined by aetiology: someone is free if she is the source of her action. Event-causal libertarians consider that mental states and events must be the result of self-determined actions. While some philosophers appeal to agential power to account for that, others assess that self-determination requires more than nondeviant causation. Philosophers such as Hobbes and Hume have denied that non-deterministic causation is possible, but nowadays it is widely considered to be possible, partially thanks to the onset of quantum physics[6]. The attention to quantum mechanics leads us also to the issue of inter-level relations (from an epistemological perspective as well as from an ontological one). That brings about, of course, the issue of reductionism. Reductionism is "(...) the view that the ultimate scientific understanding of a range of phenomena is to be gained exclusively from looking at the constituents of those phenomena and their properties"[7]. In this paper, we will refer to both epistemological and ontological reductionism, the former being the thesis according to which the theory that describes domain A is inter-theoretically reduced to the theory that describes domain B; and the latter being the thesis that asserts that domain A of reality is reduced to domain B.

Most philosophers who advocate for the possibility or the reality of free will, accept that there must be some kind of power in mature human beings. That idea leads us to the proposal according to which humans are concentrations of causal power in a world where causal regularity is scarce[1]. This thesis opposes the idea that there is a complete causal truth

to be told about most phenomena, i. e., against the widespread idea that the world is a net of causal connections. Causal regularity is not a common feature of the world; it is rather a rare one. And humans are not exceptions to that, but they are "dense concentration of causal power in a world where this is in short supply"[1].

Philosophers who advocate for causal completeness consider free will inconsistent with that. While determinism is a problem for free will, as we saw above, indeterminism is often thought to make it impossible. As it has been stated[1], regardless of whether standard compatibilism is defensible or not, the solution to the problem of freedom lies in holding indeterminism. In that line we argue here in favour of the reality of free will while advocating for a kind of indeterminism, one that denies causal completeness, because causal regularity is a rare feature of phenomena. While the causal order of the world is incomplete and partial, humans are very complex but very ordered structures and are, sometimes, causally effective: humans can make complex institutions function and are the most predictable entities, as Hume had claimed. Only few situations have a complete causal truth, and causal completeness is compatible with determinism and indeterminism. It is interesting to mention here that one of the main features of complex living organisms is that, from a physical point of view, they are open systems that interchange energy with their environment in such a way that they manage to stay out of equilibrium, dissipating energy and decreasing their entropy during many essential activities. From the point of view of this thermodynamic perspective, free will could be related to the capability of an organism of using the energy extracted from its environment to deliberately produce ordered and stable structures which form the material basis for free will based actions.

Here we adopt the view that humans are not generators of random actions, and neither are they machines[1]. A correct account of human freedom must lie between these theses. Similarly to machines, humans have functioning parts that are characterized by a strong causal behavior (the complex constraints that guarantee predictability). But unlike machines, organs have no external controls (self-control, i.e., human autonomy, is the absence of external controls).

Contrary to what Hume argued, this proposal promotes an ontology of causal powers. Human decisions can be a source of causal order: "My complexity of structure gives me a vast array of causal powers, a range of powers that would be inconceivable without that intricate machine-like internal structure. But the exercise of those powers, though obviously influenced by the circumstances I perceive myself to be in, ultimately depends on an autonomous DM process"[1]. The key in this argument is to understand causal order as something special rather than universal: human free will is, in this picture, an autonomous source of causal order.

The resolution of the debate between compatibilism vs. incompatibilism lies outside the scope of this work. Our proposal is aligned with the denial of causal completeness[1]. We consider that, regardless of the solution to the debate among compatibilists and incompatibilists, human free will can be understood as an autonomous source of causal order. We will complete this picture, the idea that causal power is required to obtain an ontology of

freedom considered in a strong sense, by emphasizing that the most interesting cases of free will have to do with causally creating (not by chance) a new situation that was not present before. But we will not limit the inquiry concerning freedom to human actions. We will also wonder about the possibility of freedom of non-human systems. To do so, let us now turn to the definitions of free will which are needed for our proposal.

In what follows, we need a definition of free will-based actions which conforms to our goals. Let us call *general free will-based action*, that kind of action in which the agent's will conforms to what they can do without restrictions. We refer to *lato sensu free will* to any notion of freedom which is based on *general free will-based actions*. Such an action can certainly take place in a deterministic world. A convict in jail may be capable of drinking water, not only because he is allowed to do so (i.e., assuming that the rules of jail impose no restrictions on that), but also because he is determined to do so due to his physiological need. Eventually, he might be completely determined to do it because of the laws of physics, depending on the assumed ontology. Therefore, a convict pouring a glass of water and drinking it can be said to have performed a general free will-based action. Notice that this notion is fully compatible with determinism, and even with the lack of freedom to drink something different, as for example, alcohol (in case that authorities do not allow it). Also, it is obvious that such an action is compatible with a non-deterministic ontology/world too. As it stands, the standard version of free will-based action is too general for our purposes.

Here we will focus on a more specific version of free will-based action, namely, one that demands that the agent is capable of changing the course of events that are not fully determined. We demand not only that the will of the agent be compatible with what this agent can actually do, but also that it should have the faculty of being able to have a different will. Coming back to the convict's example, he should not only be determined to drink water because of his biological needs, but he should be capable of deciding not to drink it and, eventually, try to take his life due to dehydration. Even if, eventually, he is forced to drink water by the jail authorities, in the restricted definition, we demand that he should be able to make choices between genuine alternatives. We refer to these as *contingent free will-based actions*, the word "contingent" indicating that things could have been different. As we will explain in more detail in what follows, such actions need real chances, i.e. the existence of different concrete possibilities, in order to have a non-trivial validity. We remark that contingent free will-based actions are a particular case of the general ones. This is so because the latter only demand that what is done is in conformity with the will or goals of the entity performing the action, and are thus compatible with both deterministic and non-deterministic ontological frameworks.

It is also crucial to remark that the concept of free will that we are interested in discussing here refers to whether the willed action is completely determined (independently of the subject) or can be free (totally or partially) from such determinations. Therefore, much of the discussion about free will centers on whether it could exist or not, and how it is compatible or not with a deterministic ontology. However, without denying the existence of such determinations, the superposition of possible real outcomes (willed actions) opens up

the possibility that willed action may have degrees of freedom that are contextually affected (see section 5). If the convict is eventually set free from jail, the scope of the things he can do will be obviously expanded. For the contingent notion of free will-based actions we will be interested in quantifying the scope of the things that the agent can actually do without restrictions. Notice that, in realistic scenarios, the will of the agent will be, more often than not, in tension with the restrictions imposed by the context in which he must make choices. Furthermore, restrictions usually operate in a non-deterministic way: there might be chances that each restriction could be overcome with a certain probability. To illustrate this point, consider a social minority under an oppressive regime. Even if some behaviours or actions were forbidden and punished with the death penalty –like gay sex in societies where it is not allowed– they might actually take place on a regular basis. Many examples of restrictions are such that they can be challenged and, eventually, overcome (for example, laws and regulations can change). Thus, there is a sense in which it can be said that an agent can eventually do something without being free to do so in legal terms. The degree to which an environment or context imposes restrictions, and the likelihood with which each restriction can be overcome, are also variables that need to be taken into account in the analysis. Convicts usually must confront more restrictions than free men. By taking into account the amount of restrictions, one realizes that the relationship between an agent and its environment is *dynamic* in most examples of interest (i.e., they depend on time), and that the restrictions can even be challenged.

