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1. Introduction

There is renewed interest concerning the relevance of Aristotle's thought for contemporary science. This is especially true regarding the political, moral and economic aspects of human life and society. Aristotelian insights have also influenced the natural sciences. Aristotle's metaphysical and epistemological conceptions provide a rich frame of analysis for many different subjects. In the present day, the Aristotelian elements are often blended with other influences. Nancy Cartwright combines elements from Aristotle with others from John Stuart Mill and Elizabeth Anscombe, and others.

In this paper I will address a number of tensions present in Cartwright's thinking, and propose that they might be overcome by a greater reliance on Aristotle and Anscombe's thought. These tensions, I will argue, are due in part to her reliance on Mill. Before enumerating these tensions, I will first outline Cartwright's thinking.

Cartwright understands scientific explanation in terms of stable causes which she calls "capacities" or "natures" (Cartwright 1992: 71, nt. 7). Her general program aims at defining what capacities are (ontology), how they are known (epistemology), and how we use them (Cartwright 2007b: 1). In this paper I will concentrate on the first two topics.

Cartwright opposes Hume's reduction of causality to regularity of mere association: "The generic causal claims of science are not reports of regularities but rather ascriptions of capacities, capacities to make things happen, case by case" (Cartwright 1989: 2-3). She also opposes covering-law explanations because they do not consider causes; they merely include the so-"probed" singular case within a general covering law. Otherwise, Cartwright agrees with Mill's proposal about the existence of "tendencies" which she identifies with her "capacities": "I suggest that the reader take my 'capacity' and Mill's 'tendency' to be synonymous" (Cartwright 1989: 170). According to Cartwright, Mill's tendencies are not tendencies of events but tendency factors or stable real causes. These tendencies or capacities may give rise to Cartwright's "nomological machines" as "stable configurations of components with deter-

minate capacities properly shielded and repeatedly running" (Cartwright 2001: 292; see also Cartwright 1999: Chapter 3, 50)[2].

Cartwright's view has been criticized in different ways. Margaret Morrison (1995) highlights a number of tensions in Cartwright's thought. First, she notes a tension between the singular and universal aspects of capacities (Morrison 1995: 163). Cartwright looks for "a concept stronger and more general" than Humean laws (Cartwright 1989: 145), "not just epistemological but metaphysical as well (…) much like essences" (1989: 146), but she puts singular causes first. Second, Morrison also sees in Cartwright a conflict between her empiricism and capacities, because the assumption that singular capacities are stronger than Humean general laws presupposes a metaphysical commitment that makes verification unnecessary. How could a person be empiricist and metaphysical at the same time? Finally, Morrison considers that Mill's "tendencies differ in important ways from Cartwright's capacities" (Morrison 1995: 166). Another point of criticism (i.e., Emma Ruttkamp 2002: 121; William R. Minto 1997) concerns Cartwright's "local realism" (Cartwright 1999: 23) and disunified view of science. This vision owes mainly to Neurath (see Hands 2001: 78, 313), and is very well illustrated by Figure 0.2 (p. 8) of *The Dappled World* (Cartwright 1999, designed by Rachel Hacking). The figure represents a set of balloons (each balloon being a science), filled with gas and floating in the sky, but tied with threads to different objects on the ground (trees, signals, lights, or another thread). (An Aristotelian interpretation of this representation will be discussed later in the paper). The final topic that I will deal with is Cartwright's skepticism about the possibility of explanation in social sciences. I think that this point needs clarifications that I will offer relying on Aristotle's thought.

In the paper, I will first analyze the Cartwright – Mill connection, then the Cartwright —Anscombe connection, and finally the Cartwright— Aristotle connection. I will show that both Anscombe and Aristotle, as acknowledged by Cartwright, have strongly influenced her capacity's account. The tensions mentioned above will be discussed by first presenting Cartwright's own arguments, which are partly based on Anscombe and Aristotle, and subsequently by considering additional Aristotelian elements. I will also argue, from an Aristotelian perspective, against those criticisms, and for Cartwright's skeptical view concerning successful explanation in natural and in social sciences.

The problem surrounding Cartwright's interpretation of Mill is tackled in the next section about the Cartwright —Mill connection. The problem of the singularism-universalism tension appears in the section about the Cartwright— Anscombe connection. The empiricism-metaphysics tension, and the problem of her disunified view of science, appear in the section about the Cartwright - Aristotle connection. This last section also includes an Aristotelian account and development of Cartwright's statements concerning social science. I will argue that there is still much we can learn from Aristotle with respect to economics and social theory.

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[2] The nomological machine is a methodological instrument that may be applied to different fields. Marcel Boumans (2005b), for example, conceives a measurement instrument as a nomological machine.

2. The Cartwright – Mill connection

Cartwright is quite explicit that her account is connected to Mill's: "[M]y views and arguments are essentially the same as Mill's in modern guise" (Cartwright 1989: 8). Her goal is to develop Mill's proposal to deal with causes in different causal situations (1989: Section 4.5, pp. 170-9). Mill's tendency idea, according to Cartwright, corresponds to "the essential behaviour of a factor" (1989: 203).

In Book III, Chapter X of his *System of Logic*, "Of the plurality of causes, and of the intermixture of effects", Mill argues that one phenomenon can be produced by different causes: "it is not true, then, that one effect must be connected with only one cause, or assemblage of conditions" (1882: 311). One phenomenon may involve a concurrence of causes. This may happen in two different ways. In the first way, the different causes modify or interfere with each other's effects, thus constituting a compound causal action. Mill exemplifies this by the joint operation of different forces in mechanics. In the other way, "illustrated by the case of chemical action, the separate effects cease entirely, and are succeeded by phenomena altogether different, and governed by different laws" (1882: 315). In the first case, Mill explains the action of each cause by saying that "it *tends* to move in that manner even when counteracted" (1882: 319: italics in the original). He concludes: "All laws of causation, in consequence of their liability to be counteracted, require to be stated in words affirmative of tendencies only, and not of actual results" (1882: 319). Cartwright (1989: 179) concludes from this that: "Mill's view has to be that the fundamental laws of nature are laws that assign stable tendencies to specific causes."

A few words on Mill's thinking about social sciences and Political Economy should be added to understand the problem involved[3]. In Book VI of his *System of Logic*, "On the Logic of the moral sciences", Mill describes the difficulties of knowledge in these sciences, given the complexity of their subject, the innumerable influencing circumstances and its modifiable character. He argues that it is extremely difficult to arrive at "the ultimate laws of human action", i.e., causal laws in this realm (1882: 597).

The only thing we can do in each branch of these *moral* sciences is to propose a hypothesis or *axiomata media* (originated inductively by our general knowledge of the topic of study) in accordance with the previous highest —and also hypothetical— generalizations we have about human nature, that are then to be verified (or not) as empirical laws. The first part (two first steps: hypothesis and deduction) of the method is called *a priori*, and the last one (empirical verification) is called *a posteriori* (1882: 605). The whole method is called *Deductive* (1882: 599). This method is applicable only when the plurality of causes is of the mechanical kind, i.e., allows for a composition of causes. When the plurality is of the other kind, a chemical-like one, the only possible method is experimental, in order to try to isolate the different influencing factors. But this is impossible given that we cannot do experiments in the required conditions specified by Mill (1882: 610-3).

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[3] For a good exposition of this topic, see Hausman 1981 and 1992, pp. 123-151, and Hands 2001, pp. 14-25.

Mill affirms that there is one branch of social science that can be studied according to the Deductive method, namely, Political Economy. This is because a main motivation for action in this field can be identified, i.e., the desire for wealth, allowing us to apply this method, explain, and even make predictions. He recognizes, however, that "there is, perhaps, no action of a man's life in which he is neither under the immediate nor under the remote influence of any impulse but the desire of wealth" (1882: 624). It would thus be "absurd" for any political economist to try to apply to a particular case his conclusions. These derive from treating the considered end as the sole end, which is unrealistic (1882: 624-5; see also 1874). Mill adds: "This approximation has then to be corrected by making proper allowance for the effects of any impulses of a different description" (1882: 625). The Deductive method of Mill resembles the Exact Method of Carl Menger (quoted by Cartwright 1999: 3 and 2002: 147).

