Perspectives on Interdisciplinarity

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Introduction

Interdisciplinarity is a phenomenon of several dimensions. The literature on this subject is dominated by studies relating to research conducted at the interface between natural sciences. This book defies these tendencies and aims to elucidate different aspects of interdisciplinarity in several academic disciplines mostly considered as a part of social sciences and humanities. Moreover, the book provides the view on interdisciplinarity "from within" specific disciplines – among the authors of individual chapters one can find representatives of philosophy, cognitive sciences, law, economics, sociology, history, and theology actively working in their research areas.

Each chapter of the book may be considered as an introduction to these aspects of each discipline's methodology in which interdisciplinarity is apparent. It should be noted, however, that we do not accept here any single, exclusively valid definition of interdisciplinarity. In fact, we believe that the boundaries between inter-, trans-, and multidisciplinarity are not rigid, and that the flow of knowledge between areas occurs in complex ways that cannot be described by a single label. Interdisciplinarity manifests itself differently in philosophy, law, and in history. Yet, it does not change the fact that in this book we try to capture these phenomena that testify to the blurring boundaries between different disciplines.

The book begins with an introductory chapter by Bartosz Brożek, which attempts to address the question of what interdisciplinarity is and how it manifests itself. The starting point of these considerations is taking science as a problem-solving endeavor. From this viewpoint, interdisciplinarity offers a wide range of

problem-solving tools unavailable within methodology characteristic for a single discipline. The author draws attention to the two key obstacles for interdisciplinary approach that require caution and methodological awareness: intellectual inertia that gravitates mind towards well-known solutions and incommensurability of research programs, sometimes even within the same discipline. The author also recalls mankind's striving for unity of knowledge, pointing out its ties with interdisciplinarity.

Łukasz Kurek addresses interdisciplinarity in philosophy in the second chapter. Although it is sometimes claimed that philosophy should be confined within a certain method, it is one of the most interdisciplinary branches of knowledge. This has been especially apparent in recent decades in the case of philosophy practiced at the intersection with natural sciences, i.e. naturalistic philosophy. A philosophical reflection on consciousness or free will carried out without referring to experimental results of cognitive sciences would be hard to imagine at the current state of the art. The chapter presents various manifestations of interdisciplinarity in naturalistic philosophy and beyond.

Cognitive science is one of the most noticeable examples of interdisciplinary research. In order to better understand human cognitive processes, this interdisciplinary research program draws from many fields of expertise, including neuroscience, psychology, philosophy and AI research. The diverse dynamics between the disciplines are presented by Mateusz Hohol, pointing out how they complement each other providing a multifaceted image of how the human mind operates.

Interdisciplinarity is also noticeable in areas that are often considered as rather pragmatic than theoretical. The law is a case studied by Marek Jakubiec in the fourth chapter. The author presents two pillars of contemporary interdisciplinarity of law. The first one is cognitive science, which dramatically changes the picture of human cognitive processes. As a result, a considerable portion of law's

descriptive presuppositions can be rendered obsolete. The second pillar is the recognition of emerging technologies that are transforming the social reality, pushing the legislation to adapt.

In the fifth chapter Marcin Gorazda points out specific distinguishable periods in the development of economics and theories worked out therein that introduced to the field elements of other sciences. Behavioral science, biology, mathematics, law, history, and sociology are just some of them. The influence of different areas of knowledge on economics varies, as does the manner in which it is exercised. Nevertheless, this does not change the fact that it seems to be one of the most interdisciplinary disciplines these days. Moreover, the author claims that interdisciplinarity in economics is a prerequisite for its further development.

The following chapter explores interdisciplinary research within sociology. Łukasz Lamża discusses three attempts to introduce methods of other sciences into sociology: the sociology of urban crime which is characterized by the author as a successful interdisciplinary project, social physics deemed unsuccessful and evolutionary sociology whose success is assessed as mixed or controversial. These three stories might help one to look at sociology as an interdisciplinary field, but in a non-obvious way.

History, as a subjective narrative about the past, needs to be interdisciplinary, since human affairs has always been influenced by social, political, economic, cultural, and many other factors. In the seventh chapter Rafał Szmytka presents the history and contemporary practice of interdisciplinarity in historical studies. The author examines the cooperation between historians and other academic communities and the absorption of their characteristic research tools into the body of historical methods. Among the specific topics discussed are the relations between history and law, medicine, psychology and art, as well as the benefits of interdisciplinary studies.

The relationship of theological reflection and the sciences has been turbulent for centuries. The adherents of religion have usually tended to place theology above natural sciences. Today, numerous theological studies cling to other disciplines, especially to the natural sciences. In the eighth chapter Damian Wąsek presents contemporary research directions that might be found in theological considerations.

The final chapter by Wojciech Załuski provides a bird's eye view on the phenomenon of interdisciplinarity. The readers' attention is brought to certain challenges that might be encountered while doing interdisciplinary research. The author identifies three major pitfalls of interdisciplinarity: deceptive similarity of concepts, improper reduction, and pars pro toto. This chapter, together with the introductory one, can be seen as a set of guidelines for those involved in interdisciplinary projects.

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What is Interdisciplinarity?

Conceptual chaos

"Interdisciplinarity" is a very fashionable concept. It is expected to appear when new research teams are created, grant proposals developed, university reports written. One might even venture to say that – at the first glance – the contemporary science is throughout interdisciplinary. The problem is that, upon closer inspection, this intriguing and innovative picture shatters into small pieces. Interdisciplinary research teams turn out to be a jumble of scientists, who stick to their ways of doing research, mostly ignoring other members of the group; in grant applications "interdisciplinarity" becomes an empty yet a strategically useful term; and the process of creating university reports is a real art, since it requires constructing a coherent whole from mutually incompatible elements.

This picture of interdisciplinarity is, of course, an exaggeration. However, there is little doubt that this fashionable term is rarely filled with any deeper and meaningful content. The reason is probably that even if we frequently refer to interdisciplinarity, it is on much rarer occasions that we consider what it is and what are its purposes. This lamentable situation is made even worse by a kind of conceptual chaos. Methodological textbooks are filled with

definitions and complicated classifications pertaining to interdisciplinarity. Let us take a closer look at some examples.

At the most general level, one often distinguishes interdisciplinarity from transdisciplinarity and multidisciplinarity. The latter is defined as an 'overlapping' of different scientific disciplines. In other words, according to this approach, theories and methods developed in different disciplines are used, but with due recognition of their traditional thematic scopes and methodological limitations. Multidisciplinarity is, therefore, an 'encyclopaedic' or 'fragmentary' endeavour, where a scientific problem is approached simultaneously from different perspectives, but no attempt at a synthesis is undertaken. In contrast, transdisciplinarity is conceived as a synthesis leading to a common set of axioms, exceeding the limits of a single discipline. In particular, such a synthesis may consist in an attempt to construct a coherent worldview based on empirical sciences, social sciences and the humanities. Interdisciplinarity finds its place in-between these extreme standpoints: it takes advantage of methods and theories of various disciplines, with an eye on the analysis, harmonisation, and local synthesis of the relationships between them. To put it in a nutshell: multidisciplinarity is additive, interdisciplinarity – interactive, while transdisciplinarity – holistic (Choi & Pak, 2006).

However, this is not the end of conceptual complications. In the literature, one can find an abundance of typologies of interdisciplinarity. One distinguishes, for example, between indiscriminate, auxiliary, composite, supplementary and unifying interdisciplinarity; or linear, structural and restrictive interdisciplinarity; or bridge-building and restructuring interdisciplinarity (cf. Heckhausen 1972; Boisot, 1972). There is no point in analysing the definitions of these concepts, although not because they are uninteresting in themselves (doubtless, any attempt at elucidating such a complex problem as interdisciplinarity is worthwhile), but rather to avoid even more confusion at the outset of our investigations.

From this perspective, it is reasonable to consider a different and very popular conceptual distinction between methodological and theoretical interdisciplinarity. The former consists in the use of methods from different disciplines in order to solve the problem at hand; the latter aims at a synthesis of the theories developed within various disciplines into a more coherent and general picture of the given aspect of reality. Below, I will try to show that these approaches are connected to two issues fundamental for the discussion of interdisciplinarity. "Methodological" interdisciplinarity grows out of the view that the basic role of science is to solve problems. "Theoretical" interdisciplinarity, in turn, is based on the need to have a coherent worldview.

2. A Methodological Eldorado

What is the goal of science? Various answers come to mind: to uncover the laws governing the Universe, to understand the nature of reality, to enable technological progress, etc. However, at the methodological level, the most adequate answer is perhaps that the goal of science is to solve problems. It may seem a trivial, and hence an innocent phrase. However, when one considers it more carefully, one can realise that it leads to profound consequences.

What is a problem? In the most simple and general terms, a problem occurs when one has too much or too little information. The former case is contradiction (or other inconsistency) in our beliefs – one believes that p and $\sim p$ are simultaneously true, e.g. that "Thunder is the product of the wrath of Zeus" and "Thunder is not the product of the wrath of Zeus". It is a problem since one does not really know what thunder is: one's worldview is fatally "broken", which makes it impossible to think and act coherently. One does not know how to explain to a child, what is thunder; one cannot decide whether a thunderstorm is a reason to make offerings

to Zeus or rather that this would make no sense. One also has to deal with a problem when one has too little information, like when we hear thunder during the storm but have no idea what it is. In principle, this is perhaps not troubling. After all, there exist an infinite number of questions for which we do not know the answers, and we can easily live with that. The lack of information only becomes a problem when it makes our actions more difficult. When you are asked what is thunder during a physics exam, your ignorance will cost you dearly.

It must be stressed that the problems we face do not materialise from nowhere, but have their histories. As Michael Heller observes, "this must be similar to Greek drama: there is a situation which gives rise to the plot and the development of various threads that compete with one another and intertwine to create a problem" (Heller, 2006, p. 99). Karl Popper captures the same thought in a more abstract and less poetic way when he makes us consider the following schema (Popper, 1972, p. 126):

$$P1 \rightarrow TT \rightarrow EE \rightarrow P2$$

P1 is the initial problem, TT is a tentative theory aimed at solving the problem, EE is the error elimination in the process of criticising the tentative theory, and P2 are the new problems created by the error-elimination of the tentative theoretical solution of an old problem (ibid., p. 126). Popper underscores two important issues here. On the one hand, solving problems – at least the more complex ones – is usually a sequence of consecutive theories. Thunder was initially considered to be the product of the wrath of gods, but already Aristotle believed that lightning was an effect of a collision of clouds and the resulting thunder is generated when the air blast induced by the lightning collides with a compaction of clouds. Today, we believe that thunder is the outcome of a rapid expansion of air within the path of a lightning strike. Crucially, the

old answers to the question of what is thunder, although false, co-constitute our understanding of the problem. Failed theories are not thrown away and forgotten but provide a broad background for our intellectual endeavours. On the other hand, Popper stresses that a solution to a problem often leads to the emergence of new problems. For example, once we understood that lightning is a natural electric phenomena, we were able to ask how to protect ourselves from it, which in turn led to the invention of the lightning rod.

The realisation that the goal of science is to solve problems which are not isolated questions but are mere threads in a rich fabric of centuries-old theoretical reflection, makes it possible to adequately describe the role of a scientist. A scientist should strive to solve problems; it is important to find a solution, and the method used for this purpose is of secondary importance. It follows that an exaggerated attachment to a methodology characteristic for a given discipline is an irrational research strategy. What matters is the outcome, not the road which leads to it. Thus, an *a priori* rejection of certain methodological tools seems a bad choice. From this perspective, interdisciplinarity is an expression of a sound methodological precept.

This idea has been masterfully exposed by Paul Feyerabend, who in *Against Method* and other writings defended the "anything goes" approach to science (cf. Feyerabend, 1975). This slogan can be read as saying that everything is equally useful; however, a better reading is that everything may be useful. In our attempts to decipher the secrets of nature, every method and every, even the most extravagant theory may turn out to be of help. It does not mean, of course, that all methods are equally efficient and rational, and all theories – equally well justified. Feyerabend says something different: he urges us to consider problems from a perspective different to the one that we are accustomed to. Instead of pondering which of the typical ways of doing research is the most efficient

and which well-established theories are true (or close to truth), we should (at least sometimes) extend our purview and search for solutions with the use of seemingly less useful intellectual tools. The reason for this precept is straightforward: standard methods and theories are tailored for standard problems. An engineer, developing a new car or an electric cooker, does not have to reach beyond the arsenal of well-proven tools. However, when dealing with an atypical problem, one will not go far by following the standard ways of doing things.

The understanding of science as a sequence of problems and – more or less successful – attempts at solving them opens the gates to a methodological Eldorado. When we decide to leave aside the mainstream methods and theories characteristic of the given discipline, we will be able to look at the problem at hand from a fundamentally different perspective, try out new, untypical ways of solving it, and in consequence formulate a nontrivial, potentially fruitful hypothesis. Here lies the justification for the methodologically understood interdisciplinarity. One needs to remember, however, that excursions in this Eldorado are no easy feat. They require considerable methodological awareness and caution, in particular in relation to two key obstacles which may be deemed inertia and incommensurability.

3. Inertia and incommensurability

It is sometimes claimed that G.W. Leibniz was the last person to have been able to claim to have mastered all areas of human knowledge. After his times, three centuries of the rapid growth of science and specialisation followed, so that today two physicists working in the same building – or even door to door – are unable to understand the research of one another. Irrespective of how one judges this phenomenon, specialisation is simply a fact. The vast scope of

human knowledge – both theoretical and practical – is impossible to grasp with our limited and imperfect individual minds.

These minds have one more feature. They become accustomed to particular ways of thinking or framing problems; they have their own preferred methods, favourite theories and cherished conceptual schemes (Kossowska, 2005). As a consequence, when they encounter a new problem, they gravitate towards well-known solutions: we prefer to follow beaten paths rather than explore unknown territories. This intellectual inertia has a sound evolutionary explanation: when we happen to find an efficient course of action, it is reasonable to stick to it, instead of looking for new ways of dealing with complex, often unpredictable reality. The problem is, however, that by definition such inertial mental tendencies make it much more difficult to develop an original hypothesis or create a revolutionary theory. Our (mostly unconscious) search for epistemic safety may be counterproductive when what we are looking for is a sound, but atypical solution to a problem.

The inertia which blocks us on our way to fully rational scientific thinking, has another, more objective (in the sense of being independent of mental mechanisms) aspect. If science, as Popper says, is a sequence of problems and their tentative solutions, its history provides the framework for, and significantly limits the field of potential intellectual endeavours – the possible trajectories of the future development of knowledge are determined at the outset and it does not suffice to overcome mental habits to change it. Something more – a revolution – is needed. Anyone attempting to understand nature in terms of the Aristotelian paradigm – hence by recourse to four causes: formal, material, efficient and final, through purely qualitative considerations without the use of mathematics – would not be able to formulate the law of gravity, only repeating after Aristotle that heavy things fall because they tend to move towards their natural place (the centre of Earth). Let us observe that this has no direct link to the psychological aspects

of scientific research; it is not the case that the scientist has become overly attached to a mode of thinking and finds it hard to distance herself from an explanation provided by Aristotle or one of his commentators. The problem is much deeper: with the acceptance of the fundamental tenets of Aristotelian philosophy and its preferred methods, science (if the term applies in this context at all) was set on a trajectory; there is no possibility of choosing some other way without rejecting those fundamental assumptions.

An important word was used in the previous paragraph: 'paradigm'. It was introduced to the vocabulary of philosophy by Thomas Kuhn in *The Structure of Scientific Revolution*. According to Kuhn, in science there exist "universally recognised (…) achievements that for a time provide model problems and solutions to a community of practitioners" (Kuhn, 1970, p. VIII). These paradigms consist not only of theories and methods, but also include a "philosophical background": a collection of fundamental beliefs, which – although they do not appear in the formulations of the theories – exercise an important influence on the way scientist conduct their research. For this reason, within paradigms conceptual schemes are developed. Even if two paradigms take advantage of the same terminology, the words they utilise have different meanings. For example, when a philosopher working in the Kantian tradition speaks of freedom, she means something different than a neuroscientist who tries to answer the question of whether we are free in our decision-making.

As a consequence, as Kuhn points out, different paradigms are *incommensurable*. They use different idioms and methods, and serve as the backdrop for developing theories, which are not incompatible, but rather incomparable. These theories are replies to *different questions*: when a Kantian philosopher considers the existence of free will, she poses a different problem than an experimental psychologist, even when they use the same words. One can even go as far as to repeat after Kuhn that scientists working within

different paradigms "practice their trades in different worlds" (ibid., p. 150). An educated person living at the beginning of the 21st century, one aware of the foundations of Newtonian physics and who understands the basic tenets, if not the technical details, of general relativity and quantum mechanics, would find the world seen through the prism of the Aristotelian four causes completely alien. Although one can try to grasp Aristotelian ideas, such an understanding is necessarily mediated through the contemporary way of seeing the world.

Arguably, incommensurability thus understood cannot constitute an obstacle for interdisciplinary research. Interdisciplinarity does not require to enrich our methodological and theoretical toolkits with the ideas of Ancient or medieval thinkers we have already dispensed with or even forgotten about. The return to the Aristotelian concept of four causes would be a pointless step back, since physics began its unprecedented march forward with the rejection of the Aristotelian qualitative conceptual schemes and the adoption of quantitative methods, which require us to use mathematical structures to model physical reality.

Alas, incommensurability is not such a trivial phenomenon. Although it is clearly and sharply visible when two fundamentally different perspectives on nature are compared – e.g., when one puts Aristotelian and modern physics against one another – incommensurability accompanies us even within the same scientific discipline. A good example is provided by cognitive sciences, when three essentially different approaches to understanding human mind are used: cognitivism, based on the belief that cognition is realised through symbolic computations taking place in the brain; connectionism, rooted in the conviction that the computations carried out by the brain are parallel and distributed; and the program of embodied cognition, where body (and hence not only brain) and its interactions with the environment are said to co-constitute the way we perceive the world and act in it. These

different paradigms not only influence various interpretations of the same experiments but determine different sets of research questions and utilise – to a degree, at least – different conceptual schemes. A similar situation may be observed in other disciplines, even in physics, and particularly in its more speculative domains such as cosmology. Incommensurability, with more or less intensity, often makes it hard to carry out dialogue within the same discipline; if so, it must constitute an even bigger obstacle in interdisciplinary endeavours.

It does not mean, however, that the incommensurability of research paradigms reduces interdisciplinarity to a completely non-realisable ideal. However, it makes it more difficult, requiring much methodological caution and deep understanding of the philosophical assumptions, goals, methods, and theories of all the involved disciplines. In interdisciplinary research there are no shortcuts. One needs to avoid the temptation offered by simple analogies and similarities. In the contemporary scientific discourse, there are few things as annoying as a neuroscientist who claims that she has solved the centuries old controversy over the existence of free will; or a philosopher who says that all of the achievements of the embodied mind paradigm were anticipated in the phenomenology of Maurice Merlau-Ponty. Of course, it is not to say that neuroscientific research is irrelevant for the philosophical controversy surrounding free will, or that Merlau-Ponty's insights cannot become an inspiration for cognitive science. This, however, requires a considerable degree of methodological awareness and a good grasp of the philosophical assumptions as well as the more concrete theories developed in both disciplines.

4. The unity of knowledge and the enticement of unification

In the late 19th century, with the progress of specialisation, a different tendency also became evident in science: the dream of the unity of knowledge. Facing a fragmentised worldview, one whose elements are developed in laboratories working according to different assumptions, theories, and methods – the human mind becomes confused. On the one hand, the size and complexity of knowledge provided by the contemporary science is so vast that it is impossible to grasp it, even if only superficially. The need for a synthesis follows: a simplified, but more understandable worldview is asked for. On the other hand, science divided into a multitude of disciplines leads to discoveries which often seem mutually inconsistent. This leads to cognitive dissonance and strengthens the need to introduce order and find unity in the knowledge we have accumulated.

The first major unification project was pursued by neopositivists from the Vienna Circle (cf. Uebel, 2020). Enchanted with the achievements of the sciences, and physics in particular, they claimed that only those sentences are meaningful which may be empirically verified. The entire edifice of science is based on what they called the protocolar sentences, i.e. reports from direct sensual experience. It is from this foundation that scientists – equipped with the logic of induction – decipher the laws of nature and develop adequate theories. Thus, the representatives of the Vienna Circle believed in the unity of science, but with a particular twist: they wanted to reduce everything scientific to what they considered to be the language of physics – sentences expressing direct observations.

The dream of the unity of knowledge reduced to the foundation science, physics, turned out to be an empty one. One can cite a number of reasons which made the neopositivist project destined

to fail from the very beginning. Arguably, the main such reason was that Moritz Schlick and other members of the Vienna Circle adopted a very simplified and inadequate view of what constitutes science in the first place. Undoubtedly, the essence of the natural sciences, and physics in particular, is the relationship between the general laws of nature expressed in the language of mathematics and empirical observations. However, the relation in question is much more subtle and multi-aspect than the neopositivists believed. As clearly demonstrated by the greatest critic of the Vienna Circle, Karl Popper, there are no observational sentences independent of a theory. Moreover, the logic of induction is useless when it comes to justifying the general laws. With the rapid progress in physics, it also turned out that even this most celebrated of scientific disciplines cannot be consider unified. The two fundamental physical theories developed in the 20th century – general relativity and quantum mechanics – are mutually incompatible, and the attempts to unify them have brought no success so far.