Therefore, it is also important for us to quantify up to which point the actions of the agent are capable of modifying the context or environment in which they take place. From our perspective, an agent that doesn't have the *possibility* of modifying its conditions of existence in a substantial way, can only expect to carry out restricted forms of *free will-based actions*. In other words, there cannot be complete freedom in an environment where agents can only choose from a pre-established set of fixed and unchangeable alternatives. Such a restricted form of freedom, reduced to a minimal degree, would be merely formal from our point of view. Notice that the restrictions need not necessarily be external to the agent, but might have an endogenous origin. As an example of this, consider a social group or individual that has a strong restriction for accessing knowledge or relevant information. For them, there will be obvious limitations for making informed decisions, thus limiting their capabilities of modifying their conditions of existence (this is one of the reasons why universal access to education and information is usually considered as one of the essential features of a freedom-based society).

In our approach, it will be crucial to take into account the novelty and the impact of the consequences of the actions in order to characterize free will based actions. We want to make a difference between an agent choosing between different brands of soda (even for the contingent notion of free will), and an agent modifying its very conditions of existence. To fix ideas, let us consider the case of a person unjustly imprisoned who, thanks to his actions based on free will, achieves justice and is released.

Another relevant example that illustrates our goals comes from art. A young music composer might face a free will-based choice between different already well-established music styles (say, classical music or rock), or might instead engage in the project of creating a completely new style of music. Clearly, both cases are examples of free will-based actions. But the latter gives place to a more radical transformation of the context. By considering these differences, we end up with a definition of free will based actions which has very interesting practical implications, as we will discuss in Section 8.

We will refer to the actions that involve not only an agent deciding between real possibilities, but also a substantial –or even radical– modification of the conditions in which the agent was situated before the action took place, as *disruptive free will-based actions*. These are the focus of our work. We refer to *stricto sensu free will* to any notion of freedom which is based on *disruptive free will-based actions*. In what follows, we will analyze different examples and try to determine which are the conditions that an ontology must satisfy in order that disruptive free will-based actions can take place.

3- Is free will possible in a deterministic world?

Newton's explanation of planetary motion was considered a major achievement in human culture. One of the main features of his approach was that the trajectories that planets follow must be solutions of a certain set of equations. These are such that, if the initial conditions of the bodies under study are specified at a certain time, their future behavior is determined for all future times. In other words, if the masses, initial positions and velocities of all the bodies involved are specified at a certain moment, their trajectories are fixed as solutions of Newton's equations. This technique was used by Newton, Leibniz and others to successfully describe a plethora of natural phenomena, gaining a lot of authority and giving place to a theory known nowadays as *classical physics*.

The ever increasing use of the laws of classical physics resulted in a substantial increase in the capability of humans to predict future events and control nature. Alongside the spread in its use, there appeared a philosophical conception of the world as a sort of perfect mechanism, in which every dynamical aspect of it is regulated by natural laws that can be known and empirically corroborated. According to this perspective, every future event is determined by the properties of all the material bodies at a given moment of time. In a world like this, there is no place for real possibilities, since there is only one: the only future which is compatible with the laws of nature and the previous conditions. Naturally, there is no place for strong versions of free will either, since they require that there must exist some real alternatives to make real choices. Thus, if a reductionist position is adopted in which every feature of the world is ultimately explained by classical physics, there is no room for the disruptive version of the notion of free will which we are interested in.

The advent of quantum mechanics around a hundred years ago shook the brightest minds. No matter the efforts of the physicists of that time, atomic phenomena resisted the deterministic description of classical mechanics. The randomness that lurked in the quantum

domain seemed to be of a form never found previously in nature. The solution came by the hand of Pauli, Heisenberg, Bohr and Born, who proposed a radical solution to the problem: quantum mechanics is a probabilistic theory, because there is an intrinsic randomness in nature. In his Nobel lecture, M. Born stated the limits of determinism clearly:

> "I should like only to say this: the determinism of classical physics turns out to be an illusion, created by overrating logical-mathematical concepts. It is an idol, not an ideal in scientific research and cannot, therefore, be used as an objection to the essentially indeterministic statistical interpretation of quantum mechanics."[8]

The statistical interpretation of quantum theory was such a radical turning point in the physicists' community, that it gave place to a new paradigm in physics practice. W. Pauli clearly stated that the probabilities of quantum theory were of a very different kind to those appearing in classical physics:

> "It was quantum mechanics that first assumed the existence of primary probabilities in the laws of nature, which could not be reduced, by means of auxiliary hypotheses, to deterministic laws, as is possible, for instance, with the thermodynamical probabilities of classical physics. This revolutionary development is considered as final by the large majority of modern physicists, first of all by Born, Heisenberg, and Bohr, with whom I myself agree. (...) "The state of a system (object) being given, only statistical predictions can in general be made about the results of future observations (primary probability), *whereas the result of the single observation is not determined by laws, being thus an ultimate fact without cause*. This is necessary in order that quantum mechanics may be regarded as the rational generalization of classical physics, and complementarity as the generalization of causality in the narrower sense."[9]

The above words by Pauli express the idea in a clear way: certain processes at the atomic level were considered ultimate facts without a cause. According to the paradigm of quantum theory, there is an intrinsic randomness in nature. This can only mean that, according to this view, possibilities are real. W. Heisenberg was very aware of this. In trying to understand how that randomness could be a real feature of nature, he proposed to revisit the Aristotelian idea of *potentia*. He explicitly said that quantum probabilities could be interpreted in terms of potentiality[10].