As mentioned in the Introduction, however, Cartwright has been criticized for her interpretation of Mill. In addition to Morrison, Christoph Schmidt-Petri (2008) argues that Cartwright's capacities are significantly different from Mill's tendencies, which he also believes are problematic in the context of Mill's entire thinking. According to Schmidt-Petri, Mill uses the concept of tendencies for entirely practical methodological reasons rather than for metaphysical reasons (2008: 292). They thus do not support Cartwright's realist view of capacities (2008: 298). A related problem is the internal inconsistency of speaking of real causes in Mill's Humean like context.

This last point is considered by Cartwright (1989: 178-9). She quotes Peter Geach on this point, but she may underestimate the possible inconsistency. Recently, however, Cartwright, in her reply to Schmidt-Petri (2008b), has admitted that she was possibly wrong in extending to Mill her concept of tendency. Geach (1961: 103) argues that Mill, confronted with the facts, was obliged to affirm the existence of these real tendencies. But he complains about finding this doctrine "mixed up with an entirely incompatible Humean invariable-succession theory"[4]. The point about this "unofficial doctrine of tendencies" is also made by Quentin Gibson (1983: 298): it "is inconsistent with his view of laws as invariable sequences".

It can nonetheless be argued that Mill was fundamentally a Humean about causality. The concept of cause in its basic sense, according to Fred Wilson (2007: 12), "is acquired through our experience of matter-of-fact regularity: it is one that relates phenomena to phenomena and not phenomena to *noumena*". A law is a regularity; to explain a fact is to put it under a law. "The ideas are joined to form a judgment of regularity, a causal judgment" (2007: 18). According to Craig Dilworth (2006: 14), "in the spirit of Hume and in defiance of common sense, Mill (…) identifies causality with succession." He also explains how N. R. Campbell attacked Mill for his Humean conception of causality as succession (2006: 27). John Skorupski (1989: 175) states: "He [Mill]

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[4] He adds that Mill's tendencies are very close to Aquinas doctrine of *inclinationes* or *appetites* in nature – interestingly, because these inclinations are also very close to Cartwright's capacities of nature (cf. Geach 1961: 104-5).

regards causation exclusively as a relation between phenomena. Uniformities in the spatio-temporal relations among phenomena are all we can know. If there are 'metaphysical' causes —causes lying 'behind' natural phenomena— we can know nothing of them; nor need they be taken into account in the analysis of inductive reasoning". Geoffrey Scarre (1998: 114) considers Mill's scientific project to be "metaphysically abstemious in its construal of causes as constant conjunctions, devoid of any hint of *a priorism* in the definition of scientific ideas, and disposed to evaluate successful science in terms of its provision of law-like generalizations to explain phenomena". Notwithstanding, Scarre differs from Skorupski when he states that for Mill theories "were more than conceptual devices for instilling order in the observational data and for facilitating predictions of phenomena" (1998: 130). For Scarre, they had a realistic aim of representing the world as it actually is (cf. 1998: 135).

Robert McRae (1948), however, suggests there is a change in Mill's conception of causality. First, we have the Mill as recipient of Berkeley and Hume. Mill states: "when I speak of the cause of any phenomenon, I do not mean a cause which is not itself a phenomenon; I make no research into the ultimate or ontological cause of any thing (…) Between the phenomena, then, which exist at any instant, and the phenomena which exist at the succeeding instant, there is an invariable order of succession (…) To certain facts, certain facts always do, and, as we believe, will continue to succeed. The invariable antecedent is termed the cause; the invariable consequent, the effect" (1882: 236-7). Then, however, in the same book, "after defining the causal relation as invariable succession between phenomena, Mill introduces considerations which are incompatible with that definition" (McRae 1948: 242). Mill realizes that there are cases in which temporal succession is not the sign of causality (e.g., day and night). As a result, he concludes: "Invariable sequence, therefore, is not synonymous with causation, unless the sequence, besides being invariable, is unconditional" (Mill 1882: 245; see also 582 –Book VI).

There are also some ideas to be found in Mill's work that are at odds with Cartwright's account of Mill: The first one is Mill's absolutely strict methodological individualism – noted by Daniel Hausman (2001: 302), Skorupski (1989: 275 and 281) and Wilson (1998: 239-45 and 2007: 31-32, 34). The Deductive Method by considering separately each cause-effect relation denies social relation as another cause or socially relevant factor. In Hausman's words, "to speak, as Mill does, of a deductive method, is misleading because the law governing the conjoint operation of causes cannot be deduced from the laws governing the component causes separately" (2001: 302). This, I think, is another inconsistency in Mill because Mill recognizes that there is a mutual interaction between effects and causes, which makes explanation even more difficult (1882: 632). Cartwright, to my understanding, would not agree with methodological individualism (see e.g. Cartwright 2007a: 26 and 75). However, one may wonder whether her nomological machines with stable causes acting individually and composing effects are not analogous of Mill's methodological individualism. The nomological machine analogy is not an organic analogy (Cartwright 2001: 290). This doubt, however, does not seem to be compatible with Cartwright's following description of nomological machines: "The

machines of interest here involve a relatively stable arrangement of parts which gives rise to a number of interconnected causal processes inside the machine plus some kind of skin or shield that limits access to the internal variables under a variety of common circumstances" (2007a: 18).

The second point is Mill's determinism. The word "determinate" continuously appears in Mill's *Logic*. This is often highlighted by scholars dedicated to Mill's thought (cf. Wilson 1998: 205, 251; 2007: 20). However, the spirit of Cartwright's proposals seems deeply contrary to determinism (see, e.g., 1999: 6, 110 about our "messy world").

Another difference between Mill and Cartwright is pointed out by Wade Hands (1994: 757-764). Cartwright empiricism, says Hands, is a practical one. Given the concepts of under-determination and theory-ladenness, we "take the naturalist turn and accept the actual practice of science in determining what science is" (Hands 1994: 760). Scientists believe in and intervene with capacities (Cartwright 1989: 168-9, 1992: 60-1). Thus, Cartwright is a naturalist first and then an empiricist. Mill instead is first an empiricist and then a naturalist. As Hands very well expresses it, for Cartwright

> the final court of appeal for philosophical debates about science is the actual practice of science (…). [W]hat science is must be regulated by the practice of science, and she argues repeatedly that real practicing scientists actually do presuppose that capacities and causal powers exist in systems they study (2001: 313 and 315).

Hands attributes this to Neurath's influence (see Cartwright 2007a: 11 and 48). In this regard Cartwright's thought also resembles Ian Hacking's (1983: 31 and Chapter 16) as she acknowledges (e.g., 1999: 5, 34).

The conclusion, then, is that Mill's ideas about the nature of causality and consequently about the methodology of science are inconsistent. In my view, this inconsistency is reflected in Cartwright's early account of Mill and the ideas she shared with him in her earlier works. There is some coincidence between the realist Mill and Cartwright, but she has discarded the other —probably the more genuine – Mill, the Humean Mill.

3. The Cartwright – Anscombe Connection

At the beginning of the first chapter of her *Hunting Causes* (2007b: 11), Cartwright states: "The central idea behind my contribution to the project [on causality] is Elizabeth Anscombe's". Cartwright refers to Anscombe's paper "Causality and Determination" (Anscombe 1971)[5]. In this chapter, Cartwright highlights the individual character of causality and the plurality of causes. She concludes by affirming: "I have presented the proposal that there are untold numbers of causal laws, all most directly represented using thick causal concepts, each with its peculiar truth makers" (2007b: 22).

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[5] Inaugural Lecture for the chair that had been held by Wittgenstein at Cambridge. Anscombe studied with Wittgenstein and was one of his literary executors (she translated him and wrote *An Introduction to Wittgenstein's Tractatus*). She was an Aristotelian and her most famous book, *Intention*, was inspired by Aristotle, and became a philosophical classic.