The spectacular failure of the unification project advocated by the Vienna Circle underscores two further important aspects of any attempt to unify knowledge. On the one hand, such projects are usually *reductionist*: they strive to show that all phenomena may ultimately be reduced to some fundamental phenomena. The contemporary ideas pertaining to the unification are also reductionist. For example, W.O. Wilson, the proponent of consilience, says:

> We are approaching a new age of synthesis, when the testing of consilience is the greatest of all intellectual challenges. Philosophy, the contemplation of the unknown, is a shrinking dominion. We have the common goal of turning as much philosophy as possible into science (Wilson, 1999, p. 12).

The Vienna Circle unification project enables yet another insightful observation. We search for the unity of knowledge by way of reduction, but it is not any kind of reduction. The basic science, one foundational for the entire edifice of human knowledge, should be physics. This choice is far from surprising since physics has enjoyed unparalleled success over the last 300 years, not only by increasing our understanding of reality, but also – through technological progress – by literally changing the world we inhabit. Moreover, an important aspect of the spectacularly efficient strategy of physics is the drive for unification. Newton discovered the law of gravity, thus combining the seemingly independent theories formulated by Galileo and Kepler; Maxwell, in his beautiful conception, unified the theories of electricity and magnetism; Einstein developed special relativity by resolving an apparent conflict between electromagnetism and classical mechanics. The successes of physics achieved through unification are so great that they generate and sustain the faith in the possibility and need to formulate the ultimate theory of the Universe, maybe even in the form of the so-called world equations. Such a grand vision was presented in 1923 in Hamburg lectures by the great mathematician David Hilbert. The world equations would enable us to deduce all the known as well as yet unknown empirical facts. Hilbert said:

> If now these world equations, and with them the framework of concepts, would be complete, and we would know that it fits in its totality with reality, then in fact one needs only thinking and conceptual deduction in order to acquire all physical knowledge.[1]

[1] Quoted after U. Majer, T. Sauer, „Hilbert's <World Equations> and His Vision of a Unified Science", in: A.J. Kox, J. Eisenstaedt (eds), *The Universe of General Relativity. Einstein Studies*, vol 11. Birkhäuser, Boston 2005.

In proposing this view of the ultimate physical theory, which would do without any experimental facts, and where everything would be deducible from "first axioms", i.e. the world equations, Hilbert was not alone. Similar ideas were expressed by Hicks, Mie, Weyl or Eddington, and a variation on this topic can be found in the contemporary cosmological conceptions of Tegmark and Tipler (Kragh, 2011). The fact that so far we are yet to stumble upon a theory which would resolve the (apparent?) incompatibility between general relativity and quantum mechanics is no reason to abandon the unification project. To the contrary: it provides us with an additional motivation to look harder, to use more subtle and refined mathematics, even if it challenges the limits of our imagination.

Unification thus understood – even if achievable – is highly problematic. The laws of physics – e.g. those comprising the General Relativity Theory or the Standard Model in particle physics – are so abstract and distant from our everyday experience that it is difficult to fully comprehend them. This point is nicely illustrated – at a much more concrete level – by W.C. Salmon. Let us consider the following situation:

> A mother leaves her active baby in a carriage in a hall that has a smooth level floor. She carefully locks the brakes on the wheels so that the carriage will not move in her absence. When she returns she finds, however, that by pushing, pulling, rocking, bouncing, etc., the baby has succeeded in moving the carriage some little distance. Another mother, whose education includes some physics, suggests that next time the carriage brakes be left unengaged. Though skeptical, the first mother tries the experiment and finds that the carriage has moved little, if at all, during her absence. She asks the other mother to explain this lack of mobility when the brakes are off (Salmon, 1990, p. 12).

This event may be explained in the spirit of unification, by recourse to a universal law – the law of the conservation of linear momentum. The baby and the carriage constitute an essentially isolated system (with respect to horizontal motion) when the brake is off but are linked with the earth when the brake is on. However, a more concrete explanation, uncovering the mechanism behind the observed phenomenon, would be much easier to grasp. One may say that when the break is off all the forces exerted by the baby on the carriage and by the carriage on the baby cancel out; and we are well accustomed with situations when forces cancel out, such as when we play Tug of War.

This example shows that explanations developed with the use of general and abstract laws do not have to lead to a better understanding of the physical phenomena and the resulting cognitive "domestication" of the world. The need to understand is ever-present in us; it is the driving force behind all the attempts at the unification of knowledge. But the understanding we are looking for is of a particular kind. It must fit within our cognitive architectures, and those are not well equipped to handle subtle, abstract mathematics. We want to "see and touch" how things work – to understand is to know the mechanism, not the general laws.

One may object to this conclusion, however, by pointing out that the development of general and abstract laws has been quite successful for more than 300 years, bringing about both an increase of knowledge and technological progress. Let us observe that the explanation of the baby and carriage event in terms of the law of conservation of linear momentum makes it possible to see the similarity between the situation described by Salmon and other, seemingly completely different phenomena: when a cannon releases a projectile, it moves in the direction opposite the projectile; or when a particle is deflected by gravity, the gravitational field will also be modified by the particle (given some chosen reference frame; cf. ibid.). These crucial aspects of the structure of

the universe are imperceptible to those who use only relative concrete, mechanistic explanations. In this context, Michael Friedman admits that science strives for greater unification – our goal is to provide a description of physical reality with as few general and abstract laws as possible. However, Friedman stresses that this procedure enhances our understanding of the world, but

> the kind of understanding provided by science is global rather than local. Scientific explanations do not confer intelligibility on individual phenomena by showing them to be somehow natural, necessary, familiar, or inevitable. However, our overall understanding of the world is increased; our total picture of nature is simplified via a reduction in the number of independent phenomena that we have to accept as ultimate (Friedman, 1974; pp. 18-19).

Thus, we are dealing with two different ways of explaining and understanding the world: the local, which proceeds by uncovering the mechanisms behind the given phenomenon, and the global, which consists of "inscribing" the phenomenon into a larger structure of the laws governing the world. Importantly, these two ways are not incompatible, but complementary. General and abstract laws enable us to discern that seemingly different areas of experience operate according to the same mechanisms.

The above considerations lead to a few important conclusions pertaining to the nature and goals of interdisciplinary research. First and foremost, the need for synthesis that is inscribed into the very core of the idea of interdisciplinarity is completely natural: it grows out of the aversion for inconsistency and fragmentised worldviews, and is driven by the willingness to obtain a more comprehensive understanding of the world. This need, however, is connected to two potential dangers. On the one hand, there exists a strong reductionist tendency which urges us to break down complex phenomena into simpler ones. By itself, the idea of reduction

is commendable: it has proven its efficiency on numerous occasions. However, when one mishandles it, lamentable consequences ensue, as illustrated by the methodological fantasies of the Vienna Circle. An extreme form of reductionism may also effectively eliminate any dialogue between scientific disciplines: when one claims that the findings of one science may be reduced to the findings of another, more fundamental science, the former is no longer an equal participant in a dialogue. On the other hand, the need for synthesis also generates strong unification tendencies. The only way to unify knowledge is to formulate more and more general and abstract laws. Again, one must repeat that there is nothing wrong with this idea in itself, since it has often successfully assisted us in our intellectual quests. However, understood too strictly, and treated as the only goal of science, it may increase our global understanding of the world while at the same time completely separating the model of reality we have developed from our everyday experience, and hence from something we know and understand well. One needs to bear this in mind when doing interdisciplinary research, mostly because different sciences provide us with explanations of various degree of generality and abstractness. It is not problematic – to the contrary: a skilful combination of global and local explanations yields a more comprehensive understanding of the analysed phenomena.

5. Conclusion: the Decalogue of Interdisciplinarity

Let us sum up the above considerations with the following Decalogue of Interdisciplinarity:

I. *Thou shall not attach yourself to words!*

It is not important whether your research should be deemed interdisciplinary, transdiciplinary, or multidisciplinary. It does not

matter whether someone refers to it as composite, supplementary or unifying. Do not spend time considering whether "your interdisciplinarity" is structural, restrictive, or bridge-building; or whether it is better to call it methodological or theoretical. It is even inessential whether your research meets any interdisciplinarity criteria. Just do your job, taking advantage of the abundance of methods and theories "officially" belonging to various disciplines.

II. *Thou shall solve problems!*

The greatest enemy of scientific curiosity is to work "in a field" or be preoccupied with "topics", instead of dealing with genuine problems. Any progress – measured by the degree in which we understand the world around us – may be made only by solving problems. If you do not know, what to do, find an interesting problem; when already carrying out research, recall from time to time what is the problem you are trying to solve. When you look at science through the prism of problems, new perspectives immediately open up, including interdisciplinary ones.

III. *Thou shall carefully consider the formulation of the problem!*

Ludwig Wittgenstein once said that a proper formulation of a problem often already includes its solution. Even if this observation was meant for philosophers working in the spirit of linguistic analysis, it contains a grain of truth for everyone. It is (almost) never a waste of time when you devote time to considering what the problem is that you are trying to solve, what are its alternative formulations (e.g., from the perspective of various disciplines), what other problems it resembles and what are its explicit and implicit assumptions.

IV. *Thou shall learn the history of the problems*

The history of a problem you are trying to solve is very informative. It is good to know where the problem comes from (and

it usually comes from successful solutions to other, older problems). You can also learn a lot from the analysis of failed, rejected solutions to "your" problem. A problem is not a single, isolated question taken out of context: we fully understand it only when we know its sources, and the history of how people have tried to deal with it. And only when we understand a problem, we may hope to find the right solution.

V. *Thou shall solve problems with any method available!*

When you understand that your only goal is to solve a problem, the way which will lead you to the solution is of secondary importance. This realisation may free you from the dictate of a method which confines you to one scientific discipline, one way of thinking, and one set of philosophical assumptions, which hinder your imagination. The thick volumes on the history of science do not contain examples of important discoveries which were made by sticking to well-verified methods.

VI. *Thou shall respect the differences between scientific disciplines!*

Scientific disciplines, and often also particular paradigms and research traditions within a discipline, are based on different philosophical assumptions, utilise different methods and make recourse to different theories. Thus, in order to efficiently move between scientific (sub)disciplines, one needs to understand and respect those dissimilarities. If you fail to notice that in a given discipline research questions are formed on the basis of some particular philosophical assumptions; or unknowingly trespass or transgress the limits of its methods; or ignore some theories it considers important, you risk developing a nonsensical vision instead of an interesting, interdisciplinary solution to a problem.

VII. Thou shall strive for a coherent worldview!

The ultimate goal of science is not to solve as many problems as possible; it is to create a comprehensive worldview. The goal has a hermeneutic dimension: it is easier to understand the world seen through the prism of a coherent theory than a world described by local, often mutually inconsistent conceptions. A comprehensive worldview has also a heuristic potential: it enables one to see new, so-far unnoticed problems, but also potentially fruitful solutions to the problems identified earlier.

VIII. Thou shall not be a thoughtless reductionist!

Reduction, understood as a search for scientific explanation by reducing complex phenomena to simpler ones, is a good research strategy. However, reduction cannot be mindless and "at any price". You cannot assume that the reduction you attempt will be successful, or else you risk adjusting facts to the assumed thesis.

IX. Thou shall avoid excessive abstraction!

If it were possible to capture the analysed phenomena in but a few general and abstract laws, the world would turn out to be less complex and easier to comprehend. Doubtless, it is a sound methodological precept, but it comes with some limitations. The temptation to simplify everything is all-embracing, but you should oppose it whenever your simplifications do not yield a better understanding of phenomena, but make you blind to them. When developing all-encompassing theories, one may easily and unknowingly "get rid" of uncomfortable facts instead of explaining them.

X. Thou shall strive for a full understanding of phenomena!

Richard Feynman once said that if one cannot explain a physical theory to undergraduates, it means that one does not understand the theory at all, even if it "works" and provides us with good, verified predictions. Understanding is the interplay between

global explanations (uncovering the general and abstract laws) and local explanations (uncovering the mechanisms behind the analysed phenomena). A successful scientific synthesis provides both: it enables one to formulate a set of general and abstract laws, but also inscribes concrete phenomena into our everyday experience of the world.

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Cognitive science: an interdisciplinary approach to mind and cognition[1]

Introduction

The mind is usually considered to be machinery which computes inner representations and employs them to act. These representations could refer to both physically existing objects, or events occurring in the proximal surrounding, and hypothetical entities (Fodor, 1975). For instance, when perceiving an object characterized by meowing, having whiskers, tail, four paws, and fur, we immediately categorize it as "cat," and reach out to pet it (unless we do not like cats). What is more, categorizing the object as a cat allows us to use our prior knowledge and say that it is a mammal and a vertebrate, that it occupies terrestrial niches, and could be our companion. Thus, one could define cognition as mental activity (e.g., categorization) sandwiched between perception (e.g., visual) and action (e.g., petting or verbal behavior).

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[1] This is the English and expanded version of a chapter (Hohol, 2019) published in the online handbook edited by Piotr Urbańczyk and Marek Jakubiec.

Although the computational-representational approach to mind and situating cognition between perception and action have been challenged (see e.g., Chemero, 2009), they are characteristic of the early stage of so-called cognitive science (henceforth, CogSci). CogSci is usually described as an interdisciplinary enterprise which aims to understand how the mind works. In the present chapter, I will focus on the interdisciplinarity of CogSci by tracking and tracing its history. At the outset, I will outline the collaboration of various disciplines since the dawn of CogSci in the 1950s to 1980s (this period is usually called classic CogSci). Then, I will take a closer look at some of the newer faces of interdisciplinarity in CogSci. These considerations will be illustrated by case studies of computer simulations in classic CogSci and more recent research on cognitive metaphors, respectively. Finally, I will describe recent controversies related to interdisciplinary studies of mind and cognition.

The interdisciplinarity of classic computational cognitive science

Although philosophers have investigated the nature of mind and cognition since ancient times, they did so purely theoretically, usually making use of introspection and anecdotes. Experimental studies have only been conducted since the 20th century, when psychology became an independent field (Gardner, 1985). It was perhaps Jean Piaget who was the first researcher to conceptualize the individual development of knowledge structures as building and transforming inner representations. His studies conducted in the period covering the 1920s-1950s involved a broad spectrum of topics, from the cognitive origins of morality, through language up to mathematical cognition (Piaget,

1926). His works from this period were not, however, widely known in the United States, where behaviorism, avoiding the concept of mental representation, predominated in experimental psychology.

In the United States, the cognitive revolution started in the mid-1950s (Bechtel, Abrahamsen, & Graham, 1998; Gardner, 1985; Miller, 2003) and gave rise to the discipline known today as CogSci. This name, given at the University of California San Diego in La Jolla, gained popularity later and in the 1970s other terms, such as cognitive studies at Harvard University and information-processing psychology at Carnegie Mellon University, were used in tandem (Miller, 2003). However, such semantic issues are not our concern here. A traditional date considered to mark the advent of CogSci is September 11, 1956, when a group of researchers interested in the information theory and related disciplines met at the symposium organized at the Massachusetts Institute of Technology. Its participants included, among others, Allen Newell and Herbert Simon, who presented their theorem proving computer program (Newell, Shaw & Simon, 1958); Noam Chomsky, who outlined his model of language build on the generative grammar approach (see Chomsky, 1980), and George Miller (1956), who presented results of studies on the limits of short-term memory.

The latter of CogSci's founding fathers, George Miller (2003), confessed after many years that he left the symposium "with a conviction, more intuitive than rational, that experimental psychology, theoretical linguistics, and the computer simulation of cognitive processes were all pieces from a larger whole and that the future would see a progressive elaboration and coordination of their shared concerns" (p. 143). Although according to the traditional view early CogSci comprised psychology, linguistics, and computer science (or artificial intelligence) and supported by

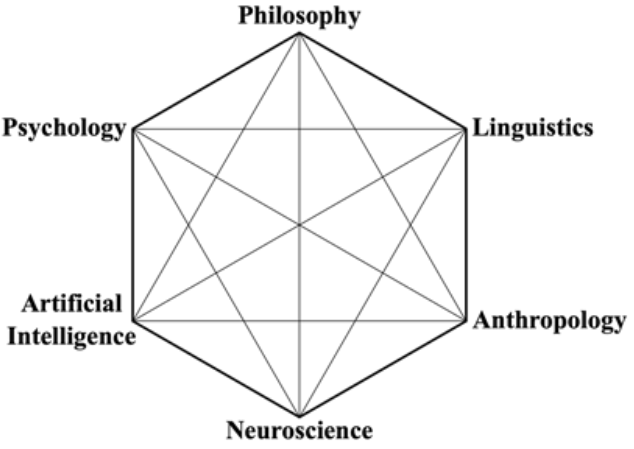

Figure 1. The structure of cognitive science (modeled on Wikipedia; CC BY--SA 3.0). According to the traditional view, CogSci on the grand scale is the product of interdisciplinary collaboration between, or joint efforts of, (experimental) psychology, philosophy (of mind), linguistics (mathematical and theoretical), neurobiology (or neuroscience), artificial intelligence (or computer science in general), as well as anthropology (both cultural and biological). They constitute nodes in the above diagram. These academic fields can interact at a smaller scale, creating more specific research interdisciplinary programs, represented by lines of the diagram. The most important of such programs are psycholinguistics and neurolinguistics, studying respectively psychological and neural mechanisms of language and communication (Aitchison, 2011; Ingram, 2007), cognitive neuroscience, interested in neural foundations of cognitive processes (Gazzaniga, 1995), computational neuroscience, modeling neural processes and its products (namely cognition and behavior) by using algorithms, artificial neural networks, and other computer tools (Churchland & Sejnowski, 1994; Miłkowski, 2013), the philosophy of artificial intelligence (Clark, 2007), neurophilosophy, undertaking the traditional philosophical problems in neuroscientific terms (Churchland, 1986), and finally, cognitive anthropology, where cognitive processes are elucidated using anthropological methods (Hutchins, 1995).

neuroscience, anthropology, and philosophy (Fig. 1), Miller claims that the first three disciplines were "central," while other three "peripheral" (ibid.). However, this does not mean that neurobiologists were not active in their labs, anthropologists did not conduct fieldwork, and philosophers did not think thoroughly in their armchairs in the pioneering years. Miller's main message is they did not work together as closely as experimental psychologists, linguists, and computer scientists.

Case study 1: Collaboration of computer scientists and psychologists within classic computational CogSci. The main goal of a computer simulation is mapping the causal structure of a simulated phenomenon by implementing crucial component parts and operations involved in a phenomenon of interest (whether it is a hurricane, stock exchange, or human cognition). This task requires, in turn, experimentally investigating and understanding the phenomenon of interest. Only then is a modeler able to recreate general regularities (and sometimes even laws) and select initial conditions constituting the phenomenon. Computer simulations of cognitive processes realized by the founding fathers of CogSci implemented interdisciplinary collaboration. Newell and Simon (1976), as well as other modelers, were particularly interested in problem-solving, both by flesh-and-blood human beings and artificial systems. To achieve relevance they implemented psychological data, e.g., verbal protocols collected under laboratory research on problem-solving (Ericsson & Simon, 1984). Solving geometric problems is a representative example. Greeno's (1978) computer program called Perdix taken into account verbal protocols obtained from students facing with Euclidean problems. Thanks to this strategy, Greeno decided to abandon the modern, purely formal, approach to geometry and implemented a more intuitive strategy, where the content of a

diagram could constitute the relevant resource for proving by the artificial engine. Geometry Tutor Expert was another psychological data-driven theorem-proving program. Its developers incorporated the results of experimental studies on the use of heuristic rules to predict further inferences based on contextual diagram properties and previously accepted statements (for more details about these and other theorem-proving programs see the chapter of Hohol, 2020). Notably, the rules of transformation in various early problem-solving programs also implemented the results of linguistic studies (see Chomsky, 1980).

Close collaboration between psychologists, linguists, and computer scientists resulted in the emergence of an approach refining the computational-representational approach to cognition sketched at the beginning of the chapter. According to Newell and Simon (1976), cognition-as-representation-processing not only happens in humans but also in all cognitive systems, including artificial ones. These researchers proposed the so-called physical symbol system hypothesis claiming that any physical system (no matter whether it is biological, like the human brain, or silicon circuits, like a computer) manipulating symbols step-by-step according to well-defined rules "has the necessary and sufficient means for general intelligent action" (ibid., p. 116). Note that, "a symbol" is understood here as *amodal* (namely, deprived of any perceptual content), *language-like* (i.e., resembling rather logic tokens than natural language ones), and *arbitrary* (this means that its processing involves only purely syntactic properties, not the structural similarity to its referent; see also (Fodor, 1975; Jackendoff, 2002). In other words, Newell and Simon's hypothesis states that if a physical system manipulates symbols it is a cognitive system; and conversely, if a system is cognitive, it is a physical system manipulating symbols. According to the hypothesis, geometric theorem

proving programs (see Case study 1) implemented in computer hardware could be dubbed cognitive systems in the same systems as flesh-and-blood geometers.