A crucial debate for metaphysics is that of possibilism vs. actualism. Different philosophical systems can be classified according to the stance they take in that regard. The developments of physics during the XX century gave much support to the possibilistic point

of view. Now the question that we want to address can be clearly stated. We have already seen that there can be no material basis for the contingent version of free will in a fully deterministic world. But is randomness enough to serve as a material basis for explaining the existence of agents that take free decisions? The perspective of quantum theory only suggests that there might exist real possibilities in nature. But there is a caveat: the possibilities of quantum theory are governed by mathematical laws. If, again, we adopt a reductionistic position, there is no escape from the laws of quantum physics. An agent which is described as a complex material body which, ultimately, or in part, is governed by quantum physics, is only granted that when confronted with certain situations, it will face real possibilities. But one can clearly envisage a description in which, even if those possibilities are real, the agent is only driven among them passively, following some underlying natural laws that it cannot control. Thus, the existence of possibilities on its own seem to not be a guarantee for the existence of free will understood in the strong sense, i.e., as based on disruptive free will based actions. There seems to be more to it. What is missing?

According to incompatibilism, free will cannot exist in a fully deterministic context: a world working like a deterministic clock has no room for free will. It can be argued that it cannot exist either in a probabilistic world where entities are passively driven by the non-deterministic laws of quantum theory in which stochasticity is the only dimension beyond deterministic constraints. Some disruptive action is needed. How can the notion of disruptive action be understood? One possibility could be to regard a disruptive action or decision as a process that lies beyond the natural laws that govern lower levels of reality. This could only happen if reductionism is false, in the sense that a complex organism is not completely subjected to exactly the same mathematical laws that govern its microscopic components. According to this perspective, the behaviour of a complex organism would have a material basis which is compatible with the existence of real possibilities in nature but, at the same time, is not solely subjected to the non-deterministic laws given by the fundamental theories of physics (or even chemistry).

From the above analysis, we conclude that, in trying to develop an adequate notion of free will, we need to articulate the following features:

- It could be argued that there must exist ontological possibilities in nature for the *stricto sensu* version of free will to exist. This would be granted by an underlying material ground governed by quantum mechanics. While there are different interpretations of quantum theory, real chances would be supported by a material ground only under the assumption that probabilistic interpretations[8] hold true, which is an unsettled debate[11].

- But even under the assumption that probabilistic interpretations hold, the laws of quantum theory alone will not grant the existence of agents capable of making disruptive free will-based actions. Free will lies beyond the natural (non-deterministic) laws in which the non-deterministic term is only driven by stochasticity: there must exist a stand-alone action of a deciding subject that makes it non-passive with regards to the laws which govern simpler, inanimate

bodies (such as atoms, molecules and rocks). This could be true only if the laws of the fundamental theories of physics were of limited applicability. Here, "limited applicability" doesn't mean that physics or chemistry are wrong, but simply that reductionism just doesn't work. That there is a domain of reality which cannot be possibly reduced to simple mathematical laws, but only a general description can be given (as is the case in many areas of the human sciences, in which mathematical modelling only plays a descriptive role, or it cannot be applied at all).

- Thus, free will seems to appear in situations in which there are real possibilities available but, at the same time, instead of simply being driven passively by non-deterministic laws, a complex material body might not be governed by these laws. That is because laws just do not apply outside very specific and limited contexts. A complex material body is capable of exerting causal power, actively creating a new situation that was not present before, not by chance, but by defining new aims and problems.

Taking into account the above points, in the following sections we will discuss some relevant examples, and try to delineate the general features of a definition of free will which accords with current scientific knowledge.

4- Is reductionism compatible with free will?

As we have already discussed in the previous section, according to current scientific knowledge there seems to be no room for free will if reductionism works. Even if the standard interpretation of quantum physics were correct, and there is actually an intrinsic randomness at the fundamental level of natural phenomena, there seems to be no known (or widely accepted) mechanism by which a mere accumulation of atoms and molecules could exhibit some feature that resembles free will. But there is some hope for free will, simply because of the following fact: reductionism seems to be doomed to fail in most areas of knowledge. This was largely discussed in previous literature[1]. Here we will just review some arguments against reductionism, and try to identify where, in the limits of applicability of fundamental laws of physics, there seems to be room for free actions.

A paradigmatic example of the failure of reductionism can be found in the very domain of physics. In classical physics, when trying to recover macroscopic thermodynamics out of the dynamics of supposedly fundamental components obeying Newton's laws, it is challenging to recover the second law of thermodynamics and the manifest irreversibility that is so characteristic of macroscopic phenomena. Similarly, when trying to recover the properties of chemical systems out of the laws of quantum theory using *ab initio* calculations, there seems to be a big gap, with no known solution at hand. The introduction of quantum theory allows us to improve the explanation of the properties of macroscopic bodies (as in,

for example, the specific heat in solids). But still, the reduction of a theory by a more fundamental one seems to be a business plagued by *ad-hoc* assumptions and ontological gaps. A paradigmatic example is that of the reduction of chemistry to physics[12]. Another good example is the reductionist approach associated with the Human Genome Project. In 1992 the preeminent geneticist and Nobel laureate Walter Gilbert pulled out of his pocket a CD containing his own genomic sequence in front of the audience, claiming "Here is a human being; it's me"[13]. Reducing human complexity to just genetic information oversimplifies the intricate interplay of genetic, environmental, and social factors that shape human biology and behaviour. In this sense, epigenetics, the study of heritable changes in gene expression that occur without altering the underlying DNA sequence, has become a fundamental field of molecular biology that was largely neglected a few decades ago.

Why is it so hard to reduce all domains of knowledge to the fundamental theories of matter of a single science? Why do the ambitious claims of some physicists (such as "we are very close to the theory of everything", "give me a stronger computer, and I will be able to predict your decisions") seem to be too naive for XXI century philosophers of science? One could argue that it could be the case that there are many technical challenges in the business of the reductionist program. Technicalities that nobody knows how to solve and, perhaps, no one ever will. In that case, even if, in principle, it could be possible to perform the desired reduction, it is a task that lies outside the capabilities of the current development of the sciences. But there could be a deeper, non-epistemic reason (or limit), namely, the possibility that reality is in itself not reducible[14], and that the ontological content of the different layers, though related, cannot be sequentially reduced. According to this possibility, when we look at the properties of atoms, we are dealing with a particular aspect of the real, but which cannot be used to fully describe, for example, social phenomena or biological systems. This possibility goes hand in hand with *ontological pluralism*[15], intended to describe a reality in which the different levels of phenomena have ontological independence[16]. Naturally, it also conforms to anti-reductionist monistic ontologies.

According to the assumption that reality cannot be described by a reductionist approach, there seems to be room for free will decision agents which, without violating any particular law of fundamental physics or chemistry, go beyond them because their actions take place in a level of complexity which lies outside of their domain of applicability. We propose this lack of applicability with respect to the alleged fundamental laws as one of the main features of a free will decision agent. The actions of such a complex system, instead of being governed by universal covering laws (as is the case of the inanimate objects studied by physics), are regulated by *situated laws*, which might be subject to radical changes after the actions take place, defining new situations, problems, and goals. The laws that regulate a given society are an example of the latter.