In *The Dappled World* (1999) she dedicates Chapter 5, "Causal diversity; causal stability" "to Elizabeth Anscombe, from whom I learned" (1999: 135). The context of this chapter was to show the particularity and multiplicity of causes: "there is a great variety of different kinds of causes and (…) even causes of the same kind can operate in different ways" (1999: 104). She also quoted Anscombe (1971) in *Nature's Capacities and their Measurement* in this context: "often the operation of a cause is chancy: the cause occurs but the appropriate effect does not always follow, and sometimes there is no further feature that makes the difference" (1989: 105).

In the essay quoted by Cartwright, "Causality and Determination" (Anscombe 1971), Anscombe argues two main theses. The first is that she "refuse[s] to identify causation as such with necessitation" (1971: 88). "Causality" she affirms, "consists in the derivativeness of an effect from its cause" (1971: 91-2). And she reasons (1971: 91):

> [I]t's not difficult to show it prima-facie wrong to associate the notion of cause with necessity or universality (…). For it being much easier to trace effects back to causes with certainty than to predict effects from causes, we often know a cause without knowing whether there is an exceptionless generalization of the kind envisaged, or whether there is a necessity.

Related to the possibility of observing causality in individual cases, Anscombe discusses two arguments. First, we actually use many causal terms in ordinary language. The idea of causality comes from an abstraction that begins with particular observations of different kinds of singular causations: "scrape, push, wet, carry, eat, burn, knock over, keep off, squash, make, hurt" (1971: 93). And this happens to such a degree that if a language did not include causal verbs we would not be able to speak about the world. The second argument stems from the problem of induction. We cannot obtain a singular cause from a generalization. Adding the clause "if normal conditions hold" is too vague. The task of excluding all the required circumstances cannot be carried out, and we do not know if we know all them.

The second thesis is an argument against determinism and for indeterminism, and she also defines the latter. She distinguishes between being determined in the sense of pre-determined and determinate. What has happened is determined once it happens and this is obvious (this is the sense in which Aristotle affirms that the past and present are necessary). What she is concerned with is pre-determination. Here another distinction arises: there are non-necessitating causes, or causes "that can fail of [their] effect without the intervention of anything to frustrate it" and necessitating causes, or causes that can only can be frustrated by interference[6]. Indeterminism, then, is the thesis that not all physical effects are necessitated by their causes. This does not mean, however, that indeterminate effects have no causes (1971: 101). The Aristotelian account of causes explains this non-necessitating cause.

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[6] For example, tetanus is a necessitating cause of death because without treatment it is not possible for one who has tetanus to survive.

Anscombe's account of causation seems to fit with Cartwright's ideas. First we observe singular causality, then we look among causes for those that are stable, and finally we say we have a law and a set of causal laws or capacities —a nomological machine— that would hold if there were not interferences. There is a plurality of causes, and indeterminism may hold even in the physical realm (see Newman 1995: 277 on Cartwright's denial of ontological determinacy)[7].

Cartwright's reply to Morrison (1995) concerning the possible tension between her singularism and universalism recalls Anscombe. Cartwright states (1995: 179-180):

> I would say that our central usage of tendency terms supposes that the association of tendencies with properties or structures (…) need not be universal; it may hold across certain regimes or domains. But within the domain in which the claim of association can be regarded as true, the tendency when appropriately triggered will always operate unless there is a good physical reason why not.

Here she is referring to necessitating causes, but she also seems to include Anscombe's non-necessitating causes: "But the exercise of a capacity need not occur universally upon triggering even when nothing interferes" (2007a: 20; cf. also 2, 4, 50-1).

There are two other points I would now like to make. First, Cartwright does not take into account —nor does she deny it— the relationship between human freedom and determinism. One may wonder whether here she follows Mill who is determinist (1882: 581 ff.). The differences between the natural and the human realm seem to be only a matter of complexity given the plurality and the unpredictable character of the causes. Anscombe states that physical indeterminism is indispensable to human freedom – we cannot be free if we do not have some control over our own physical activity. She adds, however, "but certainly it is insufficient. The physically undetermined is not thereby 'free'. For freedom at least involves the power of acting according to an idea", and this goes beyond mere non-predetermination of an indeterministic physics (1971: 102). Here we have a reason for the greater complexity of human affairs that Cartwright states; but she does not use this argument to explain it. There seems to be a lot of room for freedom in Cartwright's thought (for example, this seems to underlie Cartwright and Del Seta 1997). However, what would she say about freedom in the social sciences? I will come back to this topic in the next section.

A second point is that Anscombe's position supposes a strong metaphysical commitment regarding causes which Cartwright shares. On some occasions she leaves this commitment aside (e.g., 1992: 47-8, reprinted in 1999: 81; 2001: 277). This, however, would involve returning to what she is criticizing; instead of a kind of general nominalism we would have a singular nominalism. We

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[7] Adrian Heathcote and D. M. Armstrong (1991), while maintaining that there can be a singular identity between a cause and a law, though established a posteriori, and contingent, both quote Anscombe (1971) and Dupré and Cartwright (1988).

cannot work with "as if natures or capacities" clauses because if capacities are not real, her capacity's account would make no sense. Cartwright's metaphysical commitment, however, is clear (see e.g. 1989: 136, 139, 140, 142, 146, 147, 197, 223, 226; 1992: 51; 1995: 181; 2007a: 7, 11, 28, 32; 2007b: 49, 132, 250). For example, she affirms: "we aim in science to discover the nature of things" (1999: 181): "capabilities are more than modalities; they are something in the world" (1989: 181). Andrew Newman (1995) explains this nicely when he says that "Nancy Cartwright keeps her distance from the usual categories of metaphysics (…) Nevertheless, her arguments definitively favour realist metaphysical views" (1995: 274-5).

4. The Cartwright – Aristotle connection

Aristotle is an author often quoted by Cartwright. She cites the *Physics*, the *Metaphysics*, the *Nicomachean Ethics* and his scientific treatises. Her acknowledgment of Anscombe might also be regarded as Aristotelian. In *How the Laws of Physics Lies* she quotes Aristotle, first "analogically", to indicate that there is a trade-off between generality and truth (quoting the *Nicomachean Ethics* -1983: 9). Then she uses a passage of *Metereologica* as an example of idealization (1983: 110). Finally she cites the famous Aristotelian passage about chance – *Physics* II, 5. In *Nature's Capacities* Aristotle is one of the authors most cited, along with Mill, Glymour, Hume and Einstein. For example, she adopts Aristotelian abstraction (1989: 197-8), and uses his classification of four causes (1989: 211-214 and 218-226). She also affirms that her conception of capacities resonates with Aristotle's (1992: 45-8, 69, 1999: 72; 2001: 277, 290).

In Chapter 3 of *The Dappled World*, "Nomological Machines and the laws they produce", Cartwright argues that capacities are basic, and that the laws of nature (necessary regular associations between properties) permit an account of a system of components with stable capacities in particularly fortunate circumstances (nomological machines). This is also explained in Chapter 6 (reprinted with slight changes in 2001):

> [The thesis that] I am most prepared to defend, follows Aristotle in seeing natures as primary and behaviours, even very regular behaviours, as derivative. Regular behaviour derives from the repeated triggering of determinate systems whose natures stay fixed long enough to manifest themselves in the resulting regularity (1999: 149; 2001: 290).

But, coming back to Chapter 3 of *The Dappled World*, she then asks: "What facts then are they that make our capacity claims true?" After providing a number of arguments, she concludes:

> But so far I still think that the best worked out account that suits our needs more closely is Aristotle's doctrine on natures, which I shall defend in the next chapter. Capacity claims, about charge, say, are made true by facts about what it is in the nature of an object to do by virtue of being charged. To take this stance of course is to make a radical departure from the usual empiricist view about what kind of facts there are (1999: 72).