One could ask which component parts of physical systems are directly involved in constituting cognition? On the one hand, classic computational CogSci intentionally avoided this question, since it considered cognition as a function of the system that is explanatory autonomous from the system's physical structure. On the other hand, the founding fathers of CogSci assumed that higher cognitive functions are implemented in the prefrontal cortex, while sensorimotor cortices are not directly involved in cognition (recall the amodal nature of symbols). According to this view, the process of object categorization looks as follows (in a nutshell). First, the perception of an object involves preprocessing in sensory areas (e.g., occipital lobe for visual perception). Second, information is transmitted to the prefrontal cortex, where cognition takes place (e.g., categorization through testing proximity to the prototype or evaluating whether a perceived object meets necessary and sufficient conditions to be a category member). Finally, the results of cognitive processing serve as a trigger of action initiated in motor cortices. Importantly, stage one (processing in sensory cortices) and stage three (motor cortices activity) cannot be called cognitive.

The physical symbol system hypothesis stimulated interdisciplinary research on the computer simulation of cognitive processes. Clearly, particular disciplines delivered basic outputs. Computer science, for instance, delivered tools for computational modeling, linguistics – for analyzing symbolic transformations, and psychology – for the experimental study of human behavior. Only interdisciplinary collaboration between them allowed, however, a more comprehensive view on cognition. What is important, the information flow between computer science and psychology was bidirectional. On the one hand, experimental psychology delivered data informing and constraining modelers' efforts. On the other

hand, the results of computational simulations could serve as a source for building predictions for further psychological experiments (see Churchland & Sejnowski, 1994).

The interdisciplinarity of more recent cognitive science

The situation where CogSci was mainly constituted by psychology, linguistics, and computer science began to change at the end of the 1970s. According to Bechtel, Abrahamsen, and Graham (1998), at this time CogSci expanded "vertically into the brain and horizontally into the environment" (p. 77). New methods of measuring brain activity gained in popularity, cognitive scientists placed more research emphasis on the impact of the surrounding world – both physical and social – on cognition. Proponents of classic computational CogSci argued that external factors could be ignored, at least in the early stages of research (see Vera & Simon, 1993). Last, but not least, the change was also motivated by highlighting the problems of the classic computational CogSci. The so-called symbol grounding problem described by Steven Harnad (1990) is one of the most serious of them.

The symbol grounding problem is the following: "How can the meanings of the meaningless symbol tokens, manipulated solely on the basis of their (arbitrary) shapes, be grounded in anything but other meaningless symbols?" (Harnad, 1990, p. 335). The problem could also be expressed more intuitively. Is a total novice able to learn a foreign language with only a dictionary at their disposal? Since each word is defined by other words in a standard dictionary, and she does not understand these words, the simple answer is no. To learn something, a novice has to have at her disposal something linking at least *some* words with their referents. Returning to a more technical formulation, to solve the

symbol grounding problem, the meaning of at least *some* mental symbols (representations) should be grounded in something other than the purely syntactic properties of arbitrary symbols. For instance, some representations should be structurally similar to their referents (Gładziejewski & Miłkowski, 2017). In this way, the concept of "cat" could be defined not as a list of abstract features but rather as resembling cats we interact with. Another problem associated with the physical symbol system hypothesis is a lack of details about where concepts come from. Thus, an alternative proposal should not only solve the symbol grounding problem but also elucidate the origins of our concepts.

Embodied cognition (resp. grounded cognition) offers an alternative that promises to meet the above criteria. This approach emerged from the interdisciplinary collaboration of all six disciplines indicated in Fig. 1 in the 1980s. Its main assumption says that cognitive processes are deeply rooted in our bodies and bodily interaction with the surrounding world. Higher cognition is not sandwiched between perception and action but directly involves sensorimotor cortices. Although embodied cognition is far from being a single theory – it is a paradigm containing a wide spectrum of different and sometimes even incoherent ideas (see Wołoszyn & Hohol, 2017) – more and more researchers agree that our cognition cannot be elucidated without recourse to the body (Chemero, 2009; Clark, 1999; Davis & Markman, 2012; Johnson, 2012; Lakoff & Johnson, 1980; Wilson, 2002). More precisely, proponents of embodiment claim that the detailed structure of our bodies shape, or at least constrain, the concepts we have at our disposal. This view has been adopted in studies on many kinds of concepts, e.g., social and emotional (Carr et al., 2018), mathematical (Hohol et al., 2018), or religious (Barsalou et al., 2005). Let us look at the contribution of the constituting disciplines of cognitive science to the idea of embodiment.

The term embodied cognition appeared in philosophy for the first time at the end of the first half of the 20th century, in the milieu of the French phenomenologists. One of them, Maurice Merleau-Ponty, highlighted in his book *Phenomenology of perception* (1945/2002) that the body could be considered as a cognitive organ interacting with the world and giving meaning to our linguistic expressions. This philosophical idea was adopted by cognitive linguists in the 1980s who emphasized the interactive nature of our concepts. Zoltan Kövecses (2006), who belongs to the research tradition of cognitive linguistics, outlines the following elucidation:

> As an example, take the conceptual category of TREE. How can the body play any role in our understanding of what tree is? For one thing, we understand a tree as being upright. This comes from how we experience our own bodies; namely, that we experience ourselves as being erect. For another, we see a tree as tall. The aspect of tallness only makes sense with respect to our standard evaluation of the body's relative height. A tree is tall relative to our average human size. In this way, categories of mind are defined by the body's interaction with the environment (s. 11).

The idea of embodied cognition has also been elaborated within psychology. The theory of perceptual symbols by Lawrence Barsalou (1999, 2020) is one of the best empirically corroborated incarnations of embodiment in this field. Contrary to amodal theories, Barsalou claims that there is no single area of the brain specialized in conceptual processing or higher thinking in general. Instead, concepts are encoded in the areas primarily responsible for perception and motor control (thus the theory could be dubbed *perceptual and motor symbols*). There are two main technical terms: "simulator," and "simulation." According to Barsalou (2020), "whereas the entire body of accumulated knowledge for a

category constitutes a simulator, using the simulator to construct a conceptualization on a specific occasion constitutes a simulation" (p. 9). Let us return to our category of "cat." Whenever we encounter a cat, both cortical and subcortical structures of the brain processing the cat's properties are activated in order to encode these properties in the appropriate modalities. At the same time, these modality-specific activations are integrated into association structures (e.g., the parietal cortex). Thus the perception of a cat triggers processing in terms of how it looks (visual cortex), smells (olfactory cortex), and moves (motor cortex). Moreover, our brains process some motor opportunities associated with a cat (e.g., grooming). Last, but not least, emotional areas responsible for rewards accompanying a cat are also activated. All these signals are integrated into association areas. The following interactions with cats make this distributed pattern of activation superimposing, and after many such episodes, a simulator of "cat" became more robust. Thus, the concept of "cat" is not implemented in the brain as a list of features or as an idealized prototype, but rather as an exemplar copy saturated by perceptual and motor features (see Fig. 2). When well-established, a simulator could be used to make predictions or reasonings about cats in the process of simulation. This process involves the reenactments of all the brain areas associated with the primary experience of a cat. What is important, this process could be run to represent the cat even in its absence. In this way, we can think about cats (this includes imagine them) even when there is no physical exemplar of the cat in front of us. Finally, as Barsalou (2020) claims, "one form of concept composition results from binding multiple simulators to multiple perceived entities in the world and then relating them together with a relational simulator" (p. 9). Thus, simulators are not completely fixed, but they could be combined in various ways.

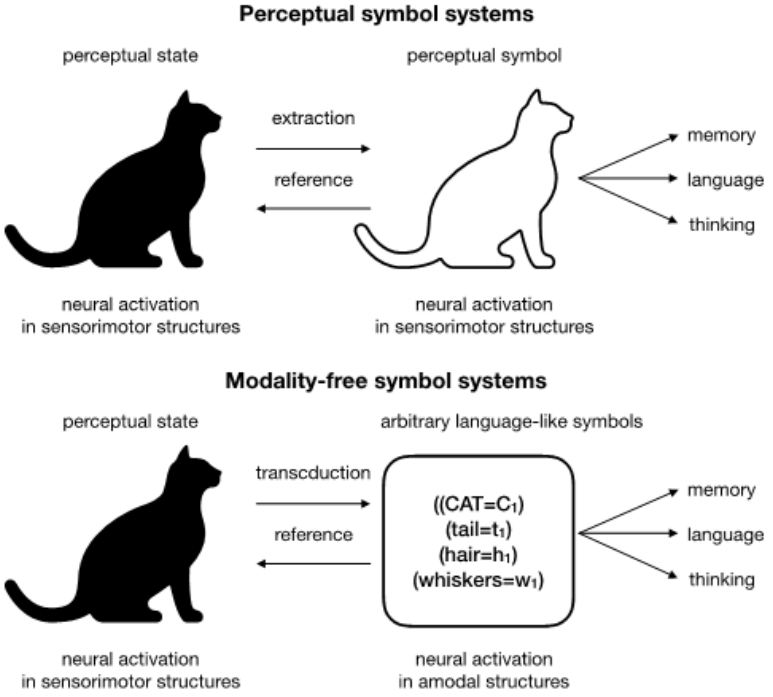

Figure 2. Theory of perceptual symbols (top) vs. physical symbol system hypothesis (down). It is modeled on Barsalou, 1999, p. 578–579. Barsalou's theory of perceptual symbols assumes that mental representations of categories, e.g., concept "cat", are analogous to perceived objects and emerge through extraction from perceptual (and motor) states. Cognition is grounded in perception and action through simulations (of reenactments) of interactions with exemplars, occurring in sensorimotor structures of our brains. On the other hand, the physical symbol system hypothesis proclaims that mental representations of categories occur in the process of the transduction of percepts to an amodal format. The conceptual processing does not involve sensorimotor structures, at least directly, but it is implemented in amodal structures of the brain. The theory of perceptual symbols is one of the best-known incarnations of the embodied CogSci, while the physical symbol system hypothesis is characteristic of classic computational CogSci.

Although the theory of perceptual (and motor) symbols grew out of psychology (Barsalou, 1999) it has been extended to other disciplines and has become a platform for successful interdisciplinary collaboration within CogSci. While the first empirical test of the theory involved behavioral experiments, neuroscientific methods were also successively used. For instance, Simmons and his colleagues (2007) found that visual structures of the brain are not only active during direct color perception but also during cognitive tasks including verification of object features performed by the participants. More literally, visual structures were not only activated when the participants perceived a yellow taxi but also when they thought about a yellow taxi. Barsalou's theory was also developed in terms of computational models (Pezzulo et al., 2011) and widely discussed on the ground of the philosophy of mind (e.g., Prinz, 2004). However, many theorists and empirical researchers noted that, although the theory of perceptual symbols convincingly elucidates the processing of concrete concepts (e.g., "cat"), abstract concepts ("democracy," "love," "prime number") constitute a severe challenge to it. Thus, other theories, expanding the idea of embodiment have been developed. In Case Study 2, I outline one of them, namely the theory of conceptual metaphors (Lakoff and Johnson, 1980), that emerged within linguistics but soon launched interdisciplinary studies.

Case study 2: Interdisciplinary studies on metaphor within embodied CogSci. In the book entitled "Metaphors we live by" (1980), the linguist George Lakoff and the philosopher Mark Johnson stated that "our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature" (p. 3). According to these authors, a metaphor means "understanding and experiencing one kind of thing in terms of another (ibid., p. 5), wherein "understanding and experiencing" indicate that this is not only about a linguistic level, but also a prelinguistic level of

cognition. Lakoff and Johnson's main tenet is that all abstract concepts are structured by concrete concepts thanks to metaphorical mappings. Ordinary metaphorical thinking occurs when we talk that she "experienced ups and downs," and "got into trouble," but then "got out of trouble," and finally (and fortunately) "lift her spirit." Another story full of metaphors is: "his diploma exam turned out to be very hard", "he tried to defend his thesis," but "he fell on the battlefield." In consequence, "he boiled with anger," but then he calmed down and understood "he should approach the exam once again." Importantly, the metaphors present in the above expressions are not linguistic conventions but the way our mind conceptualizes abstract domains. To this end, we use concrete concepts as "weight," "ascension," "falling," "boiling," and "approaching" to understand and express our experiences in the social (e.g., academic) domain. The theory of cognitive metaphors is embodied since it emphasizes that even very abstract concepts are grounded in our action and perception. Lakoff and Johnsons' idea triggered interdisciplinary collaboration in at least two aspects. First, it has been applied to the analysis of evidently distinct fields as poetics (Lakoff & Turner, 1989), philosophy (Lakoff & Johnson, 1999), politics (Lakoff, 2002), law (Brożek, 2020), and even mathematics (Lakoff & Núñez, 2000). Second, the assumption that our abstract concepts are rooted in sensorimotor experience has been investigated not only through analysis of discourse and communication but also by using a large toolkit of CogSci methods. Experimental psychologists have tested some metaphors in behavioral experiments. For instance, Casasanto and Boroditsky (2008), investigated whether metaphorical representations as "a long lecture" or "a too-short coffee break," also occur at the cognitive level. They asked participants to observe nonverbal stimuli, i.e., lines or dots, and then to reproduce their duration or spatial

shift. The researchers found that when participants made decisions about duration, they could not ignore spatial information, but not vice versa. As they concluded, this result indicates that the metaphorical mapping of space and time is not only a matter of linguistic convention but runs at the level of embodied mental processing. There are also dozens of studies indicating other abstract cognitive domains are processed via metaphorical mappings. For instance, we unconsciously think about such abstract entities as numbers in terms of objects occupying the place in a spatial continuum resembling a number line (e.g., Cipora et al., 2016). There are also neuroscientific findings in line with the theory of cognitive metaphors. For instance, some neuroimaging studies found that the processing of highly metaphorical linguistic expressions activates sensorimotor structures primarily responsible for perception and motor control (Gallese & Lakoff, 2005; Pulvermüller, 2002). Last, but not least, elements of Lakoff and Johnsons' theory have been further developed with the use of computational models (e.g., Indurkhya, 1987; Kintsch, 2000).

Challenges of the interdisciplinary study of mind and cognition

One may correctly notice that nowhere have I defined what is interdisciplinarity but rather talked about interdisciplinary *collaboration within CogSci or collaboration among representatives* of disciplines constituting CogSci. These uses at least partly resonate with the common meaning of the interdisciplinarity. It is not my goal to analyze the various variants of interdisciplinarity and related concepts in detail, such as multidisciplinarity, crossdisciplinary, or transdisciplinarity (see e.g., Alvargonzález, 2011; Ash, 2019).

Instead, I would like to introduce a frequently used distinction between *weak* and *strong* interdisciplinarity in CogSci (Gardner, 1985). The former, weak interdisciplinarity, refers to the interdisciplinary collaboration between scientists (e.g., psychologists and philosophers) whose goal is to gain deeper insight into some aspects of cognitive processing, but without any ambition of setting out a novel conceptual framework and study methods. Here, everyone comes to the joint enterprise with their own background and methods (e.g., a psychologist with behavioral experiments and the philosopher with conceptual analyses) and these academics try to do something together. On the contrary, the strong form of interdisciplinarity means the coordination of joint research efforts in order to establish a novel theoretical framework and methods of investigation. Here, everyone comes with their own background and methods but, over time, often gradually, these differences blur. This novel framework should be characterized by the integration and unification of its constituents (see Miłkowski, 2016, 2017). The majority of academics have noticed that classic computational CogSci is characterized by interdisciplinarity in a weak sense (e.g., Bechtel, Abrahamsen & Graham, 1998; Gardner, 1985). Thus, we should talk rather about *cognitive sciences* in the plural rather than as a single discipline.

However, there is no consensus about the ultimate purpose of CogSci. A traditional view is that the ambition of its founding fathers was to lay the foundations of a strong interdisciplinary CogSci. more than 60 years after the pioneering symposium at MIT one could assume the boundaries of psychology, neuroscience, computer science, linguistics, philosophy, and anthropology are blurred. Recently, Rafael Núñez and his collaborators (2019) investigated this assumption in a data-driven way. Analyzing many indicators, they concluded that CogSci is not interdisciplinary today in a strong sense. The authors found that instead of the new framework, CogSci teaching curricula at US research universities

are dominated by one of the fields (most often psychology or neuroscience). Moreover, students learn about the other CogSci fields separately and without integrative contexts. In addition to educational indicators, Núñez and colleagues investigated the content of the top journal in the field called *Cognitive Science*. They found the published papers are dominated by those from experimental psychology, and the contribution of anthropology is only marginal. On the other hand, other researchers claim that the situation where experimental psychology and neuroscience are central does not have to mean the end of cognitive science. Moreover, at least some of CogSci's founding fathers have explicitly claimed that they had no ambition of building a strongly interdisciplinary enterprise (see Gentner, 2019).

The situation becomes even more complicated when we take into account the fact that contemporary researchers called and/or calling themselves cognitive scientists not only use methods and concepts of "the founding disciplines" fruitfully (namely, psychology, computer science, linguistics, neuroscience, anthropology, and philosophy), but also fields such as evolutionary biology, comparative ethology or sociology. There are many reasons to be skeptical that this will someday lead to strong interdisciplinarity, but some voices emphasize the fact that such pluralism is not a vice but rather a virtue of CogSci (see Miłkowski & Hohol, 2020; Miłkowski, Hohol & Nowakowski, 2019 for discussion). Moreover, many valuable research programs where two or more disciplines meet have emerged within this globally weakly interdisciplinary CogSci. Cognitive neuroscience and computational neuroscience (see Fig. 1) constitute particularly fine examples of building unified frameworks and using original methodologies in order to obtain a deeper understanding of our minds.

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Interdisciplinarity in philosophy

1. Introduction

'Interdisciplinarity in philosophy' refers to philosophical reflection which engages with research in fields other than philosophy. There are numerous academic disciplines other than philosophy which philosophers have found interesting and thus we may encounter philosophical works which appeal to research conducted in the formal sciences (e.g. mathematics), to the empirical research carried out in the natural sciences (e.g. physics or biology) and social sciences (e.g. anthropology, psychology, sociology or law) as well as to the research in the humanities (e.g. history or literary theory). What is more, some thinkers appeal to applied sciences such as engineering and medicine.

For our purposes, the above enumeration of academic fields which philosophers find valuable for their own work is of significance due to the fact that this chapter will discuss interdisciplinarity in philosophy only in the context of some of these fields. In particular, we will focus on philosophical reflection which engages with the empirical sciences. This means that our discussion will exclude cases in which philosophers refer to the formal sciences and humanities.

This limitation is not a consequence of the belief that the research carried out in formal sciences or humanities is philosophically less interesting than research grounded in empirical evidence. On the contrary, many thinkers will argue that it is mathematics or history, in contrast to psychology or biology, which are intimately connected with philosophy. In the case of mathematics, already the ancient philosophers – such as the Pythagoreans who were fascinated by numbers – hypothesized that the language of mathematics may be used as a tool to discover the ultimate nature of reality. It is one of the driving ideas in philosophy that there is an ultimate nature of reality and that we can know something about it. Philosophical reflection which appeals to history has a rich tradition as well. This reflection is not only about the fact that philosophical ideas are rarely developed in an intellectual vacuum and that thinkers typically ground their claims in opposition to, or in continuity with, what has been claimed by their predecessors. What is important for philosophy is also the fact that answering some philosophical questions requires us to acknowledge that human beings are historical entities, i.e. entities shaped by both biology and culture.

The limitation of our inquiry into interdisciplinarity in philosophy to the relationship between philosophy and the empirical sciences results from how philosophy is done – or how it is usually done. Both formal sciences and humanities are – from the methodological standpoint – closer to philosophy than the empirical sciences. The formal sciences and philosophy are largely armchair disciplines, i.e. they do not require experimental investigations. Humanities and philosophy, on the other hand, are similar to the extent that both are somewhat speculative disciplines, i.e. their theories and the evidence to which they appeal lack the reliability of theories and evidence of formal and empirical sciences. To sum up, in opposition to typical philosophical investigations, the empirical sciences are grounded in experimental data and measurement and the empirical research they obtain is more reliable.

Despite the fact that empirical inquiries carried out in many disciplines are, at least *prima facie*, related to philosophical issues, empirical sciences are often regarded by philosophers with distrust as to their philosophical relevance – a theme which will continue to resurface in this chapter.

2. A little bit of history

The claim that there is a relationship between philosophy and the empirical sciences – according to which the research carried out by the empirical scientists may have an impact on philosophy and even *vice versa* – is controversial. Interdisciplinary philosophy is outside of the current philosophical mainstream. Let us take a look at what some thinkers had to say about the relationship between their discipline and empirical inquiry at the time. Philosophers like to claim that the issues they tackle are essentially conceptual or logical in nature and their solutions require rigorous and purely theoretical analyses (Putnam, 1975, p. 362). Bertrand Russell, an influential figure in twentieth century philosophy, described the difference between philosophy and the empirical sciences in the following manner: '[A philosophical proposition] must not deal specially with things on the surface of the earth, or with the solar system, or with any other portion of space and time. (…) A philosophical proposition must be applicable to everything that exists or may exist (Russell, 1917, p. 110)'.