Let us illustrate the above elements of analysis with a very concrete example. Madam Curie was one of the greatest scientists of all time. According to the rules of her epoch, it was not expected by many men that a woman would involve herself in scientific activities, and even less, that she acted with so much independence and a leadership attitude. The properties

of the radioactive materials she studied could not be changed by her will (since they lie within the scope of the laws of physics). But the social rules which govern the behaviour of human beings could be challenged and, in many situations in her life, she had to make decisions in which those social constraints had to be suspended or surpassed. As a result of her actions, a new situation came to light. By challenging the scientific status quo of her time, she contributed to create a whole field of research that was not contained in previous scientific knowledge[17]. Furthermore, her actions contributed to undermining the basis of the practices of science that tended to expel women from its high ranks (a battle that still rages nowadays). In this simple example we can identify all the elements of a disruptive free will-based action. An agent who is thrown into a specific situation which is defined by a collection of rules and possibilities. Some of these rules are unmovable constraints (for example, the laws of physics that govern the radioactive materials under study, and the concomitant cancer that ended her life), but others were susceptible of being challenged and suspended. In the action of transcending those rules, a new set of rules or a new scenario was created, with its own goals and defining problems (the study of radioactive materials and a substantial contribution to the increase of the engagement of women in cutting edge areas of science). Needless to say, Madam Curie could have turned her back on science and her research projects, and come back home when she had to face the challenges she did. But she didn't: here lies the signature of a disruptive act of free will. The history of the discovery of radioactivity is just one example among others, in which many women contributed to the development of XX century science, but did not necessarily receive the recognition she deserved.

In the above example, it is crucial to notice the interplay between the different levels of reality. On the one hand, the laws of physics. On the other hand, the instantiated social laws which govern the behaviour of individuals at a given place and epoch. Social rules cannot be reduced to the fundamental laws of physics, but this doesn't mean that they are completely independent. Madam Curie actually died of cancer, due to her exposure to radioactive materials. So the fundamental laws constitute an unmovable constraint to what agents can do, defining a great part of the scenario in which the agents are thrown. But the scenario is also defined by other rules, which are possibly dynamic, susceptible to change, and cannot be reduced to the former. The laws that dictate a high probability of getting cancer when a person is exposed to radioactivity belong to a different level than the laws that expelled women from scientific positions. The example of Madam Curie is also useful to illustrate the interaction between the individual and the environment or context in which it exists. One could even say that the individual is defined by the context in which it exists. But while science is an essentially collective endeavour involving the cooperation of many individuals, its progress is also related to the discussions, tensions and contradictions among them. The actions of free will taken by a given individual are, more often than not, in tension with its environment. And, in certain situations, the disruptive scientific discovery is carried out by a single agent or a few of them, contradicting the existing corpus of knowledge of their time.

Scientific discoveries, in many cases, can be considered as paradigmatic examples of complex chains of decisions and actions based on free will that lead to disruptive changes. A real scenario will be traversed and defined by rules and entities which belong to different levels or aspects of the real. When an agent takes a decision according to the extant rules (the brand of soda, the hair colour of a Barbie doll, or the soccer match to watch on the TV), one could say that no disruptive free will action took place. The kind of actions in which we are interested are more related to moral decisions, ethical thinking, and political and creative actions.

When radical decisions are made –decisions that deal with matters that lie beyond the activities related to the mere reproduction of life (such as eating, washing, resting, etc.)–, *stricto sensu* free will actions take place. The decision of creating a new art movement, or a new music style such as those discussed in Section 2 constitute, by definition, actions of disruptive free will. The possibility of taking radical decisions and actions has been identified as a constitutive characteristic of history, and what distinguishes, for example, humans from (at least part of) non-human animals. Ants are undoubtedly social insects, displaying a very complex network of behaviours and collective responses to thrive in their natural environment. But ants seem to have no history, in the sense that, even if they might experience complex behaviors[18], their social structure remains essentially similar for millions of years. In this context, it is worth noticing that technological developments in humans reveal a high capability of transgressing what is naturally prescribed (for example, the use of medicine and prosthesis which might prolong life and functionalities). Of course, the thesis that there exists a sharp division between the behaviour of humans and animals can be (and has been) challenged as we will see below[19]. Naturally, one could invoke degrees of free will, from the most elementary actions of decisions (deciding between apples and bananas), to the most complex ones (campaigning for President, going on strike in a dictatorial regime, or joining together to make a revolution). Our definition will be focused on capturing the latter rather than the former –but the frontier is, by its own nature, rather fuzzy. Notice again that the agents considered capable of making free decisions are not restricted to individuals, but they could also be social classes, political movements, or even species.

5- What can neurosciences say about free will?

The question of the possibility of free will was especially addressed, directly or indirectly, by neuroscience. From this perspective, free will refers to whether animals have the autonomous capacity to make decisions about their behaviour. The theoretical fields that cut across this question are mainly those of DM and consciousness. Here we will analyse the assumptions and implications of these approaches for the central discussion of this paper.

DM refers to the process of selecting an option from a set of alternatives based on its likelihood of leading to the best possible outcome. Most decisions –for example, those that rely on procedural memories (e.g., the motor plan required for speaking), perceptual DM or visual search– involve automatic and rapid processes[20,21]. However, other decisions, such as

economic, social, moral or political decisions, require higher cognitive processing, and may involve conscious access and longer reflection[20,22]. Our previous conceptualisation of complex DM enables integration of all these dimensions under the same type of process[23]. The relevance of these decisions has attracted the interest of different fields, from experimental psychology to economics, providing an amalgam of very heterogeneous studies, including mathematical models, moral dilemmas, and different DM situations, as part of the game theory's framework[24–27]. Most studies from this classical perspective are committed to assumptions of *individualism*, *selfishness* and *rationality* in decisions (mediated by value or utility) and agency; that is, that *individual* decision-makers evaluate the best available options (consciously and rationally) in order to choose the one that is in their *best interest from their own perspective*.

Criticisms to the assumptions of *selfishness* and *individualism* come from works which do not assess individual DM strategies, but cooperative[28], and non-self-interested motivations[29–31]. Firstly, it is worth noting that the cooperative or mutual support strategy is associated with the universal principles of the Enlightenment at the origin of the capitalist system[32]. It has even been described as a movement associated with qualitative leaps in the evolution of life[33,34]. The cultural battle that 'competition between individuals is a fundamental driver for the development of the species' has found powerful allies in the Synthetic Theory of Evolution (Neo-Darwinism)[35,36] and its biologicist/reductionist perspectives have legitimized unequal social conditions or individualism itself[13].