Instead of the usual empiricist view, then, she is adopting an "Aristotelian empiricist" view.

The view that most scholars hold about Aristotle's doctrine on science originates in his account of a necessary, deductive science. Aristotle, however, only exceptionally – for example in logic and mathematics – deals with science in the way detailed in the *Posterior Analytics*. This is the book where Aristotle characterizes that kind of science. It is one of the books in the set of Logical books Aristotle called the *Organon* (i.e. "instrument" of thinking). J. M. Le Blond, in his classic *Logique et Méthode chez Aristote*, maintains that "the books composing the *Organon*, are more concerned with *exposing* science in a rigorous way than with *doing* science. His scientific books, on the other hand, focus on research and they are the ones that reveal the method" (1939: 191). That is, the *Organon* contains a theory of science, while the scientific books are actual science that does not always follow the precepts of the theory. In fact, in his scientific studies —especially biological (*On the Part of Animals*, *The History of Animals*), physical (*Meteorology*), and practical (Ethics and Politics)— Aristotle allows plenty of room for experience, and he does this in order to discover and also verify scientific principles (see Lloyd 1974: pp. 99-124). He says in *Generation of Animals* (concerning his observations about the generation of bees) that "credit must be given rather to observation than to theories, and to theories only if what they affirm agrees with the observed facts" (III 10, 760b 31; cf. also *De Anima*, I, I, 639b 3 ff. and 640a 14 ff.). Causes are grasped by a sort of intellectual intuition —called abstraction— which presupposes experience but is not based on a complete enumeration of cases. Moreover, in some instances, one or a few cases suffice to abstract the universal (see Hintikka 1992: 34). But they have to pass the test of verification. Le Blond shows how Aristotle uses experience in detailed observation as well as in experiment: "flux and reflux of the research going from facts to theories and from theories to facts" (1939, p. 242). This clearly explains why Aristotle states in *Nicomachean Ethics* (VI, 8) that "a boy may become a mathematician but not a philosopher or a natural scientist." The reason, he adds, is that the philosopher and the natural scientist need experience. He states in *On Generation and Corruption* (I 2 316a 5-8):

> [l]ack of experience diminishes our power of taking a comprehensive view of admitted fact. Hence those who dwell in intimate association with nature and its phenomena are more able to lay down principles such as to admit of a wide and coherent development.

That is, experience plays a fundamental role in Aristotle's real science, but an experience that allows us to reach real causes. This is my interpretation of what Cartwright is proposing, and answers Morrison's concern about how to be an empiricist and a metaphysician at the same time.

Chapter 4 of *The Dappled World* (1999) is based on Cartwright's "Aristotelian Natures and the Modern Experimental Method" (1992). Here she persuasively shows that what science actually does by studying "the inner constitution [of things and events] is a study of an Aristotelian-style nature" (1992: 69; 1999: 102). "Still, I maintain, the use of Aristotelian-style natures is central to the

modern explanatory program. We, like Aristotle, are looking for 'a cause and principle of change and stasis in the thing in which it primarily subsists' [*Physics* II, 1, 192b22], and we, too, assume that this principle will be 'in this thing of itself and not *per accidens*'" (1992: 47; 1999: 81).[8] This argument is central to her philosophy of science, as argued by Hands:

> [T]he final court of appeal for philosophical debates about science is the actual practice of science (…). [W]hat science is must be regulated by the practice of science, and she argues repeatedly that real practicing scientists actually do presuppose that capacities and causal powers exist in systems they study" (2001: 313 and 315).

As mentioned above, Hands attributes this to Neurath's influence, but as stated above it is also highly Aristotelian. Cartwright comes back to the same idea in 2001: "I want to recall the Aristotelian idea that science aims to understand what things are, and a large part of understanding what they are is to understand what they can do, regularly and as a matter of course" (2001: 277).

There is, finally, an interesting unpublished paper by Cartwright, "No God, No Laws", that also makes reference to Aristotle. The thesis of this paper is that the concept of a law of Nature cannot be made sense of without assuming God's existence. All depends on the meaning of law of Nature. She reviews the empiricist position —"just a collection of events, one after another" (2007c: 3)— the Platonist —a relation among abstract entities— and the Instrumentalist. She then explains the problems of those positions. The empiricist is only descriptive; it cannot be taken as responsible for what happens. The Platonist offers explanations, but these have nothing to do with the empirical world. Concerning the Instrumentalist position, it is ultimately based on regularities that do not necessarily hold. Finally, she explains "Aristotelianism" as "the laws of science describe the powers that systems in Nature have by virtue of certain facts about them" (2007c: 21). She concludes: "I endorse this kind of pre-Cartesian/pre-Humean empiricism and I have spent a lot of effort trying to show that notions like powers and causings are not only compatible with an empiricist view of science but that we cannot make sense of science without them" (2007c: 22). The argument of her paper is that the other positions cannot support laws of Nature without assuming God's existence. Instead, for Aristotelianism there is no need of God. "On the Aristotle-inspired account, there is necessity and governance in Nature: natural systems have powers and events in Nature are made to occur in the way that they do by the exercise of powers" (2007c: 23). This dispensable character of God, however, is not an entirely correct reflection of Aristotle's position. For Aristotle, God is the prime mover and part of Nature (*physis*), and no power, no event, no change could exist without this prime mover (*Metaphysics*,

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[8] She adds three differences between Aristotle and modern science: (1) the change of substances for structures; (2) that causes often do not reveal themselves directly but by experiments; (3) she comes back to (1) in stressing the stability of structures (1992: 47; 1999: 81). These differences are examples of the distance that she sometimes puts on metaphysical commitments (see Newman 1995: 274-5 and the section on the Cartwright – Anscombe connection in this paper). She emphasizes that the properties studied by modern scientists do not reveal the essence of that to which they belong (1992: 48; 1999: 82).

Lambda). But in another sense it is correct, because for Aristotle the causal intervention of God in the whole of nature does not imply a special intervention, external divine plan, or design.

5. Deepening the Aristotelian Roots

Here, first, I will analyze the ontology of Cartwright's capacities from an Aristotelian perspective. Then I will tackle the topic of the knowledge of capacities and her disunified view of science.

5. 1. The ontology of capacities

According to Cartwright, capacities, natures, or "powers to do" are real causes (cf., e.g., 1989: 182). They have three elements: (1) potentiality: what a factor can or tends to do in the abstract; (2) causality: they are not mere claims about co-association; (3) stability (Cartwright 1998: 45). She calls them "natures" (1992) and quotes – as already noted – Aristotle's definition of nature as "the cause and principle of change and stasis in which it primarily subsists in virtue of itself" (*Physics* II 1 192b 22-3). She then clarifies that this is what he want to mean by capacity (1992: 71, nt. 7). Capacities, then, are internal forces, 'inner causes'.

According to Aristotle, capacities or *dynameis* are "powers to do". His definition in the *Metaphysics* is similar to the definition of a nature: "a source of movement or change, which is in another thing that the thing moved or in the same thing *qua* other" (V, 12, 1019a 15-6). *Dynamis* is an "urge of nature to grow to maturity, to realize form, and to perform the due function" (Guthrie 1967: 140)[9]. With respect to causes, Aristotle uses the idea of potentiality in reference to the material cause. However, for Cartwright and also for Aristotle, the causal structure of a nature (formal cause) is the most relevant cause in the scientific explanation of a concrete phenomenon. Causes, in any case, are the four kinds of causes considered by Aristotle, material and formal, efficient and final.

A capacity, for Aristotle, may also be a habit or disposition (*Categories* VIII) and action or passion (*Categories* IX) —physical as well as human— i.e., kinds of accidents that admit variations of degree (a way of measuring).

In a metaphysical commitment through which she refers to capacities' stability and applicability (1989: 146; see also 1992: 51), Cartwright states that "capacities are much like essences". In this regard, she affirms that her conception of capacities has Aristotelian resonances (1992: 45-8, 69, 1999: 72; 2001: 277, 290). Among the Aristotelian causes, as yet affirmed, she assigns priority to the *form*, which is similar to the causal structure (1989: 223).