The view that there is a difference between philosophy and the empirical inquiry is, of course, not a novel one. It was popular in ancient Greece and one of its proponents was Plato himself, who differentiated between *episteme* – the true and irrevocable knowledge – and *doxa*, i.e. a belief or an opinion. *Doxa* can be grounded in perceptual experience but *episteme* can be reached only through pure reasoning uncontaminated by experience.

According to Plato, the goal of philosophical inquiry is to achieve episteme. This understanding of philosophy does not merely indicate the difference between philosophy and the empirical sciences, but it creates an impassable gulf between them. As we already know, experimental evidence is fundamental in the empirical sciences yet this Platonic view remains popular among contemporary philosophers.

In our excursion into the history of philosophy we will mention one more – albeit brief – period which nevertheless influences today's thinking about the role of empirical evidence in philosophical thought. The period in question began in the 1920's Vienna and ended in the 1970's United States and coincides with the activity of the philosophical movement known as 'logical positivism'. The main proponents of logical positivism include Moritz Schlick, Otto Neurath and Rudolf Carnap who were members of the group called 'The Vienna Circle'. The Logical Positivists were inspired – if not fascinated – by the scientific developments which happened at the beginning of the 20th century. In particular, this was the period which witnessed the breakthroughs in physics made by Albert Einstein, while the developments in logic and mathematics were of significance as well. Taking into account the impressive accumulation of new scientific knowledge, the Vienna Circle found the stalemate which may be observed in philosophy (related especially to metaphysical inquiry, which aims to unearth the ultimate nature of reality) rather depressing. They were discouraged by the lack of progress in philosophy to such an extent – as well as by the difficult, if not incomprehensible terminology used by some philosophers – that they came up with the idea according to which much of the philosophical work done in the last 2,500 years was, quite literally, pure nonsense. The idea in question is the infamous 'verificationism'. According to this idea, the meaning of a word consists in its method of verification. This – admittedly odd – formulation postulates that if we are unable to observationally determine

whether a particular statement about the world is true, the statement is meaningless.

Adopting the verification principle as a criterion of the meaning of sentences uttered by philosophers has dramatic consequences for these sentences – as well as for the philosophers who utter them. Let us appeal to only one, albeit illustrative, example: Platonic metaphysics. The characteristic feature of this type of metaphysics consists in introducing entities – e.g. forms or ideas – which, by definition, cannot be observed. Forms or ideas are perfect versions of things which we observe in our daily lives – there is a form of a human being, dog, tree, river but also of courage, love or justice. Forms can only be studied in an a priori fashion as perceptual experience provides us with information about mere appearances of things, not their true forms. According to the proponents of the verification principle, Platonic metaphysics is meaningless if we regard it as a description of reality. On the grounds of verificationism, we can hold to the Platonic project of investigating forms only if we understand it as a particularly sophisticated attempt to clarify our concepts of a human being, dog, tree but also the concept of courage, love or justice. This move, however, reduces one of the great metaphysical traditions – which continuously resurfaces in many areas such as the philosophy of mathematics – to a rather tedious word game.

At the present moment, logical positivism is only another chapter in the history of philosophy and the logical positivists were already an extinct species in the 1970's. Much can be said against the positivistic ideas about philosophy yet we will mention only one objection, aimed at the verification principle. Let us focus on the following sentence: 'Atmospheric pressure is higher at the top of a mountains than at sea-level'. This sentence easily passes the test designed by verificationists, i.e. we can observe whether it is true. This indicates that the sentence is meaningful. In particular, observation tells us that the sentence in question is false as atmospheric

pressure is lower at the top of the mountain than at sea-level. Here, however, is a more problematic sentence for the verificationist: 'Atmospheric pressure is higher at the top of a mountains than at sea-level and souls exist'. If the first part of this new sentence is false ('Atmospheric pressure is higher at the top of a mountains than at sea-level'), then – according to the principles of logic – the whole sentence must be false as well. However, we cannot verify the truth of the second part of the sentence ('souls exist') which compels us to claim that the whole sentence is meaningless. But the sentence is clearly not meaningless, as at least its first part tells us something interesting about how the world is. It may seem a minor difficulty for the proponent of the verification principle but dealing with it in reality proved to be quite problematic.

For several reasons, the example of logical positivism is important to the discussion of interdisciplinarity in philosophy. The unsuccessful attempt to discredit a major part of philosophy not only made it clear how very different philosophy and the empirical sciences are, but also the unobvious ways in which they are similar to each other. In particular, the positivistic programme revealed how philosophy is autonomous from science. In the article which was thought by its authors as the introduction to logical positivism, Carnap, Hahn and Neurath claim that 'in science there are no 'depths'; there is surface everywhere' (Carnap, Hahn & Neurath, [1929] 1973, p. 306). It is an understatement to say that this claim is false. A lot is happening under the surface of science and we will return to this issue in a moment. Thus, if there are things in science which are unobservable – and unverifiable – then why should we reject philosophical theories which are unverifiable as well? The true renaissance which metaphysics has enjoyed in recent decades – after its relatively brief retreat caused by the positivistic critique – is a good example of how limited the impact of positivistic ideas was.

There is little doubt that philosophy's experience with logical positivism was one of the reasons why a number of thinkers

are now distrustful towards the empirical sciences. Some of these philosophers mistakenly believe that philosophical reflection contaminated with appeals to experimental data and scientific method leads to its unwarranted limitation or even impairment. This is why even some of the thinkers who carry out their inquiry in the context of a particular empirical science do not explicitly appeal to scientific works but make use of them in a more indirect manner. Jerry Fodor, the American philosopher who was particularly influential in the creation of the theoretical foundation of cognitive science and who most probably knew more than any other philosopher about the sciences of the mind, was also known for avoiding appeals to empirical research in his work. When asked why did he so, he replied 'citing the science would be vulgar' (Rey, 2017). Some contemporary philosophers would probably say something similar, albeit for different reasons than Fodor. He held science in high regard and one can easily observe how science influenced his works and his remark was probably motivated by his belief about the wider range of philosophical investigations in comparison to the range of scientific inquiry. In contrast, in the case of other philosophers, this remark would probably mean that the latter is useless if one is attempting to do the former.

Logical positivism gave interdisciplinary philosophy a bad reputation. The positivists not only appealed to a simplistic notion of philosophy but also of science. Still, despite the fall of this intellectual movement, some thinkers remain convinced that scientific research should inform their work. They may even agree with the claim that science is the most credible source of our knowledge about the world. However, they think that the relationship between philosophy and science is more subtle and multifaceted than assumed by the logical positivists. At the present moment this perspective is perhaps the most common and influential among philosophical views. The view in question is called 'naturalism'. Some readers may be perplexed by the claim that naturalism is

such a popular doctrine within contemporary philosophy. After all, a moment ago I also claimed that, partly due to the logical positivists, contemporary philosophers are distrustful towards the empirical sciences. However, there is no incompatibility between these claims. As we will see, naturalistic philosophy does not have to mean a philosophical reflection which appeals to experimental evidence.

3. Interdisciplinary philosophy as naturalistic philosophy

Naturalism is typically described as the view according to which philosophical reflection should be continuous with science (Papineau, 2016). This cliché sounds promising but it is difficult to determine what it amounts to. Perhaps the common feature of all incarnations of naturalism – and there are truly many of them – is the belief that there should be some sort of connection between philosophy and science. There is little agreement, however, about the details of this postulate. The capacity of naturalistic doctrine is so substantial than philosophers of very different views describe themselves as 'naturalists'. A well-known philosopher of science observes that 'philosophers, like shampoo manufacturers, would always like to call their products <<natural>>' (Godfrey-Smith 2003, p. 150). Perhaps this is the case because philosophers would not welcome the accusation that their views are artificial or unscientific. Many philosophers tend to think that their theories describe how the world is and not merely how it appears to them.

A historian of ideas may oppose the claim that naturalism is a novel philosophical idea and that its emergence was associated with the demise of logical positivism. There were naturalists in philosophy before this had happened. John Dewey, the American philosopher, described himself as a 'naturalist' in the 1920's. What is

more, naturalistic views can be found in the works of the philosophers of the Enlightenment – for instance in the works of Francis Bacon who lived at the turn of the 17th century. This English philosopher claimed that there are certain illusions which our minds are prone to be influenced by. Facts about various psychological mechanisms – or, more generally, facts about the relationship between the mind and the world – are at the heart of the endeavours of some contemporary naturalists and interdisciplinary philosophers. Reaching back to an even earlier period – in fact, the period which marked the beginning of the Western philosophy – we may observe that naturalism, or something close enough, was the view of the Pre-Socratics – the first philosophers of ancient Greece. In their explanations of the world, they made a conscious effort to avoid appeals to supernatural occurrences such as divine interventions. Doing justice to the history of philosophy, we should agree that naturalistic inclinations have been present within philosophy for a long time.

Typically, however, the beginning of the philosophical discussion explicitly aimed at naturalism is associated with contemporary times – particularly, with the year 1969. This is when the paper *Epistemology Naturalised*, authored by the American philosopher Willard V. O. Quine, was published (Quine, 1969). Despite the fact that Quine was one of the most influential critics of logical positivism, he remained influenced by positivistic ideas – a fact he himself admitted. *Epistemology Naturalised* is a good example of the continuation of some positivistic insights. In this paper Quine postulates that traditional epistemological questions – i.e. questions about the relationship between the mind and the world – are so intimately connected with the issues studied by psychologists that epistemology should be reduced to psychology. The American philosopher thought that cognition, mind, and even knowledge should be studied similarly to how things are studied within the empirical sciences.

That the contemporary discussion about naturalism begins at the time that Quine's paper was published does not merely reflect his philosophical authority. A lot of factors were significant in starting this debate but let us restrict ourselves to mentioning only two of them. In 1962, only several years before the publication of Quine's paper, an immensely influential book appeared – *The Structure of Scientific Revolutions* by Thomas Kuhn (Kuhn, 1962/2012). This book depicted science as influenced by numerous factors which include scientists' philosophical views. The idea that philosophy influences science is in opposition to the claim that they are autonomous from each other and it is one of the arguments stored in the naturalist's closet in favour of his views. Secondly, a new scientific approach to the mind emerged in the 1960's, namely cognitive science, which clashed with behaviourism and eventually led to its demise. The emergence of cognitive science was important for naturalistically minded philosophers as it promised to reveal the facts about the mind which are philosophically interesting.

Perhaps the reluctance of some philosophers to appeal to empirical research is in part a consequence of their belief that this may lead to the partial replacement of their philosophical inquiry with the related scientific inquiry. This would be in line with the version of naturalism postulated by Quine. However, naturalism comes in many flavours. The proponent of naturalism may adhere to a different, more moderate version of this doctrine, according to which philosophical problems are different from their scientific counterparts. Still, she may claim that experimental evidence may be of significance in tackling the former. On this view, empirical science is regarded as providing information which philosophers can and should take into account in their inquiries.

Yet another consequence of adopting naturalism is the adherence to nonfoundationalism – an important feature of scientific method (Heller, 2006). The nonfoundationalism of science means

that we should think about scientific theories as approximations of how things actually are and not regard them as dogmas. The naturalistic-minded philosophers think about the results of their inquiries in a similar manner – as idealizations or models of reality. Admittedly, there are philosophical claims which are so convincing that it is hard to imagine they may be false. An example of such a claim is the famous 'ought implies can' principle formulated by Immanuel Kant. This principle is aimed at our duties and it declares that it cannot be required from us to do what is impossible. However, philosophical inquiries are also full of dogmatic idealizations which are, in the best case-scenario, implausible. In this context let us mention Kant again who, in a work published in 1790, claimed that 'we may confidently assert that it is absurd for human beings even to entertain any thought of so doing or to hope that maybe another Newton may some day arise, to make intelligible to us even the genesis of but a blade of grass from natural laws that no design has ordered. Such insight we must absolutely deny to mankind.' (Kant, 1790/2007, p. 228). Kant thought that the empirical sciences would never be able to account for purpose – beginning with the intentions of human agents and ending in tropisms, i.e. the turning of plants in response to environmental stimuli. In connection to the intentions of human agents, this view is still shared by more than a few contemporary thinkers. Interestingly, the Newton of the blade of grass was born only 19 years after Kant's work in the form of Charles Darwin. The theory of evolution authored by Darwin shows how random mutations and natural selection, when they work for a sufficiently long time, can generate the illusion of purposefulness.

Interdisciplinary thinkers underscore that the important insight which science provides is that the struggle towards certainty should not be viewed as an all-or-nothing matter. Attempting to achieve certainty is, of course, commendable, if only for the fact that it helps us in perceiving mistakes in our own inquiries. This

autocorrection saves the valuable time of others who do not need to know our premature conclusions. Another advantage of the struggle towards certainty consists in the fact that it supports us in opposing currently popular views and to reach beyond them. As it happens, philosophers sometimes build their theories with the goal of them being the most famous, fashionable, or controversial intellectual efforts at a given time. On the other hand, the struggle towards certainty may be driven by the fear of making a mistake. This, in turn, may lead to a far-reaching scepticism towards the experience-based knowledge which entails the knowledge accumulated by science.

4. The intersecting planes of philosophy and science

The logical positivists were dismayed with the lack of progress in philosophy as compared to the empirical sciences and this is an observation that is not without merit. After all, there are problems being tackled by contemporary thinkers which were discussed by their predecessors many centuries – or even millennia! – ago. Admittedly, this is a feature of philosophy which some may find rather depressing. On the other hand, there is no doubting scientific progress. Even the school-level history of science is full of information about numerous scientific breakthroughs – from the Copernican revolution, Mendel's laws of inheritance or Newton's laws of motion. One can say that progress is an essential feature of science.

The limited progress in philosophy may mean that the problems which philosophers tackle are of a different nature than the problems solved by scientists. Many contemporary philosophers think that philosophical problems – in opposition to their scientific counterparts – are largely conceptual in nature. Solving scientific problems, on the other hand, requires one to explain how the

world actually is – not to how we conceptualize it. What is more, the belief in the conceptual nature of philosophy is also associated with thinkers who regard themselves as naturalists. Indeed, how we conceptualize that the world is not something supernatural but part of how the world actually is.

An example which reveals how our conceptualization of the world is itself a part of the world – in fact, a cognitively fascinating part of the world – are the numerous fictions which we universally believe in and which, due to this universal belief, can impact us in reality. Some of these fictions are legal in nature and they include large, international companies. Strictly speaking, these entities only exist in our collective imagination. However, international companies are endowed with powers which enable them to impact reality in a quite decisive manner. Due to the fact that international companies, their powers, and the law itself are social phenomena which only exist in our collective imagination, conceptual analysis – which consists in determining how the agents who appeal to law in their practical deliberations actually understand law and legal phenomena – is a dominant research methodology both in the study of law and in the philosophical inquiry. An attempt to explain the behaviour of agents who represent international companies by appealing to the activity of their brains – which ignores the legal reality which influences the deliberations of these agents – can be compared to the explanation of the behaviour of football players which ignores their intentions and focuses on the dimensions of the pitch. Experimental evidence is, as far as law and philosophy are concerned, valuable but supplementary.

What is also of significance is that within the empirical sciences the conceptual or theoretical issues are regarded as an obstacle for interdisciplinary research as well:

> Interdisciplinarity is an ambivalent term in science. Usually, it is discussed in the context of urgent practical pro-

> blems which manifestly need a team of various specialists to be dealt with more or less effectively. Engineers, economists and biologists are involved in solving agricultural problems. Jurists, sociologists and psychologists sit together to draw up plans to deal with juvenile delinquency. For practical problems it is considered valid and unavoidable but for theoretical purposes in science, interdisciplinarity is handled with great caution and even with suspicion. While they pay lip service to the principle, most scientists look upon their own discipline as either too incomplete or too immature to be coupled to another one. The prevailing attitude seems to be: first disciplinarity before engaging in interdisciplinarity (Mey, 1982, p. 140).

These beliefs about interdisciplinarity are shared by naturalistic philosophers. Preserving the continuity of philosophy and science implies the agreement that, at least in principle, there are no obstacles for an appeal to the experimental evidence in philosophical reflection. However, if we also agree that philosophical problems are often conceptual or theoretical in nature, the philosophical significance of this kind of evidence becomes limited. Conceptual problems – the solution of which requires the determination of the content of a particular part of our image of the world – do not compel one to carry out empirical investigations. We can deal with conceptual problems from our favourite armchair. What is more, various conceptual issues in philosophy are disputed to such an extent that appealing to experimental evidence in their investigation is premature. This is why attempts to confine philosophical problems to the framework of scientific research may resemble the kind of misguided postulates made by the logical positivists.

We should also observe that conceptual analysis – or at least its philosophical incarnation – should not be identified with lexical or linguistic inquiries. Conceptual analyses of a philosophical nature

may begin with investigations of the ordinary meaning of a word or a phrase, but they tend to quickly go beyond their ordinary meaning. In result, philosophical theories do not describe our ordinary linguistic practices, but they are attempts to say something about the world from our point of view. Philosophical inquiries may lead us in different directions – even if our point of departure is ordinary meaning – and this is illustrated by philosophical disputes about even the most fundamental issues.

Sometimes it is the case, however, that the philosophical dispute about a particular problem may be so closely related with the research carried out within a particular empirical science that it will be fruitful – or indeed necessary – to take into account the relevant experimental evidence in one's philosophical inquiries. Scientific investigations carried out by physicists are perhaps the model example of empirical research which cannot be neglected by thinkers interested in the nature of space and time. However, the question remains whether there is a more general way to describe the relationship between philosophy and the empirical sciences beyond enumerating the particular cases in which the experimental evidence has proven to be of direct philosophical relevance. Let us propose the following claim: the planes of philosophy and science intersect, i.e. science is relevant for philosophy and *vice versa* – when philosophical theories make empirical commitments and scientific theories make philosophical commitments.

The notion of commitment in the above-mentioned claim is not well-defined. In particular, it does not refer to commitments explicitly made by the author of a philosophical or a scientific theory. The commitments in question may be tacit, i.e. they can be determined with the aid of interpretative tools of a logical or argumentative nature used on a daily basis by philosophers and scientists. Thus, a theory can make commitments of which its author is unaware – at least initially. The weakness of this loose understanding of commitment consists of the fact that whether a theory

makes a commitment in this sense may be disputed as we will not be able to determine this fact with certainty.

Let us take a closer look at the empirical commitments of philosophical theories, leaving the philosophical commitments of scientific theories for a different occasion. An empirical commitment of a philosophical theory is a claim which can be inferred from this theory and which can be assessed empirically. We will assume that the possibility of an empirical assessment of a claim means that the claim is falsifiable, i.e. it can be discarded if the empirical evidence is incompatible with what it postulates. To sum up, the commitment of a theory is of an empirical nature if it can be discarded on the grounds of an incompatible empirical evidence.

An example of an empirical commitment of numerous philosophical theories – related to issues within the philosophy of mind, moral and legal philosophy as well as the philosophy of action – is the claim that our conscious decisions causally influence our actions. This means that if I decided to go for a walk because I came to the conclusion that I needed some exercise, it was my conscious decision which was the cause of my behaviour consisting in going for a walk. Some thinkers believe that the ubiquity of the claim that our conscious decisions influence our actions is not surprising because it is a non-negotiable part of our self-image (Caruso, 2012). For instance, we will be willing to attribute responsibility for an act if the agent could consciously influence it. If the agent could not consciously influence his action, we should refrain from attributing responsibility to him for this particular action.

In recent decades the claim that consciousness is causally efficacious has come under scrutiny. To explain why this happened, we need to appeal to empirical studies carried out by cognitive scientists. These results suggest that our experience of the causal efficacy of our consciousness, and the actual process which leads to action, may come apart (Wegner, 2002). In particular, it may be the case that despite the appearance that our action is the result

of our conscious decision, in reality our conscious decision lacked this causal power. On the one hand, it is not difficult to show that dissociations between our understanding of how things are, and how things actually are, may happen. After all, this was already observed by the earliest philosophers. The Greeks were acutely aware of the fact that even visual perception can undergo such a dissociation – a fact which is illustrated by the phenomenon of visual illusions (e.g. a stick partially submerged in water will appear broken). On the other hand, we do not cease to trust our visual perception only because it is prone to generate illusions in some cases. However, the above-mentioned studies of dissociations between our experience of conscious action initiation and the actual action initiation suggest that this type of dissociation happens more frequently than we probably think and that it is more difficult to discover in comparison to visual illusions.

The *locus classicus* in the discussion about empirical evidence against causal efficacy of consciousness is the 1977 paper by the psychologists Nisbett and Wilson suggestively entitled *Telling More Than We Can Know: Verbal Reports on Mental Processes* (Nisbett & Wilson, 1977). In this paper, the authors refer to their own studies and those of other psychologists which illustrate how limited our access to the cognitive processes which underlie our decision-making mechanism is. One the most well-known effects they discuss is the so-called 'position effect': the preference of items which are located in a specific place. In the experiment, participants were told to evaluate four articles of clothing: four different nightgowns and four identical pairs of stockings. In both cases there was a clear preference towards items which were located furthest to the right. Interestingly, as the researchers inform us, 'when asked about the reasons for their choices, no subject ever mentioned spontaneously the position of the article in the array. And, when asked directly about a possible effect of the position of the article, virtually all subjects denied it, usually with a worried glance at the

interviewer suggesting that they felt either that they had misunderstood the question or were dealing with a madman' (Nisbett & Wilson, 1977, pp. 243-244).