In any case, when analysing the cognitive dimensions of behaviour, the tension between the individual and the collective seems to show that the latter involves a greater benefit but is in principle a fragile phenomenon (with a more unstable equilibrium)[28,37,38], although this could well be explained by the influence of the dominant social norms of capitalism. An example of this is the fact that exposure to self-interest ("selfishness") models, such as Neoclassical Economics, can actually encourage self-interested behaviour[39].

Otherwise, the problem of free will in philosophy has been addressed within the framework of an individualistic philosophy[1]. The assumption of individualism has become entrenched in various scientific disciplines and in philosophy throughout the 20th century. Although the main purpose of this paper is not to discuss this assumption, it is necessary to make it explicit in the various positions that adopt it uncritically. In our proposal, we aim to distance ourselves from this assumption.

The first empirical breakdown of the assumption of "rationality" was addressed by Daniel Kahneman, who proposed that value-mediated decisions depend on relative preferences, often perceived as positive (gain) or negative (loss), based on a neutral reference that can be affected by various factors, such as social norms, expectations or level of aspiration, which may or may not be realistic[22,25]. In this sense, and according to Elster:

> *"Rational choice theory is primarily normative and only secondarily explanatory'; since 'desires and beliefs are the reasons for action': 'a rational actor chooses the action that*

realizes his desire to the greatest extent possible, in accordance with his beliefs and the totality of other desires"[40].

Kahneman's perspective challenged the Enlightenment view that humans can make purely rational or logic-based decisions and opened up the possibility of thinking of (complex) decisions as processes affected by a multiplicity of factors, intrinsic and extrinsic. It is therefore strongly accepted that decision-makers are affected by their cognitive (and social) biases, emotions, priming and social behavioural aspects during such processes[25].

While the preceding perspective is compatible with the classical notion of free will, Kahneman's proposal does not cancel out the possibility of agency and freedom. Dual process theories (DPTs), where Kahneman's work is framed, propose two types of cognitive processes involved in reasoning and DM: processes conceptualized as 'system 1' are characterized as fast and automatic, involving implicit and emotional processing and whose response does not involve conscious access; whereas 'system 2' processes involve explicit, deliberative, flexible, slow processing and always accompanied by awareness[41–43]. While most DPTs consider these processes as dichotomous (although there may be some interaction)[25,43–45], alternative hybrid models suggest a continuum between the two, and even distinguish between processes based on implicit learning (system 1) and automatic ones, defined by the individual's ability to consciously access behaviour, but not the ability to control it[43,46–48].

From the latter perspective, it is hypothesized that reflexive processes work with the preceding sensory information plus the information processed by the automatic process, thus being able to confirm or modify the final decision[42]. The taxonomy of decisions according to DPT refers to criteria defined by the type of processing and not by the object of the decision. Thus, complex decisions could involve both automatic and reflexive processes. In this sense, we speculate that there are social conditions that may promote reflexive processes or disfavour them, with automatic response predominating[49]. Thus, this perspective does not close off the possibility that, under certain conditions, and even under the influence of these implicit processes, decision-makers may take voluntary control of the decision. From these theoretical frameworks, we propose that the degree of freedom with respect to DM will be given by the involvement of reflexive processes. Even under the effect of repetition and emotional priming, top-down mechanisms can be triggered that minimize the deterministic effects of priming during the decision, expanding the degrees of freedom and volition[23,50].

What is the ontological nature of these top-down mechanisms? Although top-down mechanisms can be interpreted narrowly as those higher cognitive processes that influence information processing at previous levels, it is worth broadening this view, incorporating in an ecological sense how the social and cultural environment can impact DM processes (through the involvement of cognitive cortexes that process social aspects). In this way, without blinding the laws of physical, chemical and physiological processes, the level of complexity of the social and cultural can impact, with its own laws, on the DM process. As we have seen in the previous section, there is no room for free will if a reductionistic ontology holds. On the other hand, an ontology in which the different levels of reality are articulated in a non-reductive way could serve as the basis for an ontological account of the

notion of free will, and this would be in turn in accordance with what was previously experimentally reported[23]. In this sense, different levels of reality (molecular, individual, social, environmental) determine the conditions under which decisions can occur, favouring or not more deliberative processes, and therefore impacting the degrees of freedom that willed action can have.

However, despite all that has been noted before, the most influential objection to the idea of free will, from a neurophysiological perspective, is based on the results of Benjamin Libet's experiments. Although Libet himself refrained from supporting free will skepticism based on his results, other authors have relied on his results to defend a more radical position[51]. In Libet's experimental paradigm[52,53], subjects were required to perform a simple, voluntary, spontaneous motor action with the goal of stopping a clock. Participants are instructed to control their agentive experiences and identify the position of the clock hand at the moment when they first become aware of the "decision", "impulse" or "intention" –Libet used these terms interchangeably– to act. While the subjects were acting and controlling their impulses (intentions, decisions) to act, Libet used an electroencephalogram (EEG) to measure their neural activity. These measurements revealed preparatory brain activity (readiness potentials (RP)) that preceded the moment when subjects claimed to be aware of their decision by about 350ms and motor action by about 550ms. The argument that follows from these results is that, if there is neural activity that relates to action, before consciousness is expressed, then it is not true that it is the subject who is making a decision consciously and freely. The main problem with this argument is that it is a reductionist stance, which attempts to explain more complex processes only from simpler processes, such as physiological ones. Although physiological processes are involved (no one denies the existence of RP in Libet's experiment), voluntary decisions, or those requiring longer time scales[54], may well be caused by multiple factors, some of which depend, as we saw in the previous section, on higher levels of complexity such as social and cultural levels.

Otherwise, Libet's paradigm itself has several methodological problems. For example, subjects have their attention divided between the position of the clock and their own agency. The requirement to divide attention between two perceptual streams in this way can increase the cognitive complexity of the process and even be a notorious source of error in judgments of temporal order[55]. Despite these difficulties, Libet's basic findings have been replicated by a number of laboratories in studies that do not encounter these methodological difficulties. In most of them, there is consensus that these simple, voluntary and relatively spontaneous actions are preceded by RP by approximately 400-1000ms[56–59].

While some authors have taken a strongly sceptical position on free will, some even suggesting that it is a mere illusion[51,60], others argue that the actions studied in these experiments do not represent all voluntary and complex decisions[61–63]. Adina Roskies, for example, argues that Libet's actions are, at best, "degenerate" examples of free will: actions initiated not by conscious decisions, but by the RP. She suggests that, if we are really interested in assessing how consciousness and freedom (and responsibility) relate to action or behaviour, we should focus on actions that are based on our reasons and motivations[62]. In this

sense, our proposal of general free will is compatible with this conceptualisation of "degenerate" free will, being cases in which it is not possible to prove whether it is entirely a case of free and willed action or whether it is an automatic process. Both in the case tested in Libet's classical experiment (to press or not to press a button to stop the clock) and in our earlier example of the convict in jail (to drink or not to drink water), these agents conform to what they can do without constraint, since such actions can certainly take place in a deterministic world.