According to Cartwright, there are different kinds of causes: "causation is not one monolithic concept" (2007b: 44). This is also maintained by Aristotle (*Physics* II, 3). However, Cartwright maintains that there is a common characteristic to the plurality of causes: "the idea that causes allow us to affect the world" (2007b: 46). I will discuss in section 6.2 another ontological aspect of capacities: the ontological explanation of uncertainty in the natural and social realms.

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[9] According to the Greek-English Lexicon of Lydell – Scott (Oxford, Clarendon Press, 1900), *dynamis* is a power, might, strength; an ability to do something, a faculty, a capacity.

5. 2. The epistemology of capacities

How do we know capacities? This is not an easy task. Cartwright maintains that stable causes or capacities are known by intellectual abstraction (1989: 8, Chapter 5). Cartwright also shows that capacities —under specific (and difficult to achieve) conditions— can be deduced from probabilities, and that they can be measured (1989: -1.4 and 2.4). However, this way of proceeding always supposes that we have some causes to begin with: "no causes in, no causes out" (1989: Chapter 2), she states.

Also, measuring capacities is not a knowledge of capacities. We may measure some effects, or some things that cause other things, but not the very causation itself. We measure "indirectly" (Cartwright 2007a: 25 see also 42). However, in order to have initial experimental contact with events that manifest causes and effects (and also with the strength of the former) that allows their intellectual knowledge, measurement appears as crucial. As the classic dictum states, "nihil est in intellectus quod prius non fuerit in sensu"; this initial experimental contact is necessary. Perception and abstraction are closely related and are difficult to distinguish. In actual knowledge, the senses and the intellect intervene together. Causes are perceived by senses and intellectually understood.[10] This can also be applied to experiments. The cause may be assimilated to what Aristotle calls a "common sensible": "objects which we perceive incidentally through this or that special sense, e.g. movement, rest, figure, magnitude, number, unity" (*De Anima* III, 1, 425a 16-7). This perception is the basis of intellectual knowledge of concrete causes and is complemented by it. Measures induce or allow us to infer an abstract knowledge of causation (Cartwright 2007b: 178). This involves a process of subtracting the concrete circumstances and the material in which a cause is embedded and all that follows from doing this (1989: 187).

We have one pending topic. Cartwright's "dappled world" seems to be "merely a very complicated and diverse place" (Newman 1995: 276) where consequently the sciences must be seen as disunified, and we draw epistemic conclusions based upon an ontological view. Nevertheless, we should remember that Cartwright's targets are foundationalist views of Unified Science, which assume a univocal concept of science (Cartwright 1999: 23). In the sense that I will explain below, I think that Aristotle would take Cartwright's side. He would agree with Cartwright's figure of the floating balloons, because it includes the threads that are tied to the ground. Cartwright expresses this by saying that "the sciences are each tied, both in application and confirmation, to the same material world" (1999: 6). For Aristotle this ground would be, on the one hand, the "being" that all possible subject matters share, and, on the other hand, two other common characteristics of science: first, that science makes knowledge claims ("when a man believes in a certain way [*pisteue*] and the starting points [*archai*] are known to him (…) he has scientific knowledge [*epistatai*]", *NE* VI, 3, 1139b 33-4) and, second, that all sciences are demonstrative by deduction and/or induction (science is "a state of capacity to

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[10] On the knowledge of causality see Minto 1997: 36 ff.

demonstrate" [*hexis apodeitike*]" (*NE* VI, 3, 1139b 31). Aristotle would also agree that the experimental sciences are tied to the world both in application and confirmation. He extensively uses the concept of analogy homonymy *pròs hén*[11]. For Aristotle, causes and science are analogous concepts, because the ground, i.e., their being, is also analogous. Thanks to these common characteristics, practical science (an inexact science about a contingent subject-matter) is science by "similarity" [*omoiotesin*] (*NE* VI, 3, 1139b 19).

Homonymy *pròs hén* also applies to being. Being means a concrete thing, a substance, what a thing is (an essence), and an accident such as quality or quantity. All these realities are beings of a major or minor degree. Beings or entities present themselves, according to Aristotle, in roughly ten categories or predicates. Aristotle explained and developed this idea in the book of *Categories*[12]. There are as many predicates as manners of existence. The category "substance" is the focal meaning or "starting point" (1003b 6) of being. Substances are, by definition, ontologically primary items: their existence can be affirmed without invoking the existence of anything else[13]. Substance is individual (a *tode ti* —a this—) and separable. We have criteria of identity for each substance that make it identifiable (cf. *Metaphysics* V, 8, 1017b 23-5). The other entities fall under the rubric of accidents (*symbebekós*, *accidens* —Latin—, what happens to). Aristotle distinguishes two kinds of accidents, contingent and necessary:

> We call an accident that which attaches to something and can be truly asserted, but neither of necessity nor usually, e.g., if one in digging a hole for a plant found treasure (...) 'Accident' has also another meaning, i.e., what attaches to each thing in virtue of itself but is not in its substance, as having its angles equal to two right angles attaches to the triangle. And accidents of this sort may be eternal, but no accident of the other sort is (*Metaphysics* V, 30, 1025a 30-4).

The first class is what is contingent, not necessary. The second class is what necessarily pertains to the substance in which it inheres: for man (substance) to be social (accident); for material bodies (substances) to have an extension (accident); for an economic good (substance or accident) to have a price (accident).

Accident is what happens to a substance either immediately (an economic good is bought) or in a mediated way (through another accident/s: an economic good suffers depreciation). Accidents are *in* substances (the price of an economic good) or in other accidents thanks to substance (expectations about

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[11] Homonymous *pròs hén* concepts have different but related meanings, one of which is the "focal" or primary meaning to which the other derivative meanings refer and are connected. An example posed by Aristotle is 'healthy': the focal meaning of healthy relates to a healthy human body; derivative meanings refer to healthy foods, sports, medicines, and so on (cf. *Metaphysics*, IV, 2, 1003a 32 and ff.).

[12] Aristotle is cautious concerning the number and definition of categories. The indeterminate condition of being and the richness of reality advise us to leave this number open: cf. Aubenque (1974, pp. 179-83). For Aristotle's enumeration of the categories cf., e.g., *Categories* 4, 1b25 - 2a 4, *Topics*, I, 9, 103b 20-5.

[13] That is, from an Aristotelian point of view they are basic entities, not properties. For a general introduction to Aristotle's philosophy and metaphysics, see the classic book by Sir David Ross (1968; first edition, 1923). For a specialized more recent exposition of the Aristotelian view of substance, cf. Wiggins (2001) and Loux (2002, pp. 123-37).

the prices of assets). According to Aristotle, accidents are quantity, quality, relation, location, time, position, possession, doing (or action), and undergoing (or passion) (*Categories* 4, 1b 25 – 2a 4).

The accidental character of a subject matter does not rule out its being an object of science. There are many sciences of accidents from mechanics to politics, and from medicine, to sociology. Thus an Aristotelian could easily accept Cartwright's balloon metaphor. The neo-positivist project, in contrast, is a reductivist one that leaves out some subjects of science and forces others into a stretched orthopedic dress. Summing up, what I am maintaining is that the analogical character of the sciences and their subject-matters according to Aristotle's thought fits better with Cartwright's conception of the dappled world than the positivist univocal concept of science[14].

6. Cartwright's skepticism about capacities within the social realm

As pointed out, Cartwright is more skeptical about the possibilities of causal explanation in the social realm than in natural science[15]. Given Cartwright's Aristotelian roots, I will make Aristotelian arguments for Cartwright's skepticism and for this difference. In this section, first, I will present the problem. Then in Section 6.1 I will consider Aristotelian social capacities. In Section 6.2, I will analyze the reasons for skepticism both for the natural and social realms, highlighting the differences between both and offering Aristotelian arguments for overcoming the resisting limitation in the social sciences.