The above-mentioned study suggests that in some real-world situations people do not have any introspective access to the information which actually influences their decision-making. What is more, this fact is difficult to discern as it is illustrated by the confabulatory explanations of why a particular item was chosen which were offered by the participants and their surprise when the researchers asked whether the position of the article influenced their valuation. Although the authors of the paper in question explicitly deny that such studies indicate that consciousness lacks causal efficacy, they agree that our introspective access to the cognitive processes underlying our decision-making is limited and that our experience of the causal efficacy of our consciousness and the actual process which leads to action may come apart.

Citing empirical evidence is not the only argument in favour of the denial of the causal efficacy of consciousness and it is not even the strongest one. The empirical studies discussed by cognitive scientists only cover some types of decisions, e.g. easy decisions which are not preceded by serious considerations (such as decisions whether one ought to get a university degree). Stronger arguments in favour of the denial of the causal efficacy of consciousness are conceptual in nature and they are aimed at proving that this denial is true across the board. One such argument is the argument from the causal closure of the world which goes as follows:

Premise 1: Conscious mental states have physical causes.

Premise 2: Causation only holds among physical states.

Conclusion: Conscious mental states are identical with some physical states.

Both premises in this argument are in line with the materialistic view of the world: there are no nonphysical – or, as some would probably think, supernatural – influences on what happens in the physical world. If the premises are true, the conclusion is that conscious mental states are identical with some physical states (most probably, with the physical states of the organism having these conscious states). But if this conclusion is true, then conscious mental states are epiphenomenal as the physical effects of conscious states are, in reality, the physical effects of the physical states with which these conscious states are identical.

The empirical research outlined in the paragraph above may only falsify the claim about the causal efficacy of conscious decisions if it states the following: conscious decisions are always causally efficacious. In light of the experimental research in question, the proponent of this claim may choose to weaken it in the following manner: conscious decisions are, more often than not, causally efficacious; or even: conscious decisions are sometimes causally efficacious. The weaker version of the original claim is not falsified by the mentioned empirical research, as this research only pertains to some types of decisions, made in particular circumstances. However, one of the most valuable features of empirical studies is that they reveal things about ourselves or about features of the world which are conceptually inaccessible from the armchair (no matter how hard we investigate from the armchair the concept of water, we will not arrive at the conclusion that water is H_2O; or, most probably, no matter how hard we conceptually investigate our decision-making, we will not arrive at the conclusion that the position effect occurs). This empirical evidence enriches our concepts and is then used as data in further philosophical investigations (e.g. what does it say about ourselves – i.e. about our concept of agency – that the position effect occurs?).

Summary

One of the motivations of interdisciplinary philosophical inquiry is the desire to reconcile two images of the world: the manifest one and the scientific one (Sellars, 1956). These images appear to be incompatible in many places and perhaps some of these incompatibilities result from our insufficient understanding of these images. Understanding them better requires a lot of purely disciplinary effort, limited to philosophy or a particular empirical science alone. We must allow the possibility, however, that at least some parts of the manifest image will in fact be incompatible with its scientific counterpart. This would mean that our understanding of the issues studied by philosophers – such as the nature of the world, the mind, values, or freedom – diverges from what these issues are in reality. In itself, the observation that there are parts of the manifest image that do not correspond to reality should not worry us too much and calls for their correction may be premature. In many places, the scientific image does not correspond to reality as well. Scientific models of reality are idealizations as scientists self-consciously – and for many reasons – distort reality (Wimsatt, 2007). The falsity of scientific models cannot be, therefore, the only reason to discard them. Thus, one of the challenges for interdisciplinary philosophy is to show when and why we should be worried about the incompatibility of the manifest and the scientific images of the world. Another challenge to interdisciplinary philosophy is to account for the issue of how should we proceed with the incompatibilities in question.

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Interdisciplinary jurisprudence: between law, cognitive science, and new technologies

1. How can law be interdisciplinary?

The interdisciplinarity of law is of a specific nature and this is implied by certain features of the law. First, it is not the aim of law to describe reality, nor does law explain human behavior. Rather, it states the norms which are ruling the behavior of people and it is the law that obliges us to pay taxes, protect human life, and avoid speeding. Obviously, many generally accepted moral rules are similar to legal rules, or even equal to them, but formally we are bounded by law, not morality.

Interdisciplinarity understood as a feature of scientific research, which is conducted by the representatives of various disciplines (see Klein 1990) might seem to be inadequate when one thinks about the interdisciplinarity of law. However, if we accept a more inclusive way of defining interdisciplinarity, namely as an intellectual activity which concerns more than one discipline or harnessing results gained by different sciences, it transpires that law may be treated as interdisciplinary in many aspects.

Such a way of thinking about the law is relatively new and is linked to the emergence of naturalistic jurisprudence (about naturalism in law see Stelmach et al., 2015a; Pietrzykowski, 2017; Leiter & Entchemendy, 2012). Adherents of naturalism argue in favor of the application of scientific knowledge (especially from fields like psychology and biology) in both legal theory and legal practice. On the other hand, Polish legal philosophers are familiar with a similar notion of "external integration of jurisprudence" which refers to the integration of legal sciences and scientific knowledge (see Opałek, 1968).

Naturalism in the legal context is interpreted in numerous ways (see Stelmach et al., 2015b; Greenberg, 2011), but the general idea can be easily described. Firstly, some questions in legal philosophy can be answered or reformulated in light of contemporary scientific knowledge. In legal practice, cognitive science (especially neuroscience) can be harnessed in order to make legal decisions more adequate and empirically based (de Kogel et al., 2014). The controversy arises, however, when the methodology of applying this knowledge, as well as limits of naturalization, are discussed.

The most relevant way of understanding naturalization when interdisciplinarity in law is examined concerns the relation between legal knowledge and scientific knowledge (Brożek, 2015). Legal knowledge in a strict sense encompasses legal norms (with their descriptive presuppositions), legal doctrine, and judicial rulings. Legal knowledge *sensu largo* is enriched by theoretical and philosophical discussions (Brożek, 2015, p. 26). Scientific knowledge is composed of descriptive statements expressed by scientists. As Brożek notes, there are (at least) four relations that may exist between these two kinds of knowledge: separation, supervenience, reduction, and coherence (ibid.). According to the separation thesis, legal knowledge is independent of scientific knowledge; Kelsen's normativism serves well as an example (Kelsen, 1945). Adherents

of supervenience, hitherto applied mainly in philosophy of mind and ethics, assert that legal facts supervene on natural facts. This assumption can be traced in these (dominant) variations of legal positivism in which "social source thesis" is particularly emphasized. Supervenience is obviously much weaker than another possible solution – reduction. According to reductionism, norms can be translated into descriptive statements (Brożek, 2015).

Both separation and reduction do not seem to be appropriate descriptions of the relation between scientific and legal knowledge. Law cannot be developed as a "pure" normative system, separated from the knowledge about the world, e.g. about human decision-making processes. It is also clear from the practical point of view – scientific evidence is becoming more important in criminal and civil proceedings (neuroscientific evidence is debated especially hotly nowadays, see Shen, 2016). Law is also not reducible to mere facts. Even if we know all the facts relevant in law, e.g. all decisions made, it does not entail the law itself and its normativity. Supervenience has attracted some interest in legal philosophy (see Brożek, 2017), but it does not seem to be a point of departure in modeling the relation between scientific and legal knowledge. Another solution is needed, and the relation of coherence seems promising. The coherence is gradual and concerns the comparison between legal and scientific knowledge, or – more generally – between legal and scientific images of world (Brożek, 2015, p. 46). If the descriptive presuppositions of legal norms (expressing beliefs concerning the world, such as the mechanisms of decision-making) are based on false (or anachronistic) knowledge, then a certain part of legal knowledge is not naturalized. In the opposite situation, it is naturalized. Naturalized law, i.e. law coherent with scientific knowledge, must be interdisciplinary. Merely dogmatic theories of the human mind, based on a folk-psychological worldview or old-fashioned scientific knowledge, can be a route to disaster – law which is unable to regulate human interactions

may be effective to a certain extent, but at a certain level this lack of knowledge may negatively influence the lives of ordinary people. The interdisciplinarity of law is not only an option – it is a necessity. It does not mean, however, that there are no pitfalls to interdisciplinarity (see Załuski, 2020, this volume).

Legal interdisciplinarity is, obviously, a specific type. It embraces not only legal science, but also law as a normative tool. It is also "soft" in the sense that no modifications in legal methodology, both at the theoretical (legal philosophy) and practical level (legal practice) are supposed. Even if scientific knowledge becomes a part of legal knowledge, it does not affect the core methods of legal decision-making.

One should also note that interdisciplinarity is not necessarily naturalistic. Scientific knowledge, although it is most relevant in interdisciplinary research and practice, is just one of many points of departure for interdisciplinary endeavors. One example of non-naturalistic interdisciplinarity is the "law and literature" movement (West, 1988). Legal philosophy in general, as a part of the legal sciences, is also intrinsically interdisciplinary, as different philosophical methods and conceptual schemes are employed in the explanation of legal phenomena.

There is also another aspect of legal interdisciplinarity which has not been analyzed before. In the further parts of this chapter, I will also focus on legal changes forced by the development of technology. As will be argued, the influence of new technologies is different from that of cognitive science. It will allow me to distinguish two kinds of interdisciplinarity and elucidate the difference between interdisciplinarity understood naturalistically and "technological" interdisciplinarity.

2. The first dimension: law and cognitive science

Let us start with the first dimension of interdisciplinarity which can be considered "naturalistic". The influence of cognitive science is still a relatively new field of interest for legal philosophy. This case is particularly interesting due to increasing advancements of cognitive science in explaining the human mind, and because of the interdisciplinarity of cognitive science – which is composed of neuroscience, evolutionary sciences, psychology, philosophy and AI studies. The interdisciplinarity of law in light of cognitive science is therefore multi-faceted: it is based on an interdisciplinary science.

Two examples will be presented, each of which explains the impact of cognitive science on the law. These issues have the potential to trigger radical changes in law in general, not just in individual regulations, but rather in legal concepts, institutions, or entire branches of law. It will lead me to evaluate a position according to which cognitive science, by challenging the folk image of the human mind, can undermine the very foundations of the legal system.

Firstly, let us examine the impact of research on free will and self-control. Some results of neurobiological experiments prima facie undermine the existence of free will and strongly contradict our intuition and folk-psychological image of man. Still, it is a highly controversial matter, as the ongoing discussion concerns the interpretations of these results. Contrary to claims that "free will is an illusion" or that every choice we make is random, the emerging picture is more sophisticated. Although the classical model of volitional action (in which the subject's decision is proceeded by a prior intention and the decision takes place before the action) finds no support in the results obtained, such radical conclusions would be inadequate.

However, for the purpose of this chapter, let us ask the following question: can the possible discovery that "we do not have free will", which would be the subject of a consensus among scientists (and philosophers), become a source of a revolution in law? Let us assume (let us treat it as a specific thought experiment) that it has been shown with a high degree of probability that a person has no freedom in their decision-making and therefore cannot be blamed. Meanwhile, guilt, and – more precisely – the possibility of attributing it to the perpetrator, is the fundamental element of the structure of crime. Therefore, it can be assumed that, due to the impossibility of attributing guilt to anyone, it would be unjustified to conduct criminal proceedings. Moreover, criminal law in the modern sense would also cease to exist.

On the other hand, as long as we recognize ourselves and others as free subjects in common thinking, even against the position established by the results of neurobiological research, the existence of criminal law would be justified. Already at the beginning of the twentieth century – so long before modern neurobiological experiments – Kazimierz Twardowski noticed that the importance of the problem of free will for law and ethics is not at all obvious:

> "(...) the question arises whether the way in which the problem of freedom of the will is resolved is indifferent to ethics and criminal law. There are different opinions. They often say that the denial of the freedom of the will abolishes any difference between good and evil, between virtue and vice, it is heard that denial of the freedom of the will takes away all basis of punishments and rewards. But one can also hear the opposite sentence, namely that punishment and reward cannot be of any importance if it is assumed that the will is free. Conversely, they tell us again that by denying the freedom of the will, one loses the right to hold anyone accountable, etc. It can be seen from such statements that, according to a fairly common opinion, it is not indifferent to ethics and

> criminal law whether one accepts or denies"(Twardowski, 1905/1963, p. 125).

Although more than a hundred years have passed since Twardowski's deliberations, the questions he raised about the importance of research on free will are still valid. Moreover, there are tendencies to consider that this issue is irrelevant from a criminal law perspective, and the only problem that the issue of free will raises is "confusion among (...) [those] who think that free will is a problem" (Morse, 2007, p. 204).

There is no place here to analyze the philosophical and neurobiological discussion on free will since it goes far beyond the scope of the book. This problem was merely mentioned because it is a particularly illustrative example of a potential impact of science on law. Although it may intuitively seem that this influence will be crucial – after all, if we are not free, why punish anyone? – a moment of reflection is enough to see the complexity of the free-will difficulty. Apart from the possible ineffectiveness of the law "without penalties" – it may be manifested, for example, in the lynch law – there is one more argument that is important for this discussion. I will return to it at the last point of the chapter, but it is worth mentioning now: science does not provide "final solutions" and thus the naturalization of law is difficult.

However, neurobiology not only affects law by questioning the issue of guilt and legal responsibility. "Neurolaw" is a new interdisciplinary science that has emerged at the intersection of law and neuroscience (see Picozza, 2015). It serves as a good example of the importance of scientific knowledge, both for the philosophy of law and for legal practice. Neurolaw is a multifaceted research area yet two major dimensions can be indicated. The first, the theoretical, consists of research on the meaning of legal concepts in light of the achievements of neuroscience. For example, the impact of research on the neurobiology of emotions is analyzed in the

context of declarations of will in contracts (Brożek, 2015; Zyzik, 2016). The aim is to describe the assumptions underlying the legal understanding of the mental mechanisms that are responsible for a declaration of will, and to assess whether these assumptions are adequate given the scientific knowledge at our disposal. The practical dimension of neurolaw embraces, among others: the use of neuroscientific evidence in criminal and civil proceedings; the regulation of new legal problems that arise in connection with the development of neurobiology and medicine; adapting legal institutions to the current state of knowledge (Goodenough & Tucker, 2010; de Kogel et al., 2014).

A practical question regarding the interdisciplinarity of law in this case concerns the ways of applying neuroscience in court proceedings. In American jurisprudence, two basic standards for evaluating evidence have emerged (Bernstein & Jackson, 2004) and they can also be a reference point in the analysis of the admissibility of this kind of evidence in other legal systems. The first (historically older) is the so-called *Frye standard*. In its light, when deciding whether a specific piece of evidence may be used, the court assesses whether a given method has been approved by representatives of a relevant scientific discipline. Therefore, it is crucial to check whether the method used to obtain specific evidence is evaluated as adequate by a community of scientists.

The situation is different for the Daubert standard, which became an alternative to Frye in the 1990s (Bernstein & Jackson, 2004). In light of these rules, judges are responsible for determining whether the method of the evidence is appropriate from the perspective of contemporary science and appropriate in the context of the case under examination. Among the specific elements that should be taken into account are:

– determining whether the theory / technique is testable (falsifiable) and whether it has been tested,

– determination whether the theory / technique has been described in a way characteristic for scientific publications,

– the risk of error related to the use of a specific technique,

– determining whether the theory / technique is widely adopted in the scientific community (see Bernstein & Jackson, 2004; Zyzik, 2011; Jakubiec, 2018).

According to the Daubert standard, the scope of knowledge that the judges must apply is much wider: it is not just about saying that a given method is recognized by the scientific community, but about its independent evaluation. Obviously, the judge will harness the opinions of experts in such an assessment. However, this does not change the fact that with the spread of the Daubert standard in the USA, judicial decisions require "broader" interdisciplinarity – understood here as the need to include scientific knowledge in legal analyzes.

3. The second dimension: law and new technologies

Nowadays, when we think about the challenges that technological development poses to law, we are faced with a wide range of problems that require the legislator's response. Below I will outline a few issues which constitute a good point of reference for our further considerations. These will be legal problems related to the fintech industry, startups, and responsibility for the actions of autonomous machines. As above, I will not go into detail about the legal problems; rather I will treat them as examples that will allow to illustrate how the interdisciplinarity of law is manifested here. Moreover, the influence of new technologies on law is usually not analyzed in publications on the interdisciplinarity of law.

Let us start with financial technology. "Fintech" is an abbreviation of the part of the financial industry which is based on new information technologies (Arner, Barberis & Buckley, 2015). It

is about enterprises that operate with the extensive use of tools such as mobile applications. Importantly, it is indicated (ibid.) that modern fintech is in fact "fintech 3.0", as the technological transmission of information is currently a qualitative leap within one phenomenon (whose origins are related, among others, to the creation of the telegraph, used for the first time for commercial purposes in 1838 (Barbirolii, 1997, after: Arner et al., 2015). The 1980s can be considered as the period of transition from "fintech 1.0" to "fintech 2.0", and the key phenomenon related to this transition is the process of digitalization (ibid.). Arner et al. recognize traditional financial institutions as "fintech 2.0" (ibid., p. 3). What distinguishes "fintech 3.0" is the nature of startups (more about startups below) as well as the way they operate, so it is worth noting that fintech "2.0" and "3.0" exist in parallel to one another.

The development of this sector is mentioned in the context of the interdisciplinary nature of law, as it is a good example of the influence that technology has on legal regulations. This impact means that technological knowledge becomes a relevant element of legal knowledge. It is impossible to introduce standards for the operation of fintech enterprises without knowledge of the technical mechanisms of their functioning. Of course, this does not mean that lawyers (legislators, judges, attorneys, etc.) must have such knowledge. Rather – as in many other cases – interdisciplinarity means the need for cooperation between representatives of legal sciences and specialists in the field of finance and new technologies. The role of the latter is analogous to that of the experts which I mentioned in the context of the naturalization of law.

The challenges faced by lawyers include, inter alia, the regulation of the activities of these enterprises from the perspective of banking law. In particular, it seems reasonable to ask whether the recommendations of the Financial Supervision Authorities, significantly affecting the activities of banks, should also apply to the fintech industry. In addition, legal cybersecurity regulations turn out

to be crucial. Financial technologies are part of a wider phenomenon, namely the growing importance of startups.

Start-ups are new enterprises with specific features, such as raising capital from investors ("business angels"), striving to obtain a significant position on the market as quickly as possible, operating under uncertainty, and – most importantly – their activity is strongly related with new technologies, i.e. operating in the field of the digital economy (see Skala, 2007). The first three features, of course, may also apply to other enterprises. What distinguishes startups is the crucial importance of information technology to their operations. The largest startups, such as Facebook, Dropbox, Coursera, Spotify, or Uber would not be able to function without the rapid increase of importance of the Internet in people's daily lives over the last two decades.

However, law was not – and is still not – prepared for the dynamic development of the startup market. This is evidenced by constantly emerging legal problems, as well as discussions concerning the *de lege ferenda* postulates. User privacy issues are only one of the most serious concerns. It is also unclear how to regulate the activities of certain companies of this type.

There is no place here to deal with strictly legal issues. From the perspective of the analysis of interdisciplinarity in law, an important fact is that the regulations of startup activities enforce interdisciplinarity – knowledge about the mechanisms of their functioning turns out to be crucial, both in creating regulations and in applying the law. Sometimes merely the basic knowledge that most people who use online services have will be enough, but it will be necessary to include specialized knowledge in some situations. This is the case of startups that use technologically advanced tools based on blockchain. The regulation of their activities cannot take place without the legislator obtaining a good working knowledge of blockchain mechanisms. In this case, expert opinions act

as a source of this knowledge, which subsequently becomes part of legal knowledge.

The third example I would like to mention concerns a question that has gained media attention in recent years and appears in many academic publications (see e.g. Brożek & Jakubiec, 2017; Hage, 2017; Mamak, 2017): how to regulate the liability of autonomous vehicles? This is a special case of a more general problem related to the legal status of autonomous machines.

First of all, it is worth considering what this autonomy means and why it becomes a reason for posing more serious philosophical and legal questions. Usually, autonomy is associated with several features (Franklin & Graesser, 1997), such as:

(1) self-control: the autonomous machine is not directly controlled by another agent;

(2) goal-orientation: the actions of the machine are not limited to simple response to stimuli;

(3) learning: shaping future behaviors on the basis of acquired experiences (ibid.).

Assigning the above characteristics to a machine raises questions about the nature of its actions, and more specifically about the possibility of introducing a legal form of liability borne by machines. Various answers to these questions can be related to two basic views on this matter (Brożek & Jakubiec, 2017). The first is called "restrictivism." According to it, autonomous machines cannot be responsible; they will never become persons in the legal sense due to the lack of certain characteristics such as awareness, freedom of decision-making, etc. (Fischer & Ravizza, 2000). According to the opposite position ("permissivism"), there are no legal restrictions on the implementation of the construction of machine liability; the law is a flexible tool.