The main objection to the sceptical position goes back again to the fact that we can distinguish between two types of processes: automatic or deliberative decisions. As previously analysed, willed decisions can have different degrees of freedom depending on the predominance of automatic or deliberative processes. In this sense, the experimental task in Libet's paradigm induces willed action, but since it lacks relevance for the subject, constitutes a particular example of agency in which automatic components predominate in the willed action[64]. Although Libet's actions involve an act of will, they do not involve deliberation, at least not immediately prior to the action. In this sense, Roskies is right to identify the central cases of free will with deliberation and rational reflection. In fact, the evidence suggests that RP behaves very differently in the context of deliberative action[65]. If RP is not necessarily causally involved in deliberative processes, the question that arises is whether Libet's results are evidence that RP involves neural activity that causes movement (motor activity). In fact, some authors even question the causal chain "RP onset → awareness → movement"[66]. For instance, Tim Bayne distinguishes between two notions of initiation, a weak and a strong one[64]. In the weak one, a free and voluntary action must be initiated by a conscious action; whereas in the strong one, such a conscious decision must be uncaused. Regarding the first version, although it does not always imply that a preparatory neural activity precedes the conscious decision[65], hybrid/continuum DPTs even allow us to interpret this fact without denying the causal role of the conscious decision on the action. In this sense, the RP may correspond to an automatic component of the process, but voluntary action also requires conscious approval or veto[48,67–69]. Otherwise, RP has been observed in decisions that do not involve motor action, or where the decision is not to move[55]. Consciousness would not be the illusionary "phenomenology of conscious initiation" (awareness), but a necessary component of system 2 for the willed action to occur.

On the other hand, the strong version, which incompatibilists are surely inclined to support, establishes the need for consciousness to be undetermined. While awareness would be determined by genetic and acquired factors[70], consciousness itself deals with a more complex problem, where structural elements (neural bases) are interwoven and individualized during development and life experience, endowing it with a unique and singular dimension (individual, subjective, even phenomenological) into a social dimension (intersubjective, cultural, gender, social class, etc.). It is this dimension that, at least, leaves open the possibility of a multi-causal consciousness, where the individual tissue involves elements of different levels that are related, depending on one's personal history, and to a certain degree, in a haphazard manner. Cognitive processes are clearly multileveled, and would encompass

both unconscious and conscious processes. Most cognitive processes are unconscious, but with a certain degree of complexity and arousal some cognitive processes become conscious.

Furthermore, it is clear that consciousness appears at different levels of complexity. The complex neurodynamic of cortical networks often involve activities related to perception, attention and associative memory, but also volition and activity in sensory and motor areas[71]. If we understand volition in free will as a process of conscious intentionality, then it should comprise the operations of predicting, planning and learning actions[72]. Intentions involve the brain's creation and projection of alternative desired or feared future states. Such hypotheses are constructed from inferences from past experience, and serve to control choices and directions of actions in the present. Presumably, as Liljenström rightly points out, intentionality or free will cannot be explained by linear causality but rather by circular causality[71]. This type of causality best represents the complexity of the cognitive processes, involving 'action-perception cycles', in which perception is both the result of a preceding action and the condition for a following action, so that both events are integrated into the same inseparable process. This perspective is not only consistent with hybrid theories of dual processes, Emotion 2-factor theory, the integration of top-down and bottom-up processes, and post-cognitivism positions, but is also more compatible with the non-reductionist position we are adopting in this work.

What might be the ontological nature of circular causality in complex processes such as free will or consciousness? It could be argued that basic physiological phenomena have more to do with the lower levels of physics and chemistry (or biology), while the higher ones (those involving reflection and planning) could be linked to a level of reality that is not reducible to the above and that gives rise to varying degrees of indeterminacy. This is the limit of the "covering laws" mentioned in the previous section.

6- Can animals, other organisms, or even cells have free will?

The notion of will in animals has been analysed extensively in the literature. The positions vary from those who affirm that animals have no will at all (and thus, no free will), to those that affirm that all animals have it. If human beings are considered a result of a process of natural evolution –and if *Homo sapiens* are assumed to possess free will– the question about how this special feature might have arisen in natural history emerges. Do animals possess will (and free will) in different degrees? For example, one might think that a dolphin or a chimpanzee have more free will than a cockroach or a jellyfish. There exists some sort of consensus in the idea that superior mammals have consciousness and free will to some degree. But the definition of these notions is, of course, problematic.

During Modernity, *speciesism* –and, in general terms, a good part of humanism– has identified the human being with the quality of agency, that is, with the particularity of possessing free will. The rest of living beings, in general, have been categorized in a lower

hierarchy, lacking agency or free will. This type of experience originates in the total distinction, accepted in spite of all evidence, between *Homo sapiens* and the rest of the animals; a distinction that acquires its most famous and finished form in Descartes formulations[73]. Cartesian body-soul dualism entails the idea that animals are simply automata[74]. Descartes condemns animals to be nothing more or less than clockwork, simple machines[75]. This idea made it possible to justify the dissection of live animals and their use in the cosmetic, pharmaceutical and food industries, among others: if animals are just machines, they do not suffer pain. This is very convenient given that the purpose of the lives of many millions of animals (to be born, to live –for a short time– and to die) is to serve human consumption and human needs. We can only be sure of our own sensations, of our own pain or suffering. The legacy of that period manifests itself today in our attitude towards laboratory animals. Typical laboratory animals such as mice or rabbits are not capable of expressing their suffering in the way we humans do. The justification for this type of mistreatment is also supported by arguments such as the one that states that since animals are not capable either of recognizing that they have rights or of fulfilling obligations, no rights can be attributed to them[75].

A speciesist philosophical tradition, from St. Thomas Aquinas, through Descartes and Kant to Nagel, is opposed by the vision of a few philosophers with an animalistic and anti-speciesist stance[75]. Such is the case of Montaigne and his thesis in relation to the image of the circle of the living, which is opposed to the thesis of the scale or hierarchy where the human being stands above other creatures, a thesis defended by humanism in general. The thesis of the circle of the living will come to present and represent a critique of the humanist positions of the time, highlighting an approach against presumption (in its metaphysical, ethical, political and economic dimensions), in short, against human vanity and pride[76]. It is noteworthy how this speciesism, this presumption, is highlighted by Montaigne in a pathological key: our illness.