In *Nature Capacities*, Cartwright maintains that both the natural and social sciences belong to a world that is governed by capacities and that cannot be made sense of without them (1989: 2). She has recently stated:

> Social science is hard, but not impossible. Nor should that be surprising; natural science is exceedingly hard and it does not confront so many problems as social science – problems of complexity, of reflexivity, of lack of control. Moreover the natural sciences more or less choose the problems they will solve but the social sciences are asked to solve the problems that policy throws up (2007b: 42).

She is especially skeptical concerning Economics:

> The natural thought about the difference between the most fundamental capacities studied in physics and the capacities studied in economics is that the economic capacities are derived whereas those of fundamental physics are basic. Economic features have the

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[14] Another possible interpretation of the figure would be post-modern. I think that this would be alien to Cartwright's view. As Hands suggests, "Cartwright is antifoundationalist, and extremely sensitive to both theory-ladenness and underdetermination, while staying safely away from the slippery slope of relativism. There is objective knowledge; it is just local, disunified, and quite different from what was proffered by the Received View" (2001: 313). It could be analogical. In this way, each science has its own subject (cf. Le Blond 1937: 196ff on the varieties of methods). On this topic the similarity between Hacking's and Cartwright's also seems clear. Hacking exemplifies this disunity of science view by the story of Babel Library of J. L. Borges (1983: 219). One may wonder, however, whether Borges' Babel Library would fit with Aristotle and Cartwright.

[15] For a discussion of Cartwright's skepticism see Boumans 2005a: 102, Hoover 2002: 157-8, 173 or Reiss 2008.

> capacities they do because of some underlying social, institutional,
> legal and psychological arrangements that give rise to them. So the
> strengths of economic capacities can be changed, unlike many in
> physics, because the underlying structures from which they derive
> can be altered (2007a: 54).

For Cartwright, economic models need to make many unrealistic assumptions "in just the wrong way" given the paucity of economic principles with serious empirical content. As a result, their conclusions are not applicable to real situations (2007a: 78 and V *passim*). Finally she suggests that we should try to understand how structure affects outcomes (2007a: 79).

These difficulties social science confronts do not necessarily imply that social capacities do not exist. At least, I did not find Cartwright denying social capacities exist: she even speaks of them in the former quotation. Let us consider Julian Reiss' view of the matter (Reiss 2008).

Reiss firstly affirms, based on his reading of Cartwright, that she is a skeptic about the existence of social capacities: "to be consistent she cannot believe that the social world is actually governed by capacities" (Reiss 2008: 265). His argument is that social science methods (theoretical economics, natural experiments and singular causes analysis – or bootstrapping) *fail to yield knowledge about* social capacities. But, Reiss reasonably adds, although there is no good (positive) reason to believe in the existence of social capacities, there is also no good reason to believe they do not exist. He thus declares himself as an agnostic but not an atheist regarding social capacities.

Be that as it may, however, the situation of social science is desperate. Given that for Cartwright scientific explanation is explanation by stable causes, and that there has been little success in finding stable causes in social science, how are we to speak about capacities in social science?

Reiss (2008: 280-5) first proposes a more empirically based detection of capacities. He contends that we should give up reliance on economic theory and pursue a more empirical social science. For him, the empirical road has not yet been walked (2008: 283). He brings up Gustav Schmoller's methodological principles of inductively analyzing situation by situation, and says that he does not see a better way of finding social capacities. Cartwright agrees: "we need to look on a case-by-case basis" (2008a: 290). Second, Cartwright emphasizes understanding the institutional structure underlying social phenomena (2007a: 79). Third, Reiss also suggests trying "to find a number of "off-the-shelf" principles that are informative about how to export claims established by a natural experiment to other contexts" (2008: 282). He offers as an example Geoffrey Hodgson's proposal for general biological, psychological, anthropological and sociological principles abstracted from history (Hodgson 2001: 326-7).

I think that this is a sensible triple strategy: enlarge the number of possible principles, infer them from a case-by-case analysis, and rely more heavily on institutional structure. We can indeed find elements of this triple strategy in Aristotle, so that he can be said to discuss general social capacities (Section 6.1). Further, Aristotle deals with practical affairs beginning with a case-by-

case treatment (Section 6.2). Finally, for him the stability of causes of social phenomena presupposes their embodiment in institutions (in the broad sense of the term that includes habits, routines and institutions in a narrow sense, Section 6.2).

6.1. On the existence of Aristotelian Social Capacities

From his observation of human beings and societies Aristotle comes to some general conclusions regarding what we may call "social capacities". Social capacities are first, capacities of human beings inasmuch as they constitute society, and second, capacities of the society itself. To Aristotle, society (the *polis*) is an ordered unity of human beings in which the unities of things may be substantial, merely accidental, or unities of order. We have a substantial unity when, for example, we fuse copper and iron and as a result get bronze; each previous substance loses its own substantiality and a new substance appears. We have a merely accidental unity when for example we put one paper over others, and so on, until we get a pile of papers. Each paper preserves its substantiality. The unity only adds an accidental property: being over or under another paper. Finally, we have a unity of order when, for example, we assemble the parts of a machine in a way that it performs a function. Each part preserves its substantiality but the order also allows each part to contribute to the common goal of the whole machine.

Aristotle denies that the *polis* is a substantial unity against Plato's monistic conception of society (*Politics* II, 2). He also denies that the *polis* is a merely accidental unity, as Babylon was, for example (*Politics* III, 3).

Ontologically, then, the Aristotelian *polis* is an order —a quality— of relationships —actions of people— an ordered relation (a *prós ti*). The order is given by the fact that these actions aim at a common goal that is a shared thought and intention of those people. The foundation of this order of relations between families that constitutes a *polis* is the orientation of their actions towards an end: a perfect and self-sufficing existence (*autárkous*), a life of good actions (*kalôn práxeon*) (*Politics* III, IX, 1280b 29-35 and 1280b 39- 1281a 4). According to him the quest for the good life and for good actions in the *polis* corresponds to a natural urge of human beings. He speaks of an immanent impulse towards association as some kind of instinct oriented toward association (*Politics* I, 2, 1253a 29-30). Thanks to language humans can declare and reach consensus about common values; individual human beings, families, villages, social institutions and *poleis* look for the good life and good actions through mutual communication, which enable them to establish or discover the common goals they will pursue (*Politics* I, 2, 1253a 14-20). These powers and activities enable us to identify at least the following capacities (*dynameis*)[16]:

   i.   Language: man is the only animal furnished with this capacity. Language does not develop independently of society (*Politics* I, 2).

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[16] This list may help to study the very much discussed topic of a list of capabilities for Sen. Note that I am not tied to this particular list: Aristotle did not like closed lists. The list is not exhaustive and it might be formulated in other ways. Some of the capacities are very much related and may be rather indistinguishable.

ii. Rationality: the word used by Aristotle to express language is *logos*. *Logos* also means reason, which is the source of language.

iii. Sociability: "there is therefore an immanent impulse in all the men towards an association of this order" (*Politics* I, 2, 1253a 29-30). For Aristotle, social interaction is crucial for the development of rationality and men have this natural impulse towards association.

iv. Communication, enabled by rationality, language and sociability.

v. Moral sense: "It is the peculiarity of man (…) that he alone possesses a perception of good and evil, of the just and the unjust, and of other similar qualities," Aristotle affirms (*Politics* I, 2, 1253a 14-18).

vi. Capacity to look for common aims. For him, these aims make a family or a polis: they are not mere aggregations (*Politics* I, 2, 1253a 18-20).

We may also think about "economic capacities". According to Aristotle, exchange and the possibility of possessing the goods are necessary when looking for a Good Life, and they are consequently also a condition of a *polis* (*Politics* III, 9, 1280b 29-35). Ontologically, the market is also a net or order of relations – of buyers and sellers, people who exchange. The order or unity comes from the coincidence of wills keen to buy or sell in order to satisfy their needs, and this coincidence is usually achieved thanks to prices. This last web of relations belongs to the broader web of society.