Adherents of both of these approaches seem to overlook an important aspect of the problem. The law is rooted in a common conceptual scheme – and therefore it must be based on it otherwise

it cannot serve as an effective tool regulating social life (Brożek & Jakubiec, 2017). "Responsibility" has a roughly defined colloquial meaning – the law cannot be created separately from this meaning, otherwise it will become incomprehensible to the addressees of the legal rules.

The aforementioned distinction between restrictivism and permissivism may seem purely theoretical. Indeed, when we think about the challenges that technological developments pose to the law nowadays, we are unlikely to think about the introduction of the criminal liability of artifacts into the Criminal Code. Instead, we are confronted with a broad catalog of problems related to autonomous machines that already require a response from the legislature. Crucially, from the perspective of the topic of this chapter, they also represent manifestations of forced interdisciplinarity.

First, even if we agree that it would be inexpedient to "punish" autonomous machines, the problem of the entity responsible for the damage they cause arises. While the entity bearing civil liability can be identified relatively easily (e.g. in the Polish legal system, the reference point is Article 435 of the Civil Code), the question of criminal liability is problematic due to the lack of human control over the activity of the autonomous agent.

Second, there is the question of how to design the software of autonomous machines, particularly important in the case of autonomous cars. Should the car strongly protect its owner "at the expense" of other road users in the case of an emergency situation? How should the "decision" problem be addressed in a situation where an accident cannot be avoided and the car must hit two people or one, with one being more likely to suffer death than the other? Finally, should the owner be able to make his or her own changes to the software which has been designed to protect his or her health and life "at all costs"? There is no doubt that these issues require legal regulation – and its introduction will have to be

preceded by the work of interdisciplinary teams including lawyers, philosophers, and representatives of the world of technology.

The examples outlined above provide a glimpse into the way technology is forcing changes in the law. The increasing interdisciplinarity of law is connected with the need for legal knowledge to "absorb" the knowledge of new technologies. What is noticeable here is the fundamental difference between the relevance of technological knowledge and of the knowledge gained by cognitive scientists to the law. Although the impact on the law is discernible in both cases, technology changes the law at its "surface" rather than at its "core." If the need arises to regulate the status of a fintech company or to decide who is liable for damages caused by an autonomous car, the changes introduced by new legal norms will not fundamentally affect the meaning of legal concepts, legal institutions, or even entire branches of law. Of course, this may change in the future: if it turns out that we can create machines that are sufficiently autonomous and intelligent enough to be able to recognize the meaning of their actions and modify their patterns of behavior to a higher degree than at present, perhaps the debate between the "restrictivists" and "permissivists" will become central to the legal debate. In this context, philosophical analyses of consciousness, responsibility, or free will should prove relevant. The introduction of a new category of subjects capable of bearing responsibility would indeed constitute a modification of the "core" of civil or criminal law.

4. The limits of interdisciplinary jurisprudence

Although, as I argued above, the interdisciplinarity of the law is an inevitable phenomenon, one should identify its limits. These will be discernible if we consider the naturalization of law, which is the first of the above-discussed manifestations of interdisciplinarity.

However, it would be difficult to talk about the limits of interdisciplinarity in the law in the context of technological development, as the relationship between law and technology is of a different nature than in the case of law and the cognitive sciences. Lawyers use technology, and technological development compels legal change; however, we are moving here more on the level of direct impact on particular rules. This means that if the need arises to regulate the status of autonomous machines, for example, the legislator should create new norms relating to particular situations by employing their knowledge concerning technology. Of course, it can be argued that also some legal concepts have changed their meaning due to the technological revolution. Take a look at Article 60 of the Polish Civil Code:

Subject to the exceptions provided for in the law, the will of a person performing a legal action may be expressed by any behavior of that person that reveals his or her will sufficiently, including the disclosure of that will in electronic form (statement of will).

The legislator used the term "electronic form". There is no doubt that its meaning has been modified since 2002, when this reference to the electronic form of the declaration of will appeared. This is due to the development of electronic communication tools and it can be anticipated that the ways of electronic communication will undergo changes in the decades to come. The interpretation of this provision (as well as of many others) will therefore require reference to the current state of knowledge of computer science and related fields.

Thus, technology is forcing multifaceted legal changes, but it is not leading toward such a potentially profound modification of the law as in the case of the cognitive sciences. This "potentiality" is pivotal, because it is what makes it difficult to have a clear-cut position on this issue.

Again, let us refer to a question we have already discussed: can the neuroscience of free will change the law? Should the possible

discovery that the human freedom to make decisions is much lower than we assume in our ordinary image of ourselves have an impact on the law in the form of a shift away from punishment to therapy? While there are various positions in the philosophy of criminal law (see Jones, 2002), including "conservative" ones, i.e., in favor of maintaining the current state of the law and conceptual grid even in the face of changes in the scientific picture of the world, the potential for changing the basic institutions of the law in this case is even difficult to imagine. Less "potentially revolutionary" but still important changes may be associated with the effort to reconcile the state of legal knowledge with that obtained from other research conducted within the cognitive sciences and concerning embodied cognition, evolution, emotions, or heuristics. These are manifestations of interdisciplinary research within the legal sciences.

These examples illustrate two difficulties in applying the achievements of the cognitive sciences to law, which I have already pointed out earlier (this also applies to other scientific disciplines, as the difficulty is universal, although perhaps of a gradual nature). The first of these can be referred to as the "tension problem".

The tension problem can be formulated in the following manner:[1]

(1) law should be naturalized because the legal system cannot exist in isolation from scientific knowledge;

(2) the cognitive sciences, due to their dynamic development, do not provide ultimate theories that can constitute the basis for naturalization (they are not a proper "source" for naturalization, as we are far from formulating an adequate description of cognitive mechanisms);

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[1] The tension problem was presented earlier in: M. Jakubiec, Final remarks [in:] *Cognitive science in practice* (Kognitywistyka w praktyce), M. Jakubiec (ed.), Copernicus College 2018.

(3) cognitive science is the best currently available source of knowledge about cognitive mechanisms.

Of course, each of these statements can be contested. With respect to (1), it is not difficult to imagine a position where we should not pursue naturalization, although it would be difficult to justify it today. Anti-naturalism, even though it has often provided a counterweight to naturalism in the past, now seems to be standing on the sidelines. For example, the position of the nineteenth-century Marburg neo-Kantians, who expressed their conviction about the very limited cognitive value of the empirical sciences, does not provide any counterbalance today to the advocates of applying the knowledge obtained by cognitive scientists to law. If we accept (1), then at the same time (without going into details) we can assume the adequacy of (3). Cognitive science, of course, encompasses a whole range of disciplines such as neuroscience and psychology, among others, and naturalization must be understood broadly (without being limited to a narrow catalog of disciplines). The most problematic is statement (2). After all, one can see that it applies to all of science: even those theories that we consider "closest to the truth" are constantly being modified and thus it may be considered trivial. In conjunction with (1) and (3), however, it is a source of difficulty.

The tension problem outlined above should not be taken as an argument for rejecting the relevance of cognitive science to law. It is, however, a warning against excessive optimism and seeing science as the source of a revolution in law (see, e.g., Winter, 2001). Although the sciences are changing the law, the history of science is all too keen to lecture us about the constant revisibility of the state of knowledge, whether spanning several centuries or recent decades.

The second difficulty marking the limits of law's interdisciplinarity is the problem of law's social understanding and the

compatibility of its descriptive presuppositions with common knowledge. Significantly, we encounter it in the application of both scientific and technological knowledge. Even if we assume that the tension problem will cease to mark the boundaries of interdisciplinarity over time, we will still have to deal with the relationship between the colloquial and scientific conceptual networks which will significantly influence the shape of law.

In closing, it is worth noting that law today is a more interdisciplinary field than it was a few years ago and that the law of the future will be much more interdisciplinary than it is today. As a result, far from losing their relevance, questions about the limits of interdisciplinarity will remain to be answered.

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Interdisciplinarity in economics

Introduction. The interdisciplinarity and imperialism of economics

Economics is a science continually seeking a definition of the scope of its research and it is also represented by various schools which define that scope differently, make various assumptions and apply diverse research methods. Traditionally, and according to most student handbooks, we distinguish between microeconomics (historically older), which deals with the principles of scarce resource management in households and enterprises, and macroeconomics, which deals with the economy as a whole. In the current chapter, the considerations on interdisciplinarity will be limited to these two branches of economic sciences and we thus exclude other disciplines such as marketing, management, commodity science, accountancy, public finances, public administration etc. First, those disciplines do not traditionally belong to economics. Second, their possible inclusion in a chapter on interdisciplinarity may lead to the conclusion that it would be hard to find any field of scientific knowledge with which a broadly understood notion of economics would not be in a necessary relation. It includes such fields as physics and chemistry in case of commodity science, where the

physical features of certain goods and their chemical composition are crucial for the determination of their market position or value, or medicine which is essential for the determination of the scope of publicly financed medical services. Such a restriction let us focus exclusively on those scientific areas which are traditionally and intuitively connected with economics.

Below we distinguish and discuss the following four areas of interdisciplinarity. They include:

- Economics with politics, ethics and law
- Economics with mathematics and informatics
- Economics with history, sociology and demography
- Economics with psychology, biology and evolutionary theory

The division into broader areas of knowledge and not separate scientific disciplines seems to be more appropriate for at least two reasons. Firstly, specific sciences often have an internal problem with the definition of their subject of research, and regardless of whether they wish it or not, they invade their typical areas of investigation and adopt the same methods. In social sciences, this seems to be a universal practice and the division into specific disciplines plays a more administrative than scientific function. Secondly, following the development of economics, we can highlight specific, distinct periods and theories worked out therein which introduced elements of other sciences to economics, usually in bulk. Examples will be quoted below.

A characteristic feature of economics which needs to be stated in advance is also that it not only draws from other sciences but is above all invasive. It encroaches the spheres of other disciplines with its assumptions and analytical tools and presents the investigated phenomena in a different light. This imperialism of economics has its origin in the fact that among other social sciences, it seems to be the most "exact", mainly due to the widespread application of mathematical tools. It also appears to be the noblest,

due to the relatively high social status of economists and their impact on particular political decisions. This imperialism can be illustrated with three examples:

1. The invasion of sociology and demography. Gary Becker (1930-2014), the Nobel prize in economics laureate,[1] applied economic tools and measurements of utility to family decisions (utility from marriage or children) (Becker, 1981). Later, economists similarily tried to explain the fall in fertility in developed countries by arguing that procreational strategies had changed due to the preference of quality over quantity in terms of offspring. Increased investment inputs in quality leave fewer resources for quantity (Kaplan & Lancaster, 1999).
2. The invasion of political sciences. The Chicago school of public choice gave rise to this since they used economic tools for the analysis of political decisions, in particular joint democratic decisions (Tullock & Buchanan, 1999). The area of politics above all includes the various social programmes where economics steps in with sophisticated cost and benefit analysis. Exceptional controversies evoke those which refer to human life and health, and the Danish economist, Bjørn Lomborg, contributed to this topic in particular. He was the founder of the so-called Copenhagen Consensus, the forum for the exchange of economic ideas on the most efficient social programmes in terms of benefits for the entire population of the world (e.g. the number of saved human beings versus the required costs) (Lomborg, 2013).

[1] The notion of a Nobel prize in economics is a simplification. The last will of Alfred Nobel did not specify economics as one of the disciplines where a prize from the Nobel Foundaton should be awared. It was established later, by the Sveriges Riksbank in 1968 as the Prize in Economic Sciences in Memory of Alfred Nobel and is managed by the Nobel Foundation and awarded by the Royal Swedish Academy of Science.

3. The invasion of the theory of law. The so-called economic analysis of law includes both a descriptive component (the law is economically efficient and economically efficiently behave their subjects – judges, officials, judicial process participants, criminals) as well as a normative component (the law should be economically efficient). This sort of analysis extends from the most "economic" braches of law as civil responsibility for damages and compensations to apparently the least economic, as the analysis of crime benefits with respect to the likelihood of the perpetrator being caught and convicted and the negative utilities from the possible punishment ((Kornhauser, 2015), (Stelmach et al., 2007)).

Economics, political sciences, ethics and law

Modern economics originated with Adam Smith (1723-1790) and his intellectual heirs, the classical economists David Ricardo (1772-1823), Thomas Malthus (1766-1834) or John S. Mill (1806-1873). The connections between economics and politics, ethics and law (the latter being an at least partial emanation of ethical rules) were obvious. Economics was long called political economics, a fact that was supposed to emphasise those connections. The fundamental questions which were to be answered were essentially ethical. For Smith, the author of *An Inquiry into the Nature and Causes of the Wealth of Nations* (Smith, 1907), the question was about why some countries are rich, and some are not. The wealth of citizens was thus approached as the desired good and the recognition of its grounds as a form of instructions for governments on how to make citizens wealthier. Those instructions include rules on commercial relationships, both domestic and international, as well as ethical and legal principles of levies' imposition and collection. A market agent looking primarily after her

private interests, one whose stance is far from altruistic, by sacrificing herself for family, motherland or religion, becomes the unconscious co-constructor of a spontaneous order bringing benefits for the whole community (the so-called invisible hand of the market). Malthus, a priest of the Church of England, went even further in his economic-demographic analysis, drawing attention to the fact that subsidising the least wealthy is counter-effective and leads to impoverishment (Malthus, 2011). The Utilitarians introduced a peculiar conjunction between economics and ethics. The co-founder of this school, John S. Mill, was a moral philosopher, social thinker, economist and methodologist. Utilitarian ethics assumed that the highest good for humans is the production of pleasure and the prevention of pain, and thus individual wellbeing. (Mill, 2013). This ethic is consequential, which means that actions taken or omitted are judged in terms of their ultimate consequences and not by their reference to specific ideal patterns or intentions. Such an ethic coincides well with the shared expectations towards public policy, which is concerned with effects and not right intentions. It also coincides well with economic analysis, which is intended for utility maximisation regardless of the definition. Such an ethic is also egalitarian since it does not privilege any one yet, from the other side, it does not emphasise individual preferences. Trivially, we may say that we all have the same stomachs which deserve to be fed. Libertarianism is a partial antitype of that ethic. Through various concepts of a social contract, it acknowledges the catalogue of individual rights as being an untouchable foundation of a liberal order (Rawls, 2005).

An argument between those two ethical-political concepts has divided economists until today. Among them are those who advocate the far-reaching intervention of governments in order to balance wealth inequalities, e.g. (Piketty, 2017) while others are watchmen of individual liberties and the free market, willingly accepting even significant social inequalities (Friedman, 2002).

Modern welfare economics, which was founded by Arthur Pigou (1877-1959) (Pigou, 1920) complements the association between economics and both ethics and politics. Although the first welfare economists used intentional simplifications for their analyses by reducing the concept of welfare to its material aspects, and thus primarily expecting a policy intended to further the improvement of citizens' material wellbeing from the government, later ones began to pay attention to the immaterial aspects of life such as individual happiness and the factors influencing it. In consequence, they started to work out the measures of wellbeing which might compete with the almost universally used gross domestic product (GDP), the so-called hybrid measures. Among the most recognised of these is the HDI (*human development index*) which is composed of components representing economic development, education and healthcare.

It is because of those ethical-political ingredients in economic theories economists adopted the classification proposed by John Neville Keynes (1805-1878) for positive economics (which similarily to natural sciences describes regularities discovered in the market), normative economics (which is essentially economic ethics, as it attempts to answer questions as to what is good or not in the economy or economic policy), and the art of economics (which develops economic tools for achieving the normatively desired objectives based on the recognised economic principles) (Keynes, 1999). The latter is a kind of social engineering, usually realised by the appropriate lawmaking body (through measures like a minimum wage or progressive income tax for the wealthiest).

Economics, mathematics and informatics

One can hardly imagine contemporary economics without mathematics. Among all of the social sciences, it is the most

mathematised. An economist who does not know algebra, mathematic analysis, differential calculus or statistics is condemned to scientific non-existence. Yet economists began to apply mathematical tools relatively late. The above mentioned classic figures used them frugally or even not at all. The introduction of mathematics into the mainstream was led from two independent directions. Firstly, by means of the so-called marginal revolution in economics initiated by scholars from three different geographical areas: Carl Menger from Austria (1840-1921) (Menger, 2007), William S. Jevons from United Kingdom (1835-1882) (Jevons, 2011) and Leon Walras from France (1834-1910) (Walras, 1926). They changed the way in which the concepts of value and price were perceived. Classical economists considered them a derivative of manufacturing costs in which the costs of labour played a significant part. Marginalists acknowledged that the critical element bringing about the price of the particular commodity is its consumer utility, which diminishes with the consumption of each additional unit of that commodity. Thus they introduced the notion of marginal utility and the commodity value based on demand. Such an approach (especially in the case of Jevons and Walras) forced them to apply the advanced mathematical analysis of the function of supply and demand in search of the intersections of the curves – points of market equilibrium. The latter concept was introduced by Leon Walras, and is one of the most significant in contemporary economics. At present, the dynamic stochastic general equilibrium models constructed by central banks, commercial banks or governments are the direct successors of that concept. The marginal revolution and the introduction of mathematics initiated neo-classical economics and its extensive critique. Mathematical models of market equilibrium became increasingly complicated, taking into account a growing number of variables, not only including the agents' preferences, costs of production or financial costs but also technological innovations or endogenous

and exogenous shocks. The mathematical precision and derived results was obtained from data observed on the market. Economics gained a complex, aggregated mathematical analysis of abstract actions of market agents who are perfectly informed, competitive and rational maximisers of their utility. The models may even fulfil Mill's postulate of making economics like geometry, which allows us to understand market relations in accordance with the assumptions made but does not allow us to create an empirically adequate description of the economic realm and even less the application of the art of economics by actively influencing the market. Critics of such an approach termed it a "celestial mechanics for the non-existent universe". The co-creators of the current also noticed those dangers, among them Alfred Marschall (1842-1924), a mathematician who completed the task of economics mathematisation and is also well-known for the following quotation illustrating the proper method of the application of mathematical tools in economics:

> (1) Use mathematics as shorthand language, rather than as an engine of inquiry. (2) Keep to them till you have done. (3) Translate into English. (4) Then illustrate by examples that are important in real life (5) Burn the mathematics. (6) If you can't succeed in 4, burn 3. (Raffaelli et al., 2006, p. 144)

Secondly, the mathematisation of economics came from the institutional current and had a completely different character. Institutionalists belonged to the camp of the firm critics of classical and neoclassical economics, arguing that the assumptions and abstractions applied therein are unacceptable simplifications, ones which are not able to adequately represent the institutional complexity and dynamics of the economic realm. That realm is not only composed of agents rationally maximising their utility but

also of cultural determinants, changeable historically and geographically, which reveals themselves in social institutions, companies, associations, families, states and their authorities, laws and legal institutions including property and methods of its protection. Since they became the predecessors of advanced interdisciplinarity in economic research, they will be mentioned later below. They contributed to the mathematisation of economics through their attempts at the statistical and mathematical description of the market. We owe the widespread use of well-known measures like the gross domestic product (GDP), the consumer price index (PCI), unemployment rate, public debt, trade deficit etc. to American institutionalists. In 1920 Wesley Clair Mitchell (1874-1948) and others founded *National Bureau of Economic Research* where Simon Kuznets (1901-1985) developed the first estimations of the national income of the USA. Their approach was, however, fundamentally different from classics and neo-classics. They replaced the analysis of a complex set of equations based on *a priori* assumptions with the search for regularities in the previous collection of historical data and inductive reasoning. However, merely collecting data requires an advanced statistical apparatus. Data are not accessible by the simple observation, but they need the construction of an appropriate model and operational way of their collecting. The calculation of an apparently simple consumer price index is a complex operation, one which requires the previous construction of the market basket of representative items, attribution of the weights to each item with respect to its significance and consumption level, and then the collection of information on the items' prices and their variability in the investigated period. The economic measure is thus a social construct, a model based on our knowledge on markets, cultural determinants and statistical instruments (Chwalczyk, 2019). The foundations for this method were laid not by an economist but by a 19th century sociologist, Adolphe Quetelet (1796-1874), a predecessor of

collecting the statistical and demographical data describing the society and their further analysis towards regularities discovering (Quetelet, 1835). Institutionalists applied his methods broadly and developed them creatively. We not only owe the construction of economic measures to them but also a historical, inductive analysis in search of necessary compounds and correlations. Econometricians construct linear regression models which are used in microeconomics, among others, to determine the variables shaping a commodity market value and thus to forecast its future price. In macroeconomics, those relations give rise to dynamically determinate monetary policy, for instance, such as quantitative easing recently applied by the European Central Bank. One handbook example of such a relation is the Phillips curve, which determines a quantitative dependency between price inflation and an unemployment rate on the basis of historical observations of those two variables (Phillips, 1958). At present, similar research is being conducted with the use of advanced IT tools which can not only proceed hundreds or thousands of variables but can also suggest candidates for causally relevant ones. Big data and AI analytical tools (like semantic text analysis) opens up room for an entirely different kind of economic research, where the subject of analysis is the impact of the content of stock exchange reports on macroeconomic variables (Nyman et al., 2018).