The process of DM has historically been related to the concepts of intelligence and will. The capacity to make decisions is considered a necessary and sufficient attribute of a subject endowed with intelligence who acts with will and intention. However, areas investigating DM processes, whether associated with biological or artificial entities, have relaxed the term in recent decades. It is common, nowadays, to speak of decisions made by programs, algorithms or robots, without necessarily presupposing that they have free will. Similarly, in the field of molecular systems biology it is common to investigate mechanisms of cell DM[77,78] in reference to the process by which cells gather information from their local microenvironment and regulate their internal states to create appropriate responses, without implying that cells have consciousness or free will. On the other hand, there has also been much progress to support animalistic and anti-speciesist positions, which consider that empathy and ethics also exist in other species. For instance, De Waal's investigations shed light on how we evolved from a long line of animals that care for the weak and build cooperation through reciprocal help[79].

However, there are positions that connect human beings to the rest of living forms, but not on the basis of granting other species human virtues or capacities. On the contrary, these positions deny the existence of free will, putting this concept in the same bag that former "esoteric" postulates such as the soul, the ether or the vital principle occupy today in

the scientific worldview. One of the authors who best describes this perspective is Anthony R. Cashmore. This author argues that any action, no matter how "free" it may seem, simply reflects the organism's genetics and environmental history, down to a fraction of a microsecond before any action. Thus, there is a trinity of forces –genes, environment and stochasticity (GES)– that governs all of biology, including behavior[51]. The will, according to this author, has no causal properties. Consciousness (to whose existence this author is committed), rather than being a means by which we influence behaviour, is simply a mechanism by which we record unconscious neural activity and behaviour. Cashmore draws on important thinkers who have preceded him. Such is the case of Thomas Huxley, who reviewed the history of the hypothesis that animals are automata and argued that the feeling we call volition is not the cause of the voluntary act, but merely the symbol in consciousness of the stage in the brain that is the immediate cause of the act: "the steam-whistle which accompanies the work of a locomotive engine is without influence upon its machinery"[80]. Similarly, Albert Einstein posited that if the moon, in the act of completing its eternal path around the earth, were endowed with self-consciousness, it would be completely convinced that it is traveling its path by itself[81]. According to these conceptions, consciousness then gives us an apparent sense of responsibility, of agency, the illusion of control. While the impression is that we are making "free" conscious decisions, the reality is that consciousness is simply a state of self-perception that reflects the inputs, and these are an inevitable consequence of the GES trinity. In short, our free will would be an illusion and our response mechanisms would be no different in essence from those governing the behaviour of a yeast.

In summary, there are three main positions regarding the possibility of existence of free will in animals: those who affirm that animals, like humans, possess free will (at least some of them and to some extent); those who deny free will for both humans and non-human animals; and those who maintain that only humans are free agents. Our goal is to find the minimal conditions that an ontology must satisfy in order to grant the possibility of free will. As we have previously seen, an ontological reduction to the lower levels of reality seems to be incompatible with that goal. Indeed, many of the authors that claim that consciousness is nothing but a useful fiction, silently assume a reductionistic position. On the contrary, from the perspective of an anti-reductionist or pluralistic stance in which real possibilities are assumed to exist, the ground for a very general definition of free will can be found, as we show in the next section.

7- A non-reductionist definition of free will related to undetermined potentiality

From our previous analysis, it can be argued that a condition of possibility for the existence of actions based in *stricto sensu* free-will is the existence of real possibilities. So, free actions develop or make such possibilities actual. In this regard, a revision of the Aristotelian distinction between *potentiality* and *actuality* can assist us. In this framework, agents act by bringing possibilities into actuality. In this process the agent not only brings

potentiality into actuality but is also involved in the emergence of novel undetermined possibilities.

It's worth reminding that if the actions of the subject were entirely undetermined, there would be no room for strong versions of free actions, as any decision would be a purely random movement. At the same time, a mechanical cause-and-effect determination of the environment on a subject –where biological and physico-chemical determinations function only as a clockwork mechanism capable of processing environmental information and generating a (theoretically predictable) response– would also preclude the possibility of disruptive free and voluntary actions.

Aristotle distinguished between actuality and potentiality to account for change. How should we understand these notions in the philosophical tradition? Change is, according to Aristotle, the passage from a state of potentiality to a state of actuality. But actuality is prior to potentiality, not in the order of time, but in the sense that it has ontological priority over potentiality. Actuality is understood as the reality of being: potentiality makes sense if it is understood in relation to actuality (in light of actuality). Actuality is the principle of being, inasmuch as it is what determines being, that is to say, it makes being *what it is*[82]. There are beings insofar as there is actuality. Potentiality, on the contrary, is associated with virtuality, with possibility, with a sort of non-being; potentiality is understood as *imperfection*: a risk for being[83]. Potentiality in Aristotle is always the potentiality of something *determined*: a boy is potentially a man, but a man is not potentially a horse (something is potentiality X and not Y).

Therefore, in opposition to properties in actuality, properties in potentiality are considered deficient: they are what has not yet been brought into actuality. According to this ontological perspective, possibility or potentiality is not actual (it is not real), but a kind of lack in itself or lack of reality, which endangers being. The field of potentiality, strictly speaking, is not real like that of actuality. In the Aristotelian sense, actuality is responsible for persistence insofar as it informs change, being ontologically prior to potentiality. But that is not the only way to understand potentiality.

In our proposal, potentiality is a condition of possibility for strong versions of free will, i. e., a condition of possibility for an ontology to give room for *stricto sensu* freedom. How should we understand the dimension of the possible? There are different ways to understand the realm of the possible. Possibilists hold, on the basis of the distinction between actuality and potentiality, that some things are not actual but they still have *being*. There are things that are not actual but *could have been*. For classical possibilists there are different modes of being. There is *actuality* (or *existence*) and there is another mode of existence –sometimes called *subsistence*– which is the existence of the things that are not actual or that fail to be actual. These things are called *possibilia*: things that are *contingently* non-actual[84]. Existence can be understood in Aristotelian terms, as something that has been brought to actuality. But it can also be understood as *concrete* existence in space-time, more than simply actuality. According to this position, the set of being things is bigger than the one of existing things, because the former includes abstract entities. I. e., in order *to be*, it is not necessary *to*

exist (to concretely exist in space and time nor to be actual). For possibilists, some things (of course) exist, but there are things that do not exist, while they still "there are".

There are different kinds of possibilisms, even though it is common to call just *possibilism* to classical possibilism. David Lewis holds a peculiar view, named *Lewisian possibilism*. While classical possibilism assumes that there is a distinction between *being* and *existence* (or *actuality*), Lewis denies that, following Quine[85]. According to Lewis there are no things that do not exist but could have existed[86]. But Lewis makes a distinction among existence and actuality: some existing things have not been brought to actuality. But actuality is not an intrinsic property of things; actuality is a relation: a thing is in act relative to another thing when they occupy the same possible world[87]. No particular ontological property separates possible objects or worlds from worlds or objects in act. Possible worlds exist as the actual world does[88].