According to Aristotle, both society and exchange are natural in the sense that they are institutions demanded by human nature in order to achieve its natural fulfilment. Man is *zoón politikòn* (e.g. *Politics* I, 2, 1253a 3-4) and *zoón oikonomikòn* (*Eudemian Ethics* VII, 10, 1242a 22-3). However, for Aristotle "natural" in the human realm does not mean 'spontaneous' or 'automatic'. *Polis* and exchange are tasks that need to be performed with effort. They are not mere givens. This does not mean that there cannot arise institutions that facilitate this performance and work quite automatically. As John Finnis asserts, "now such relationships in part are, and in part are not, the outcome of human intelligence, practical reasonableness, and effort" (1980: 136). The task of politics and economics, precisely, is to discover and to shape these institutions which foster suitable habits for dealing with economic coordination. In any case, as stated before, provided that one goal of these institutions is to shape habits, the institutions alone are like empty structures needing to be filled. That is, we may consider also as an economic capacity (*oikonomiké* as *dynamis*: cf. Crespo 2006: 777): the capacity to look for the goods that we need for the good life.

Lastly, Aristotle's *Nicomachean Ethics* is an exposition of the different virtues —good habits— that human beings should develop in order to achieve the good life in the *polis*. Aristotle considers two kinds of virtues, intellectual and moral. The intellectual virtues are: intuitive reason, philosophical wisdom, scientific knowledge, practical wisdom, and art; the most important moral virtues are practical wisdom (i.e., prudence, which is both an intellectual and moral virtue), justice, temperance, and fortitude.

Aristotle maintains that individuals are equipped by nature with the ability to acquire virtues, and good habits bring this capacity to completion and fulfilment (*Nicomachean Ethics* I, 2, 1103a 24-6). These good habits are firmly fixed

dispositions. It is by the repetition of actions that habits become fixed in the human person. What are the main means, then, for fostering these habits? According to Aristotle, they are education and law, i.e., institutional means.

In sum, virtues originate in natural capacities and are developed by habits in the context of human interaction. However, humans are free and may also act against virtue. Moreover, they also have passions that often incline them to act contrary to virtue. Although individuals habitually intend to act rightly, they may be incontinent (*akrates*) and fail to do so (*Nicomachean Ethics* VII). Human events are thus a compound of different capacities interacting, converging or diverging.

In conclusion, the Aristotelian view of social capacities is that they exist in multiple forms. The problem with this view, on the one hand, is that they are still very general and, on the other hand, they interact in a system which has such a complexity that makes the design of social nomological machines extremely difficult. This leads us to a second question.

6.2. Why is it more difficult to know social capacities than natural capacities?

Cartwright emphasizes the "problems of complexity, of reflexivity, of lack of control" (2007b: 42). Natural science explains capacities with difficulty, but social science has additional problems. If uncertainty reigns in both realms, what are the different sources of uncertainty that make things more difficult in the social one?

Let us begin with nature. Capacities, we have concluded, are aligned with formal cause (and consequently final cause), that is, with structure and function. *It seems then that capacities act necessarily, because if a natural thing has an essence or formal cause it will act according to it*. But in nature, Aristotle holds, necessity is not absolute, but hypothetical. The necessity of, for example, a specific matter is conditional upon those formal and final causes (*Physics* II, 9; see also Sorabji 1980: Chapter 9).

For instance, why is a saw such as it is? To effect so-and-so and for the sake of so-and-so. This end, however, cannot be realized unless the saw is made of iron. It is, therefore, necessary for it to be of iron, if we are to have a saw and perform the operation of sawing. What is necessary then, is necessary on a hypothesis; it is not a result necessarily determined by antecedents (*Physics* II, 9, 200a 10-15).

That is, in nature events are generated by a conditional convergence of causes that do not always simultaneously occur. Thus, "some cases, moreover, we find that, at least, for the most part and commonly, tend in a certain direction, and yet they may issue at times in the other or rarer direction" (*On Interpretation* IX, 19a 20-3). What is material is contingent. This is an ontological matter. The constitution of material natural things is such as to require a convergence of principles to produce the very thing and its activities. "Those things that are not uninterruptedly actual exhibit a potentiality, that is, a may be or may not be. If such things may be or may not be, events may take place or not" (*On Interpretation* IX, 19a 10-3). One of those principles is matter "which is capable of being otherwise than as it usually is" (*Metaphysics* VI, 2, 1027a 14).

Hence, the Aristotelian conception of causality is closely related to the so-called "hylomorphic" character of natural things. This case corresponds to the no-necessitating category of Anscombe, "one that can fail of its effect without the intervention of anything to frustrate it" (1971: 101).

Additionally, Aristotle states "things come into being either by art or by nature or by luck (*týche*) or by spontaneity (*automáto*)" (*Metaphysics* XII, 3, 1070a 6-7; cf. also VII, 7, 1032a 12-3). Obviously, both luck and spontaneity are additional sources of uncertainty. Both terms express an event that results by coincidence (*apo symptômatôn*: *Physics* II, 8, 199a 1-5). But, does coincidence rule out causality? Aristotle's answer is "no"; lucky or spontaneous events have causes; but they are indefinite: "that is why chance is supposed to belong to the class of the indefinite and to be inscrutable to man" (*Physics* II, 5, 197a 9-10). Chance is an accidental cause that results from the incidental conjunction of some indefinite causes. Although accidental causes are 'accidental', they still remain causes. The cause frustrated may be a non-necessitating cause as well as a necessitating cause. If we relate *On Interpretation* 9 to *Posterior Analytics* II, 12 we conclude that for him causality is determined from the present to the past, but not from the present to the future (see Vigo 2006: 112, nt. 6).

A lot of events are "infected" by accidental often unknown causes that make them somewhat hazardous. This is why when chance enters, there is no regularity (*Physics* II, 8, 198b 35). However, as Ackrill (1981: 40) notes in reference to *Physics* II 7 198a 5-12, "luck and chance, he [Aristotle] is claiming, presuppose patterns of normal, regular, goal directed action". Thus, luck and chance do not impede the tendency of capacities towards their ends. Let us hear Aristotle again:

> Those things are natural which, by continuous movement originated from an internal principle, arrive at some completion: the same completion is not reached from every principle [each one has its own], and it is not by chance; but always the tendency in each is towards the same end, if there is no impediment (*Physics* II, 8, 199b 15-19).

In addition, Aristotle also considers the possibility of defects, both in arts (technique) and nature (*Physics* II, 8, 199a 33 – 199b 6). All these former caveats indeed make natural science "exceedingly hard" (Cartwright 2007b: 42). What difficulties are there added in the social realm?

Returning to chance, we have seen that Aristotle mentions luck (*týche*) and spontaneity (*autómaton*). What is the criterion for this distinction? Luck pertains to the human and social realm, being a specific difference of spontaneity, the genus:

> They differ in that 'spontaneity' is the wider term (...) Chance [luck] and what results from chance are appropriate to agents that are capable of good fortune and of moral action generally. Therefore necessarily chance is in the sphere of moral actions (*Physics* II, 6, 197a 36 – 197b 2).

This specific meaning of chance has a reason. The moral sphere is also called by Aristotle the "practical" sphere. According to Aristotle, this practical realm is more contingent that the natural realm. Aristotle recognizes this 'weaker' or inexact character of the practical (*Nicomachean Ethics* I, 3, 1094b 11-27). He identifies two reasons for this 'inexactness' of practical sciences: "variety and fluctuation" (*daiphoran kai planen*) of actions[17]. That is, there are many possible situations and the human being may change his decisions. This is why, for Aristotle, human action is always singular. He says:

> We must, however, not only make this *general statement*, but also apply it to the individual facts. For among statements about conduct those which are general apply more widely, but those *which are particular are more true*, since conduct has to do with *individual* cases, and our statements must harmonize with the facts in these cases (*Nicomachean Ethics*, II, 7, 1107a 31-3, emphasis added).