Economics, history, sociology and demography

Classical economics developed as a science which was independent of time and socio-geographical context. It does not mean that Smith or Ricardo did not perceive the differences in the economic development of particular countries. They assumed, however, that the economic principles proposed by them are universal and apply to all humans and commercial societies independently of the

historical period and geographical area.[2] From their perspective, historical and social analyses were useless both for understanding the economy and for predicting its further development. Furthermore, the predictions made by them did not come true, which gave rise to a critique mentioned above of classical economics and the foundation of the historical school in Germany and the institutional one in the USA.

In the 19th century, social philosophy in Germany was deeply influenced by historical reasoning which had its roots in Hegel's philosophy. No wonder that local economists as an obvious fact acknowledged, that the abstraction from the "national spirit" in economic research could not succeed. The key to understanding economic phenomena had to be holistic analysis encompassing all aspects of society, especially a causal, historical path for reaching its current stage of socio-economic development. Such analysis allows the identification of historical principles, revealing themselves in consecutive stages of development in which different economic laws may be in force. One of the representatives of this would be Gustav von Schmoller (1838-1917), who once got into a personal dispute with Carl Menger (1840-1921), the representative of the Austrian school of economics, and who advocated the continuation of theclassical approach. Max Weber (1864-1920) was a German thinker who drew on the achievements of sociologists in applying different research methods. He became famous in economics with his investigation on the impact of institutional religion on the economic development of particular states in Germany. He put forward a thesis that specific aspects of protestant ethics, embracing the duty of education, work ethos, restrictions

[2] The problem of the universality of economic laws is a necessary simplification. Some authors claim that even in the case of classics, one can hardly speak about their deemed postulates for time and place independent and universal economic laws (Hardt, 2017). Undoubtedly taking into account other economic schools, this idea was close to them.

on consumption and reinvesting the resources, contributed to the significant enrichment of those German states where that religion prevailed, while states which where Roman-Catholic dominated remained agricultural and poorer (Weber, 2002). Although his research is nowadays criticised, for many economists the method and the approach where a cultural factor may shed light on the success or defeat of many social policies remains valid.[3]

Those cultural circumstances drew the attention of the forerunner of American institutionalism, Thorstein Veblen (1857-1929). Veblen, who himself did not conduct empirical research, was peculiar in his description of the market and agents acting thereon in terms of cultural and evolutionary factors. The behaviour of agents on the market, striving for enrichment, stockpiling money and financial assets, conspicuous consumption, and rivalry were all analysed in terms of cultural evolution, social Darwinism, actions subordinated to domination and procreation (Veblen, 1994). Even today, contemporary economists use Veblen's notion of effect to recall the specific shape of a demand curve in reference to the so-called positional goods,[4] for which demand does not fall with rising prices but grows.

Friedrich Engels and Karl Marx were also outstanding representatives of the historical and sociological approach in economics. The former became famous for his penetrating sociological analysis of the condition of the working-class in Manchester

[3] An interesting example is an analysis of the economic reforms Poland underwent in the early 1990s. The shock therapy applied by Leszek Balcerowicz in Poland and Yegor Gaidar in Russia were similar, but the results appeared to be completely different. Regardless of many reservations, the Polish reforms are considered exemplary while Russia had to struggle with recession for many years following them (Backhouse, 2010).

[4] Positional goods are the goods that people value because of their limited supply, and because they convey a high relative standing within society, and not due to the increased utility they may carry.

(Engels, 1993). It not only comprised their economic conditions but also the urbanistic aspects of the city districts inhabited by them, which contributes to social exclusion and separation from other social classes. Marx, on the other hand, focused his considerations around the historical changes of the socio-economic environment throughout the centuries. He did so although his fundamental theory of value based on labour resembled the concepts of classical economists. In this respect, he was faithful to the historical-dialectical method worked out by Hegel. In contemporary economics, the research method based on contradictions and conflicts between social classes and looking for a possible synthesis is merely a historical curiosity. What remained, however, and is still observable nowadays, is the research underlining the unique role of individual and collective consciousness, which may significantly influence economic relationships, and which is bound up with the specific historical moment, the level of technological development or the level of individual preference satisfaction. It is often illustrated by Marx's quote that "the social being determines consciousness.", which expresses the hypothesis that the actual development of the means of production determines our image of the world and relationships therein and not the other way round (Marx, 2019). The view is shared by most economists, who lean towards explaining the social changes with technological progress. The contradictory view is represented by Deidre McCloskey. She claims that it is the other way round and socio-cultural changes are a necessary condition of the subsequent technological inventions (McCloskey, 2016). The argument is vital as in the version of welfare economics mentioned above, one can often meet with various recommendations regarding the most efficient methods for economic growth stimulation and thus common welfare. Trivially speaking, resolving the problem of whether we should first educate or first distribute mobile phones and develop the transport infrastructure becomes the critical issue. Current debates on the welfare

measurement reflect this dispute too, with the proposed measures increasingly referring to local, individual and historical variables. The welfare economics of Amartya Sen, Nobel prize laureate in 1998, would be an outstanding example. He proposed measuring human welfare through their capabilities, determined by the local socio-economic circumstances and functionalities which are individually chosen ways of life and actions (Sen, 2009).

The connections between economics and demography were noticed relatively early on, with Thomas Malthus paying attention in his work to the relations between the economic status of the most impoverished social layers and their population (Malthus, 2011). Briefly, this was seen to grow with rising incomes, which meant there was a greater number of children to be fed, and instantly led to a fall in *per capita* income, which again led to a decrease in population. Those demographical changes have a circular nature, with a tendency to growing impoverishment. Luckily those predictions have not come true, but the way of analysis attracted the attention of economists to the strong correlation between the density of the population, its social structure and age diversity and its economic status. Such research has been conducted in various contexts, but nowadays two phenomena known to economists are worth mentioning in particular:

1. Demographic dividend, which means the situation in which in the age structure of the society is dominated by young people in the working or early pre-working age. It is usually an indicator of a high likelihood of coming economic growth or adversarially, social conflict. The first effect is connected to the growing number of those who contribute to rising GDP in relation to non-contributing children and elders. The second effect arises out of the increased aggression levels of adolescent men (Bloom et al., 2003).
2. Secular stagnation means a particular case of economic stagnation, which might be due to the greying of society. It comprises

a stagnation or fall in GDP combined with a fall of investment and an over-accumulation of financial assets (elders are more frugal and tend to take fewer investment risks), and following price deflation combined with falling consumption (due to elders' different preferences).

Economics, psychology, biology and evolution

The links between economics and those sciences should rather open a chapter on interdisciplinarity and not close it. At the very beginning, economics was (and still is) first and foremost a science of human action. The action is undertaken in a particular context which is the market and the choices made thereon, none of which alters their psychological and neurocognitive foundations. No wonder, that economists focused their interest on those foundations from the outset, constructing a specific model of human action on the market. Many of them, besides economics, also dealt with psychological problems.5 At present, branches of economics like behavioural economics, neuroeconomics or evolutionary economics are founded on comprehensive psychological and biological knowledge of human beings.

Unfortunately, in a period when scientific assumptions and research methods were developing, among the humanists prevailed a picture of a man as an autonomous entity, self-conscious, intentional (or equipped with free will) and rational. Although further psychological research had increasingly undermined this optimistic image, from one side by the psychoanalysis of Sigmund Freud,

[5] Adam Smith is the author of an essay which nowadays might be classified as psycho-ethical (Smith, 2006). Ludwig von Mises in his opus magnum, in the first chapters, dealt with praxeology, analysing mainly the determinants of humans' actions (von Mises, 1996). Friedrich von Hayek wrote a book on cognitive psychology (Hayek, 1992).

from the other by the behaviourism of Frederic Skinner, until the 1970s most of these assumptions remained unchanged. Economics seemed resitant to those new currents. Two assumptions which constitute the so-called "folk psychology" were crucial for early economists. An agent acting on the market is intentional. She is equipped with free will, which enables her to choose the preferred system of values, according to which her goals and preferences are determined. That intentionality makes economics belong to the humanities so that it cannot be practised like physics. Human economic actions cannot also be reduced to biological, and subsequently to chemical and physical laws. Such a picture of a man was commonly shared by both classical and neoclassical economists, including Frank Knight (1885-1972) (Knight, 2008) or the above mentioned Max Weber (Weber, 1985). The second crucial assumption is an agent's rationality, which in economic models is understood in a threefold manner:

- In conditions of certainty, in accordance with the theory of ordinal utility; Briefly, it means that if the intentional agent has specific preferences, she is rational if they are complete (agent can always decide whether she prefers A over B or both options are equally preferred) and transitive (if an agent prefers A over B and B over C she should also prefer A over C).
- In conditions of uncertainty, in accordance with the theory of expected utility; The theory requires a kind rational calculation. First, an agent has to estimate the probability of states A or B occurrence and attribute them numeric values respectively to her strength of preferences than she multiplies the values of estimated probability and utility to get the value of the so-called expected utility.
- In conditions of interactions between two or more agents, rationality requires the analysis of the other agent's matrix of utilities and the calculation of an optimal strategy in accordance with game theory.

Those assumptions were further constrained by simplifications arising from the subject of economics research. John Stuart Mill postulated economics to be a science "(…) concerned with him [a man] solely as a being who desires to possess wealth, and who is capable of judging of the comparative efficacy of means for obtaining that end. It predicts only such of the phenomena of the social state as take place in consequence of the pursuit of wealth. It makes entire abstraction of every other human passion or motive; (Mill, 2008, p. 41)." In this manner he defined economic man – *homo oeconomicus*. It seems essential that as much as the assumptions of intentionality and rationality express the conviction that humans reveal those features, their reduction to wealth maximisers was clearly an artificial simplification. Neither Mill nor any of his intellectual heirs claimed that the pursuit of wealth or, as it was later rephrased, the pursuit of agent's utility maximisation regardless of how it was defined, was the sole factor motivating humans for actions. We merely abstract from any other human emotions, considering them irrelevant for economic analysis, and consecutive economic models were constructed upon those assumptions.

The first serious breach in this consensus was due to John Maynard Keynes (1883-1946). The co-founder of contemporary macroeconomics expressly distanced himself from the rational economic man, drawing our attention to the fact that one of the causes of market instability was a specific feature of human nature which makes us base our decisions on spontaneous optimism rather than mathematical calculations. The engine for our actions is our *animal spirit* (Keynes, 2009). Consequently, the macroeconomic mechanisms described by Keynes were grounded in analyses of the mutual relations between aggregated economic variables (e.g. aggregated demand or supply), disregarding any references to agents rationally acting on the market.

The reintroduction of tpsychology to economics was done in the 1970s, not in the folk version this time but rather behavioural

and experimental. The first attempt was made by the economist, Herbert Simon (1916-2001), who introduced an agent to economic models who was imperfectly informed and signified by "bounded rationality". She does not maximise utility but rather works out solutions which are sub-optimal, sufficiently good. We owe a genuine breakthrough to two Israeli psychologists, Daniel Kahneman and Amos Tversky (1937-1996), the former also being a Nobel prize winner. In 1979, they published a paper on their research into agent rationality and economic choices, which became the basis for their prospect theory (Kahneman & Tversky, 1979). The novelty of their research came on the one side from the proposed hypotheses, which undermined the agent rationality assumption, and on the other side from the scientific methods applied, namely the psychological experiments. The first experiments revealed three systemic and repeatable deviations from classical rationality, which are commonly termed *cognitive bias*. They were the:

1. Certainty effect, according to which agents overestimate results which are certain over those which are only likely;
2. Reflection effect, according to which agents are risk-averse if the risk is combined with the potential loss and risk-seeking if it is followed by potential gain.
3. Isolation effect, according to which agents overestimate the significance of the distinguishable elements of the alternatives and underestimate the elements which are common for them.

This research launched numerous experiments revealing subsequent cognitive biases resulting in deviations from model rationality. Apart from the above, they include ambiguity aversion, risk aversion, *status quo* tendency, framing effect, anchoring effect, mental accounting, endowment effect, sunk costs effect, hyperbolic discounting, probability matching and many others. Those experiments cemented the conviction of economists that the assumption of market rationality was mistaken and that of its intentionality

was dubious at best. However, it left an unsolved problem of how much those assumptions are approximate so that models constructed on their basis nonetheless produce the accurate predictions. Anyway, the discovered effects encouraged economists to attempt their incorporation into those models or at least for their application in the science of management, marketing, sales techniques and public policies. Management and sales techniques seem to be the most obvious fields for exploitation. The prior knowledge of cognitive biases may be creatively used to manipulate agents' decisions, either for constructing motivational systems or systems of nudges to improve productivity or induce particular consumer choices. Public policy (excluding electoral manipulations) seems to be practically and ethically less eligible for being influenced by such knowledge. Yet even in this domain, one could construct specific social programmes so that agents would more often make choices which are beneficial for them, such as prophylactic medical examination, restricting the consumption of harmful substances (tobacco, alcohol, sugar), saving for retirement or insuring against the consequences of accidental damaging events (Thaler & Sunstein, 2009).

The research on the determinants of our market choices did not end with the experimental discovery of systemic biases but also includes the biological grounds for decision-making, such as the impact of specific substances (hormones). Among the most well known are for example dopamine, a hormone of reward, oxytocin, which fuels collaboration, and testosterone, the hormone behind aggression and competition. They are produced naturally by an organism, but their levels are changeable, and there are external factors that may influence it and they may also be artificially injected. Another field of research is the quest for regularities and correlations between decision-making and the activity of particular brain modules, the so-called neuroeconomics (Camerer, 2007). If we knew which parts of the brain are responsible for controlling

specific actions or emotions, by tracking or evoking their activity, we might predict the agent's decision.

All of this sounds very promising, but research and experiments conducted so far seem to reveal only the increasing complexity of the subject matter and any attempts to work out a metatheory which would let us construct good predictive models have not yet been fruitful. One of the likely reasons for this failure is our evolutionary ability to adapt to any given changeable environment. Even if it is imperfect and sometimes slow, it means that the apparently stable patterns of our behaviour, systemic and repeatable deviations from classical rationality, change without any identifiable meta-principle. It leads us subsequently towards evolutionary economics and the impact of the theory of evolution on economics. The first attempts to link those two disciplines were made by early institutionalists. The already mentioned Thorstein Veblen postulated that economics would become an evolutionary science, and he complained that in its classical version, it sadly had not been (Veblen, 1898). Later institutionalists also often referred to environmental variability and the need to adapt behavioural patterns, including market behaviour. The latter is no longer a subject of universal economic laws but should instead be analysed similarily to biological traits which are subject to evolutionary pressure. An exceptional contribution to this approach was made by Friedrich August von Hayek, with his concept of spontaneous order (Hayek, 1983). It assumes that a significant part of modern civilisation including legal institutions, institutions of the free market (property, commercial exchange, contracts) was shaped as an effect of cultural evolution based on the concept of group selection and they are not a product of intentional human design. Group selection operates by the selection and proliferation of those cultural traits which provide the prevalence of one group over another, even if the specific trait is not advantageous for the agent carrying it. An example could be the strong tribal instinct among

humans and the emotion of group identity (national, tribal or cultural), which goes in conjunction with the readiness for individual sacrifices, which are costly from an individual perspective but which make the group consisting of ready-for-sacrifice agents prevail over others. It is easy to notice that the mechanism of group selection may lead to the creation of behavioural patterns which could be counter-effective for utility maximisation which is often assumed in economic models. The same mechanism may also be responsible for the observed deviations from classical rationality. This observation has led some contemporary economists to introduce another category of rationality – ecological. It predicts the occurrence of specific heuristics in market behaviours which are apparently irrational, but essentially arise out of adaptive processes (Gigerenzer & Todd, 1999). Contemporary economists exploit those concepts for complex analyses of hedge fund investments strategies and the search for the ultimate causes of the recent financial crisis (Lo, 2017).

Conclusions

Interdisciplinarity in economics is a condition for the further development of the discipline. Closing itself in abstract mathematical models has not served economics well and any attempt at abstraction from actual market determinants leads to foundations for the science whose usefulness is dubious. In cases where "people-bridges" lead to a breath of fresh air from other fields, it has resulted in new creative theories or even entirely new economic schools. A contemporary philosopher of science, Julian Reiss, asked the question about objectivity in economics and rephrased it into a problem as to what features should be held by an expert that I would trust. The first postulate was his interdisciplinary orientation – "read more widely!" (Reiss, 2014).

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Sociology as an interdisciplinary science

1. Sociology: a branch of the humanities or a science?

Some sociologists might object to seeing their discipline listed as a subject of the humanities. In fact, the debate on its status and place amongst academic disciplines has been one of the key issues that has defined the identity of sociology. Before we address the main problem of this chapter, it might be instructive to revise the key points in that debate – which will, incidentally, introduce the subject of its interdisciplinary character.

The discussion as to whether sociology is a science or a branch of humanities (a question which is often bypassed by the introduction of "social sciences" as a separate category of academic disciplines) began right with the definition of that discipline. The "founding father" of sociology, August Comte (1798-1857) defined it – as part of his all-encompassing system of knowledge – as a positive science *par excellence*, one based on empirical data. It has been remarked that "19th century sociology may be described, almost without reservations, *as positivist* sociology" (Szacki 2002, p. 244).

In opposition to this trend – which spawned, among others, two great visions of the 19th century social thought: the evolutionary sociology of Herbert Spencer and Adolphe Quetelet's "social physics" (both will be discussed further in this chapter) – the "humanist" perspective had been increasingly vocal by the end of the century. Its key postulate was that a member of a society does not experience "just facts", but rather "interpreted facts". While a fish in a school of fish or a sheep in a flock exist within a social reality, they don't *interpret* this reality in their own individual ways. Humans do so all the time and their subjective approach to social structures influences, in a tangible, measureable way, these same structures.

Hence "interpretive understanding" (*Verstehen*) that became one of the core concepts of the "anti-positivist" movement, well exemplified by Max Weber's claim that "sociology . . . is a science concerning itself with the interpretive understanding of social action and thereby with a causal explanation of its course and consequences. We shall speak of «action» insofar as the acting individual attaches a subjective meaning to his behavior--be it overt or covert, omission or acquiescence. Action is «social» insofar as its subjective meaning takes account of the behavior of others and is thereby oriented in its course" (Weber, 1921/1968, p. 4).

The debate between positivists and antipositivists is long gone, at least if expressed as such. With time it became apparent that actual research is most benefitted by an eclectic methodology that still remains the standard approach in the social sciences. Two works are often cited as early examples of that attitude: Durkheim's *Le suicide* (1897) and *The Polish Peasant in Europe and America* by Znaniecki and Thomas (1918-1920). Durkheim's monograph – now somewhat outdated, but still oft quoted as an early example of a rational and systematic study of suicide – revealed both statistical regularities (such as that men commit suicide more often than women or that rates of suicide decrease during times of war) and

insights into subjective individual motivations (hence his famous "four types of suicide": egoistic, altruistic, anomic and fatalistic). Znaniecki and Thomas synthesized a voluminous corpus of letters and other personal documents to present a monumental picture of the life of Polish emigrants. Their work is opened by a methodological chapter that forcefully argues for combining objective data with the "understanding" of social reality being analyzed.

Contemporary sociology is a typical pluralistic science. Quantitative analysis is still highly regarded and statistical tools are consistently taught in university-level curricula and held in high regard. Machine learning has recently been enthusiastically welcomed by social scientists (Molina & Garip, 2019) who make use of broad access to huge volumes of data about human economical, lifestyle and social choices recorded on social media. On the other hand, there are still certain areas in sociology – such as the sociology of family or health – where "insightful" study of individual motivations is seen as a key tool for the researcher (see e.g. Zhou & Gonzales, 2019).

Having said that, it is important to note that not all attempts to introduce the methods of other sciences into sociology have succeeded. The following three sections will describe three cases that might be characterized as, respectively, successful, unsuccessful, and partly successful. In the final section I will attempt to analyze them to venture a general commentary about the interdisciplinary tendencies in humanities.

2. A success story: the sociology of urban crime

This first choice is motivated by personal reasons. Urban sociology has been my first area of study within sociology and my MA thesis, *Theft. City. Space. Criminological ecology of Będzin* (Lamża, 2009), presented an analysis of my hometown's "criminal landscape". My

method of choice was a modern rendering of a traditional tool – spot maps – developed in the 1920s by the members of the Chicago school of sociology (Park et al., 1925).

The core postulate of the Chicago school was a systematic analysis of city space performed in a manner borrowed from biological sciences. In historical analyses, the works of Frederick Clements, plant ecologist, are usually highlighted as the main source of inspiration. In his work on ecological succession in plant communities (Clements, 1916) he noted that certain ecological regularities are true for all living creatures, including humans. In particular, while individual plants grow and die, a population is not only continuous, but also has a tendency to organize its abiotic environment in a way that promotes its longevity. In the long run, for instance, xerophilic ("dry-loving") plants influence soil in a way that keeps its moisture low, therefore making it harder to colonize by other plants. At that time, this constituted news.

The creators of the Chicago school, inspired by such research (Cavan, 1983), decided to study city space in a statistical manner, using Chicago as their "testing range": a city than in the 1910s and 1920s dealt with significant social issues and high levels of crime. Park *et al.* extensively used spot maps, i.e. maps of a given area with variously colored spots that represent events such as theft, burglary or act of vandalism. In this way, "hot spots" are identified, where crime is particularly intense. The different areas of the city are then marked according to ethnic composition, poverty level, population density, but also, for example, the amount of green areas or the quality of street lighting. This type of research leads to important discoveries, for example, a well-known regularity that areas of a city with a greater percentage of green areas are characterized by lower crime rates (Kuo & Sullivan, 2001).