Despite the differences among these positions, we do not aim to address possibilism here, but we consider these proposals relevant, as they highlight that the realm of the possible can be understood not merely as a lack of being –or a sort of non-being, as in the traditional Aristotelian approach. Free will is a causal power of producing something new, as making real or bringing something possible into actuality. The produced novelty can be more or less far away from what was expected, and regarding that, our definition of disruptive free will actions is relevant. Let us recall that in this kind of actions, the agent performs a free will action that lies beyond deterministic and probabilistic laws at lower levels of reality, producing thus, creatively and voluntarily, a new state of things.

Disruptive free will can be defined as the production or causal creation of novelty. Since it is a matter of degree (there can be more or less free will), we are especially interested in those cases where novelty emerges. This creative or causal production of novelty can be understood as bringing possibilities into actuality. We do not necessarily commit here to any specific form of possibilism; we rather evaluate the presence of greater free will insofar as less anticipated possibilities are actualized, or as novelties are generated that more profoundly transform a given context –i. e., which depart more significantly from an expected outcome. That does not mean that potentiality must *exist* in the same way as actuality does, but it requires potentiality to be considered as undetermined and not merely subsidiary to actuality.

Free action does not mean for us an undetermined action, unrestricted by any limitations. It does not mean simply a non-conditioned action by external or internal constraints. Rather, we understand disruptive freedom, in the cases in which we are most interested, as the capacity to create radically new scenarios from a given situation –scenarios that are not the expected ones. Let us emphasize what we have pointed out in previous sections: contemporary scientific knowledge points in this direction, since the regularities historically represented as natural laws acquire a statistical character, while the universe of possibilities is bounded or restricted by what we consider to be fundamental limits. We can identify the universe of possibilities, restricted by certain boundaries that give shape to phenomena represented in scientific knowledge as fundamental laws (such as the

impossibility of superluminal communication or motion, or the existence of universal constants themselves), as the set of potential existences: entities or events.

In our proposal, *stricto sensu* liberty is not simply the possibility to do otherwise, or the possibility of having wished otherwise. It is a power to create something different, something not expected given certain preconditions. The accent would not be placed on the free decision (to do otherwise), or on the non-determination of the will (to have been able to desire (will) otherwise), but on a causal power to create something new, something not expected given the previous state of things, i. e., to produce some ontological novelty in the world. Related to our proposal regarding free will, a positive notion of freedom[89–92] can be grounded in an ethic of *potentia*[93]. According to this view, relationships and agencies are valued based on their capacity to give rise to a greater and more diverse expression of the potentialities that can be brought into actuality. Furthermore, to place the focus on the notion of potentiality leads to a positive notion of freedom as an *ethical* idea.

The above discussion can be connected argumentatively with the distinction between individual and social degrees of freedom. As we have shown in certain examples, an individual can develop free actions. But when an action creates something radically new, in cases of disruptive free actions, it seems reasonable to expect those actions from collectives. Some possibilities that are far away from the actual state of things will hardly be actualized by an individual, but can be actualized as the result of a collective praxis: the laws created as an expression of the general will[94], the transformations produced by the working class or the modifications of the law energized by womens'movements[95], to provide a few examples. A radical new project is more likely to be the result of a collective praxis and not of an individual's decision. The human being is, above all, a social animal.

8- Conclusions

In this work we have discussed the conditions for an ontology to grant the possibility of actions based on free will. This analysis led to a very general account of an agent with free will. We have addressed different aspects of the problem. By analysing different paradigmatic cases, namely, the physicalist approach, extant discussions about free will in biological systems and the neurosciences, we have outlined the general features that a complex system must possess in order to be capable of making decisions or taking actions based on strong versions of free will. We have seen that the mere existence of real chances in nature is not enough for granting the possibility of free will. A reductionist approach based on deterministic laws, or even in the probabilistic laws of quantum physics, would only give place to a passive system, which is not capable of changing its conditions of existence in a substantial way. We have argued that actions based on *stricto sensu* free will can lie beyond deterministic and probabilistic laws that operate at lower levels of reality and that define the scenario into which the agent is thrown. As a consequence of an action based on disruptive free will, a new set of rules, possibilities and conditions must emerge. Thus, we have

established a difference between disruptive decisions based on free will on one side, and elementary decisions on the other, since the output of the latter results in a passive reproduction of the conditions previous to their instantiation. We have stressed the relevance of this difference using the examples discussed in Section 2. Though the frontier between them might be fussy, one can identify two qualitative different limits.

We have shown that our definition can successfully accommodate many paradigmatic examples. It can accommodate the actions of individuals (humans and non-human animals), political groups, social classes or even States. Some of these examples might be considered with respect to our definition of free will, as is the case with artificial intelligence systems, since one could be reluctant to admit that a machine is capable of making decisions based on free will. Notwithstanding, the generality and adaptability to different ontologies of our proposal could be considered as an advantage, since it could be useful for addressing problems related to ethics with regard to the implementation of policies related to AI –a topic that we will address in future works.

From the perspective we adopted here, we have seen that a revised version of the Aristotelian notion of potentiality can be useful to address the problem of free will. On the one hand, it has a traceable connection with material conditions that give place to randomness in nature, namely, with probabilistic interpretations of quantum theory potentiality. On the other hand, it is a notion which exceeds the fundamental level, and can be used in the social and biological domains. Naturally, our proposal opens the door to further interrogation in specific areas. The definitions of strong versions of free will and freedom of action are implicit in the discussion about which are the concrete rules that should be implemented in order to grant and promote freedom among citizens of a nation. Freedom of choosing our brand of soda, or our occupation, or even pre-established gender options, is usually desirable. But is clearly insufficient according to our definition of freedom based on disruptive free will. Deciding agents should be able to create their own paths and, eventually, to change the rules and regulations, increasing the scope of the possibilities at hand. Our definition of disruptive free will is not restricted to individuals, but it also applies to collectives that might even not have well defined borders of membership. It sheds new light on the problem of establishing how the rules of a society should be designed in such a way that they promote guarantees of freedom to such collective entities. These tasks have become urgent matters in contemporary societies, given the challenges that appear related to clashes of cultures during massive immigration waves, or when trying to improve the standard of living of oppressed minorities. We will expand on these interesting challenges in future work.

In conclusion, we have discussed which conditions are necessary for *stricto sensu* free will and autonomy to exist. We argued that determinism is compatible only with weak versions of free will on the one hand, and stressed, on the other, that our own agency can be interpreted as having causal properties to operate in a world that is neither completely determined nor completely indeterminate. From this perspective, free will agents, far from being putative exceptions in a network of seamless causal connections, are in fact dense concentrations of causal power in a world where it is in short supply. At its heart, autonomy

would matter because it carries the promise that our actions can shape a more just and better world[1].

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