And also,

> (...) actions are in the class of *particulars*, and the particular acts here are voluntary. What sort of things are to be chosen, and in return for what, it is not easy to state; for there are many differences in the *particular* cases (*Nicomachean Ethics*, III, 1, 1110b 6-8, emphasis added).

In the "practical syllogism", the secondary premise always refers to a particular situation. Hence, in practical sciences conclusions (actions) cannot be achieved without passing through the singular. Properties of actions are variable. An action may be just or unjust according to the situation; and the concrete determination or content of a just situation is also variable (cf., e.g. *Nicomachean Ethics*, V 10, 1137b 28-30 on equity: "... about some things it is impossible to lay down a law (...) For when the thing is indefinite the rule is also indefinite"). Aristotle also affirms this with regard to wealth, beauty, and courage, among others. This is why he says, for example, that "a young man is not a proper hearer of lectures on political science; for he is inexperienced in the actions that occur in life, but its discussions start from these and are about these" (*Nicomachean Ethics* I, 3, 1095a 2-4). He often compares politics with medicine in this respect: "Matters concerned with conduct and questions about what is good for us have no fixity, any more than matters of health" (*Nicomachean Ethics* II, 2, 1104a 4-9). Let us remember that practical science, as conceived by Aristotle, concerns ends in action. However, the more "practical" practical sciences are, the less general they become. By leaving generality behind to move towards concrete reality, science limits its scope. That is something that ought to be kept in mind; we should look for a balanced position. If we try to include all relevant factors in a concrete situation we lose generality and, thus, explanatory power for different situations in the conclusions we reach. But as we try to gain generality, we lose contact with reality as it actually is, and thus explanatory predictive and normative 'efficiency'.

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[17] The adjective *Diaphóros* means "different" and the verb *planáo* means "to make to wander", "to lead astray, mislead, deceive", "to do a thing irregularly or at random" (*Greek-English Lexikon*, Liddell and Scott).

Can we speak about prediction in the conditions above? Only if we can restrict ourselves to stable situations that are fully specified (social nomological machines). How is it possible given this case-by-case process? The answer is by relying on generalizations based in institutions and social structures.

Probable generalizations from the point of view of Aristotle's "rigorous" science are not scientific, for science deals with universals. However, the contingency of the subject matter justifies the use of generalizations instead of universals in science. For Aristotle, this is applicable even to Physics. For him, there are more reasons for applying it to human action, because freedom adds an extra quota of contingency. This is the case of practical science. Generalizations in practical science are actual dispositions or habits. The more stable the habits and tendencies the more predictable the outcomes. Aristotle develops a theory about the stability of habits (*Nicomachean Ethics*, VII, 9, 1151b 25-7 and VII, 10, 1152 a, 26-7). When habits are sufficiently stable as to constitute social institutions, practical science is firmly based. Therefore, institutions are very important for they consolidate tendencies and habits and facilitate accurate science. Thus, we can predict better when social institutions are solidly consolidated.

Thus, we have in Aristotle some very general principles stemming from the observation of human beings and society, a case-by-case analysis of particular practical situations, and an emphasis on institutionalized behaviours that may give rise to stable causes. That is, we find in Aristotle arguments for the triple Reiss-Cartwright's strategy. Let us return to Cartwright again:

> Social science is hard, but not impossible. Nor should that be surprising; natural science is exceedingly hard and it does not confront so many problems as social science – problems of complexity, of reflexivity, of lack of control. Moreover the natural sciences more or less choose the problems they will solve but the social sciences are asked to solve the problems that policy throws up (2007b: 42).

Complexity and reflexivity imply "variety and fluctuation", and rule out general analysis of social matters. These "problems" are related to human interpretations and freedom, which paradoxically are some of the most valuable human characteristics. In the social realm, these "limitations" imply well-delimited subjects if we really want to explain this. The perspective on prediction is even more limited because conditions are always prone to change. However, all these difficulties do not rule out capacities. Although their content surely changes, the power of thinking, talking, valuing and socializing remain untouched. And we have also institutions that give stability to causes.

But there remains a fundamental question. Are Cartwright's complexity, reflexivity and lack of control really related the Aristotelian practical realm, a realm where freedom explains the greater difficulty for explanation? Or is Cartwright a naturalist as Mill, and the difference between the natural and social realm is only one of a greater complexity?[18]. Moreover, it is not clear what complexity does mean to Cartwright.

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[18] On Cartwright as a naturalist, see Hands 2001: 313. On Mill as a naturalist, see Skorupski: 1998. In 1999: 151 (2001: 292) she seems to sustain this position.

7. Conclusion

Looking for causes as the way of explaining in science has not been the most usual position in the philosophy of science of modern times. There are, however, philosophers who have not abandoned this classical goal. Cartwright is one of them. She has clearly holds that explanation is the aim of science and that sciences should explain by real causes.

Cartwright has originally assimilated her concept of capacities with Mill's concept of tendencies. Nevertheless, Mill is not a good ally for Cartwright's project. We can find in him interesting insights but they are blended with seemingly inconsistent positions. His theory of causality seems to be inconsistent and he adheres to determinism. Besides, Mill's naturalism does not distinguish the physical and social realms by anything more than complexity (more causes acting and at a deeper level).

In contrast, we find in Aristotle and in Anscombe's interpretations of causality more adequate companions to sustain an alternative doctrine of explanation by real causes in sciences - in terms of their singularity and about indeterminism. The "trade-off" in this proposal is the acceptance of metaphysics, i.e., that causes are ontologically real, not mere products of the senses or the mind. From this perspective, causality is a process of actualizing the power of an entity that may or may not occur due to internal or external factors. Matter, as conceived by Aristotle, is open to different actualizations. "What desires the form is matter, as the female desires the male" (*Physics* I 9 192a 22-3); but the adequate form is not always present. And that may be because either there is not an agent, or the agent is not capable, or it does not have the proportionate end to produce the effect[19]. We could ask: how many children have not been born because there was not a sexual act, how many were not born because the act or the process of generation were artificially interrupted, or how many because there was a biological or psychological defect in the male or the female? How many storms have failed to happen? How many units of a particular product have not been sold due to shortages in production or due to a bad marketing campaign? We may know sometimes, but the richness of reality is such that it is often impossible to know. We are not gods. Our limited knowledge, however, is enough to manage our lives in an appropriate way.

Nancy Cartwright assumes a relatively greater difficulty exists in achieving causal explanations in the social realm than in the natural one. Given the similarity of her conceptual framework for causal explanation to that of Aristotle and Anscombe, I have suggested that they could offer good philosophical arguments to justify this difference. The greater complexity, the reflexivity and the lack of control have to do with human singular situations and with human freedom.

The specific limitations of the social realm pointed out by Cartwright and justified by Aristotle have led economists to design specific formalized models. They are blueprints of socio-economic nomological machines that explain

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[19] For the Aristotelian doctrine of the four causes see, e.g., Anscombe and Geach 1961, 44-54, Henry Veatch 1974, 41-55 or William Wallace 1996, 3-34.

the events under well-defined constraints (see Cartwright 2001 and 2002). But Cartwright offers a warning. The social scientist must be careful about saying what real capacities are presupposed in his/her models as blueprints of nomological machines (Cartwright 1999: 53 ff.). This care entails careful observation and verification. Let us hear again from Aristotle: "credit must be given rather to observation than to theories, and to theories only if what they affirm agrees with the observed facts" (*Generation of Animals* III 10, 760b 31).

Indeed theories are often too general and do not achieve real explanations. Although those models need "hyper-fine tuning" (Cartwright 2002: 146), they leave the doors opened to hope: "social science is hard, but not impossible." This hope would probably stem from the stability or regularity produced by institutions, habits or routines (Cartwright 1999: 138). It seems then that the correct way of doing social science should start by studying the underlying structure of social capacities and events (Cartwright 2007a: 79).

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