The study of spatial correlations was only one part of Chicago school agenda – after all, correlation is not causation. Hence, a necessary complementary element: the theory of "criminal

decision-making" (Bernasco *et al.*, 2017). The most famous early investigator of the "criminal mind" was Edwin Sutherland (1883-1950), who in the 1930s spent five years working with a Chicago professional thief Chic Conwell to finally publish the classic work of forensic psychology, *The Professional Thief* (Conwell & Sutherland, 1937). Sutherland's most famous observation was that the motivational structure of criminals is no different from that of non-criminals. As Chic Conwell stated: "Professional theft is a business like any other business". Sutherland's proposal sparked enormous controversy in the world of sociology and forensics, which in the 1920s was still to some extent based on 19th-century criminological theories that a "criminal mind" is somehow broken and that criminal tendencies can be inferred from the shape of a person's skull (as taught by the "science" of phrenology, today considered pseudoscience). Sutherland affirmed his reputation as the *enfant terrible* of sociology by publishing *White Collar Crime* in 1949 (Sutherland, 1949).

Further discussion of the development of urban criminology is unnecessary. I think the interdisciplinary character of this area of study has already been sufficiently demonstrated. Can it, however, be regarded as a "success story"? That does seem to be the case, as demonstrated by the continued presence of the methods, language, and assumptions of Chicago school in sociology, both in theory and in practice. Standard textbooks on shaping safe urban spaces (e.g. Wuschke, 2016) apply almost all of the assumptions of the Chicago school, even those still controversial from the theoretical point of view, such as the "broken windows theory". Spot maps are used extensively by the police throughout the world. In Poland, one of the first publicly available crime maps created using the "Chicago method" was the one published at the now closed portal www.crimi.pl, created in cooperation with the Provincial Police Headquarters in Katowice. Currently, the Head Office of Geodesy and Cartography, in cooperation with the National Police

Headquarters, provides data on security threats in the form of the National Map of Security Threats, available online. In both cases, the creators openly refer to the Chicago school of sociology.

3. A failed attempt: social physics

Today, the term "social physics" is mostly used to describe a philosophical project initiated by the French economist Henri de Saint-Simon, and developed to the greatest extent by Adolphe Quételet. The name is hardly used outside of this purely historical context – which in itself shows that the proposal didn't "sink in".

Saint-Simon, who was not an impartial theorist, but an ideologically committed reformer promoting his own version of utopian socialism, argued that the renewal of society can only be achieved on the basis of scientific ideas. Science, as a coherent system of laws, is organized around one fundamental law which Saint-Simon identified as the universal law of gravity. His social theory was based on the idea of treating society as a purely physical entity influenced by the laws of nature. More concerned with ideology than with actual sociological problems, Saint-Simon never put forward a real theory of society which his spiritual successor, Quételet, at least attempted to do.

Lambert Adolphe Jacques Quételet (1796-1874) was a Belgian astronomer, mathematician, statistician, and, only after all that, a sociologist. Fascinated by all kinds of measurements and constantly collecting huge amounts of data on crime, marriage and suicide, as well as the dimensions of the human body, Quételet is sometimes called the "father of social demography" and is often credited with defining the body mass index, BMI.

Based on his extensive statistical tables, he developed the concept of the "average man" (*l'homme moyen*), intended to be a sociological equivalent of the concept of the center of gravity in physics.

Just as the behavior of any rigid body can be reduced to the movement of its center of gravity, the same, Quételet proclaimed, is true for a society. All deviations from the mean are canceled out, so that social statics and dynamics can be predicted on the basis of well-determined statistical parameters of the whole population. Free will was downplayed as a capricious individual phenomenon of no importance on a social scale. Since you can predict, for example, the number of suicides or crimes that will occur in a given year, it does not matter which specific individual will commit them. "Society contains the germs of all crimes that will be committed" and the individual criminal is only a blind tool in the hands of social forces (Quételet, 1869, p. 97). The task of the social scientist is therefore to identify the fundamental forces affecting the society and to separate *causes accidentelles* from *causes constantes*, *causes variables* and *causes perturbatrices*... and so on.

The reasons for the failure of this program and its shortcomings are all too obvious and have already been described many times in the literature (see, for example, Glymour, 1983). Quételet's social physics is, above all, completely incapable of shedding light on the essence, causes and consequences of social phenomena. Unlike the parameters of gas – to which social physicists have referred, and in which particles with higher velocities are actually balanced by slower particles– all the relevant variables describing human societies also have a qualitative aspect which cannot be "summed up". For example, one could, purely theoretically, determine an individual's "level of dissatisfaction ", ultimately yielding an averaged "dissatisfaction parameter" of society. However, the people who are particularly dissatisfied are not "balanced" by people who are particularly satisfied – a group of highly dissatisfied people can cause social revolutions: a phenomenon that cannot be predicted from quantitative parameters alone.

Generally speaking, "social physics" is now seen only as a historical curiosity and the program of describing society as a whole in the language of physics should be considered a complete failure.

4. A mixed success: evolutionary sociology

The presence of the theory of evolution in social sciences is a complex and non-trivial issue. On the surface, it might seem difficult today to find a branch of social sciences that has not been influenced by evolutionary thinking. It is hard to overestimate the extent to which contemporary sociology has been influenced by the knowledge gained over the last 150 years that family, state, military, economic or religious structures not only "evolve" in a broad, metaphorical sense, but also the under the influence of actual evolutionary processes as described within biology. Today, for example, the hypothesis that religious systems have an adaptive value for groups is being actively studied (Whitehouse et al., 2019). It might seem that the marriage between social and biological sciences is a simple story of success yet this doesn't seem to be the case.

First of all, the attitude of sociologists to the term „evolutionism" can be very critical. The assessment of the contribution to social sciences of Herbert Spencer – the author of a great philosophical-scientific pan-evolutionary synthesis – is rather negative. A separate issue, quite important, but certainly beyond the scope of this chapter, is the presence of evolutionary justifications in Marxist theory of society, which today is understandably controversial. The term „evolutionism" is also infamously connected with the school of evolutionary anthropology popular at the turn of the 20th century which divided human races into „lower" and „higher", as well as „primitive" and „developed".

The fate of the term „sociobiology", popularized by Edward Wilson, author of *Sociobiology: The New Synthesis* (Wilson, 1975),

is also puzzling. While it might seem that by the 1970s there should no longer be any doubt that evolutionary explanations for social behavior are valid and much needed, Wilson's book received mixed reviews. Stephen Jay Gould, a famous paleontologist and evolutionary biologist, became a particularly vocal opponent of sociobiology. Since the 1980s, the popularity of sociobiology has been steadily declining and today the term is rarely used, solely in historical and comparative studies.

The reputation of the term "evolutionism" amongst the historians of social sciences is so bad that Jerzy Szacki in his *History of Sociological Thought* states plainly that "from the point of view of most scientists of the 20th century, evolutionism not only gave false answers but also posed the wrong questions". However, it is worth noting what Szacki exactly had in mind: not every application of the theory of evolution in sociology, but a specific "-ism": a narrowly defined, comprehensive research attitude that attempts to explain all social phenomena through the lens of evolutionary theory. At the same time, referring to evolutionary processes is a common, highly regarded procedure in social sciences.

5. Summary

Although in a text as short as this chapter it would be unwise to attempt to present any synthetic vision of the interdisciplinarity of sociology, I hope that the examples presented above illustrate at least some basic regularities characteristic of the relationship of sociology with other sciences.

First, it is a science that cannot escape a multitude of methods and languages, for the simple fact that two centuries of systematic study showed conclusively that both the objective, reductionist, quantitative perspective and the humanist insight-based perspective have a lot to offer to a sociologist. Reading the current issue of any

major sociology journal shows that what is most appreciated today are works that start with high-quality quantitative data and then try to interpret them in the spirit of "*Verstand* sociology". At the time of writing this chapter, the most recent issue of the "Annual Review of Sociology" was No. 45 (2019) where one may find, among others, an article on romantic and sexual relationships in young adults (Tillman *et al.*, 2019) or about the role of space in shaping social bonds (Small & Adler, 2019); in both cases, the review of statistical data was only a starting point for an analysis that takes into account the psychological reality of a given social phenomenon.

Second, sociology, therefore, doesn't "tolerate" methodological fundamentalism. All attempts to "purify" sociology or organize it around a single theory have failed, as illustrated above by the attempts to reduce social sciences to physics or to the theory of evolution, but also other research programs that are not discussed here, such as the models of society based on conflict, exchange, power, or information. It is a known fact among historians of science that pluralism is an inalienable characteristic of sociology (see, for example, Payne et al., 2004).

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Interdisciplinarity in historical studies

The academic discipline of history was born in and of the nineteenth century. At that time, it adopted the model of event and political history, choosing to focus on the fates and fortunes of states and nations. Since its main protagonists were rulers, great commanders, and the people of the topmost social echelons, it differed little from ancient historiography. Researchers of the day concerned themselves largely with the analysis of written sources such as documents issued by official bodies, or legal acts. As it developed, it created a set of tools, the so-called auxiliary sciences of history, designed to improve its studies. Genealogy rationalised the knowledge of family histories and heraldry covered coats of arms, while tools were developed for analysing seals in sphragistics, and for analysing coins in numismatics. Gradually, historians augmented their source base with personal notes and began to use artefacts of material culture. Along with the development of history as a science and the expansion of its toolset, the spectrum of research questions began to broaden. The "what it was like" inherent to event history began to give way to the question of "why it happened like that". This paradigm shift brought with it the pursuit of new sources that might capture the broader social, cultural or economic context. The implementation of this approach was

made possible by cooperation with other scientific communities and the absorption of their characteristic research tools.

The history of interdisciplinarity in historical studies

Interdisciplinarity in history traces its beginnings to the early twentieth century. In 1898, Karl Lamprecht, a German scholar of economic history associated with the University of Leipzig, together with the geographer Friedrich Ratzel, founded a geographic and historical seminar. The proposal to depart from the classical political history practised by the broader school of historians associated with Leopold von Ranke and his students in favour of a history of culture (*Kulturgeschichte*) was made fully realisable under the aegis of the Institute of Universal History and Culture (*Institut für Kultur- und Universalgeschichte*) established on his initiative. It was the first research centre to be independent of university structures and directly subordinate to the Ministry of Science. Lamprecht's works emphasised the role of cultural history and material factors (Schleier, 1988). He pointed to the need to research societies – not only individual entities – using research methods from disciplines such as sociology, psychology, anthropology and art history. He argued that Ranke's concept of historiography *wie es eigentlich gewesen ist* [how it really was] was incomplete if it failed to address *wie es geworden sei* [how it came to be] – an issue that cannot be investigated without analysing a range of environmental and economic factors. Although Lamprecht's work was criticised by his German contemporaries, it was accepted by historians overseas and in neighbouring France (Abushouk & Zweiri, 2016, p. X).

Independently of Lamprecht, the American historian James Harvey Robinson took a similar direction. He called for the history of politics and diplomacy to be set aside: it should be replaced by historical research focusing on social and economic changes,

and changes in worldview. In this way, co-created by Robinson's students at Columbia University, a new trend called "New History" slowly took shape. These students included Lynn Thorndike, the author of works on the history of witchcraft and science on the Old Continent; Dorothy Stimson, who studied the influence and reception of the Copernican system; and Carl Becker, who analysed the intellectual foundations of the English, American, and French Revolutions (Abushouk & Zweiri, 2016, pp. XI–XII).

Another milestone in interdisciplinary historiography was marked by the work of the French historian and philosopher Henri Berr. According to him, historical writing should be synthetic, drawing mainly on three disciplines: history, sociology and philosophy. By combining detailed research on the fate of individual entities with studies on the activities of societies and their institutions including an understanding of the motives behind actions (i.e. thoughts and philosophy), a holistic view of the humanities was to emerge (Abushouk & Zweiri, 2016, p. XII).

Although Henri Berr's concept did not find favour among sociologists – mainly due to the difficulty in incorporating historical explanations into qualitative research in the social sciences – the importance of synthesis and the need to use methods proposed by other disciplines were grasped by the French historians who were already working with Berre, and who founded the journal *Annales d'Histoire Economique et Sociale*. Its first issue was published in 1929 and became a platform for representatives of social sciences and the humanities to exchange ideas. Its first editors were Lucien Febvre and Marc Bloch. Since 1994, the periodical has been published under the title *Annales. Histoire, Sciences Sociales*, while a parallel English edition was launched in 2012. The school of historical writing that grew up around the creators of the journal advocated a synthetic perspective within a long-term approach (*longue durée*). Its members addressed interdisciplinary topics combining studies in such areas as geography, sociology, literary

studies, and psychology. Historians associated with the quarterly used source texts, which had previously been treated with reluctance in historical writing. Working with personal and demographic sources and quantitative methods, thereby extending the historian's toolset with those available to, for example, geographers and sociologists, they contributed to the development of historical anthropology. This subdiscipline of history placed at the heart of its research the fate of the common man – his day-to-day life, mentality, rituals, customs and material culture, setting them in a broad social and geographical context.

Representing the *Annales* school, Fernand Braudel, Lucien Febvre, Emanuel Le Roy Ladurie and Marc Bloch had a significant influence on the subsequent development of world historiography. Their works contributed to a renaissance of interdisciplinary research in the United States, where the *Journal of Interdisciplinary History* came into being in the 1970s. The overriding goal of the journal's editors was no longer to seek to address whether historians could use tools and methodologies from other disciplines, but to determine how to employ them for their research purposes (Abushouk & Zweiri, 2016, pp. XIII–XIV).

The practice of interdisciplinary studies

Since the second half of the twentieth century, there has been a notable "overproduction" of historical sources. The collection has been expanded by the opportunities afforded by human advancements, such as digital sources and data series developed using specialised technologies (e.g. radiocarbon dating). This has utterly reshaped the research landscape, allowing researchers to go beyond a single discipline and encouraging the creation of large research teams. The activities of researchers are supported by national agencies, such as the Polish National Science Centre (NCN) and the

National Centre for Research and Development (NCBiR), as well as international institutions, with the European Research Council to the fore. A similar role is played by inter-university consortia aiming to stimulate scientific circles, to implement projects and to procure grants. In this context, interdisciplinarity in historical studies offers an opportunity to make the academic telling of history more attractive and to increase its presence in mass culture (Napora & Woźniak, 2017, pp. 119–130).

History and quantitative methods

Frederick Jackson Turner wrote in 1904 that a historian's work should apply both statistical and critical methods to a collected data series (Turner, 1932; Kunas, 2016, pp. 58–59). William H. Sewell pointed out that tax registers, wills, inventories, and the accounts of cities and charities were sources that allowed social relations and the functioning of institutions to be reconstructed (Sewell, 2005, p. 27; Kunnas, 2016, pp. 58–59). At the same time, the appearance of computers and the possibility for almost limitless database creation met with reluctance among some historians, who perceived the danger of chaos posed by an excess of information. Some turned instead to examining specific case studies and to microhistory. The advantages of computational methods in social history, and in studies on historical demographics and economic history, were emphasised by Jürgen Kocka. Analysing numerical data and using them to create various models is a way to supplement or falsify research hypotheses. At the same time, he noted that deciding to reject such methods would represent a step backwards (Kocka, 2003, pp. 21–28; Kunnas, 2016, p. 60).

The idea of combining qualitative and quantitative analyses in practice was proposed by Bartosz Ogórek in his book *Niezatarte piętno. Wpływ I wojny światowej na ludność miasta Krakowa* (2018)

[The indelible stamp. How World War I affected the population of the city of Kraków]. This combination allowed for a completely new presentation of the individual and the wider community in the face of the Great War of 1914–18. One interesting example of a project combining the analysis of various numerical data types with historical reflection is the *Interaktywny atlas statystyczno-demograficzny Królestwa Polskiego* [Interactive Statistical and Demographic Atlas of the Kingdom of Poland], which covers the years 1815–1914 and was developed by scientists associated with the University of Warmia and Mazury in Olsztyn (Krzysztof Narojczyk, Andrzej Korytko) and the Jagiellonian University (Konrad Wnęk, Lidia Zyblikiewicz). The researchers intend to order the collected material and mark it on maps. This presentation of data will not only be graphically more attractive, but it will, above all, allow the occurrence of particular phenomena in specific areas to be understood. The analysed issues include breakdowns of ethnicity, land ownership, literacy, and hygiene.

History and law

The historians' use of source material from judicial institutions in the form of interrogation records or criminal records held in town or village halls proved to greatly broaden the historical perspective. In this regard, the 1975 publication of *Montaillou, village occitan de 1294 a 1324* was something of a landmark (1st English edition in 1978, 2013). Its author, Emmanuel le Roy Ladurie, analysed Inquisitorial registers created in the diocese of Pamiers, in Occitan. Based on testimonies collected by the inquisitors, he recreated the details of life in the town on the Spanish–French border.

In Poland, a perspective based on court files was proposed by Tomasz Wiślicz-Iwanieczyk. In the 2012 book *Upodobanie. Małżeństwa i związki nieformalne na wsi polskiej XVII–XVIII wieku*

[Pleasure. Marriages and informal relationships in the 17th- and 18th-century Polish countryside] (2012), he portrayed male–female relations in peasant communities in the Polish–Lithuanian Commonwealth. This choice of source material not only allowed for a reconstruction of the rural population's attitude to marriage, but also of the entire gamut of history of everyday life, including legal and social norms. The growing popularity of judicial court sources and their usefulness to historians and law historians is evidenced by the in-depth commentaries in editions of early-modern criminal records from Kraków (Mikuła, Uruszczak & Karabowicz, 2013) and Dobczyce (Mikuła, 2013) prepared by a team led by Wacław Uruszczak and Maciej Mikuła.

History and psychology

Surprising conclusions can be derived from psychological analyses attempting to explain historical processes and the decisions of rulers, politicians, and ordinary people. Although psychology is a relatively young discipline, having its roots in the nineteenth century, its relationship with historical writing is almost as long as that of historiography itself (Porada 2016, pp. 142-149). Even *The Histories* of Herodotus (484–425 BCE) described in detail the mental state of the Persian king Cambises, which justified the actions of the ruler (Marchewka, 2008, pp. 76–88). Knowledge from the domain of psychology was used to analyse the famously cruel behaviour and actions and irrational decisions of Emperor Caligula (Auguet, 1984), and King George III of Great Britain, whose rule was affected by mental disorders and porphyria (Peters, 2011, pp. 261–264). Shell shock, i.e. post-traumatic stress disorder and the destructive influence of the experience of war on the human mind, was the subject of Ben Shephard's deliberations on the intersection of military history, medical history and social history (Shephard,

2000). Adolf Hitler was a phenomenon who has intrigued historians and psychologists alike. He was the subject of Stephen Marks' 2007 book *Warum Folgten Sie Hitler? Die Psychologie des Nationalsozialismus* [Why Did They Follow Hitler? The Psychology of National Socialism in Germany]. Publications by Maciej Dymkowski (2003, 2016) emphasise the great potential afforded by the marriage of psychology and history. In them he addresses issues related to the motivations of the Crusaders in going to the Holy Land or the causes of the Polish nobility's megalomania.

The combination of these two disciplines created a new subdiscipline of history – the history of emotions. The first steps in this field had already been taken by Lucien Febvre in 1941, with the publication of an article in *Annales* in which he dealt with issues related to the definition of emotion (*sensibilité*), sources (court files, iconography, literature) and the cooperation with psychology. The breakthrough came with a works published in the 1980s and 1990s by Peter Gay, a historian associated with Yale University. The shift towards using psychoanalysis in historiography was particularly strong in the five-volume work *The Bourgeois Experience: From Victoria to Freud*. The subject under the looking glass – Victorian middle-class society – was seen in a whole new light. Gay focused on aspects such as physicality, sexuality, and mentality.

The history of emotions not only draws on psychology but also on cultural anthropology (the anthropology of emotions) and sociology (Pierre Bourdieu's concept of emotional habitus). On the other hand, research institutions in Europe propose extending the set of basic historical categories, i.e. class, race and gender, to include emotions.

History and medicine

Literary texts and historical sources have excellently documented the impact of diseases on the fates of individuals, communities and countries. The ubiquity of death terrified and fascinated contemporaries, contributing to motifs of passing-on being heavily represented in the texts of culture. Here it would suffice to mention the Black Death epidemic that depopulated Western Europe in the mid-fourteenth century. Boccaccio and Petrarch wrote of the harvest that it reaped at the time, while the plague that hit London in 1665 became the main character in Daniel Defoe's novel *A Journal of the Plague Year*. This work, first published in 1722, inspired many later authors, such as H G Wells, Albert Camus and Gustaw Herling-Grudziński. In 1999, it was even the subject of an animated short directed by Steffen Schäffler.

Questions as to how health was understood in previous centuries, what disease was, how the human body was perceived (humoural theory), what methods were used in treatment, how effective they were, what the attitude was to treatment, and how knowledge about medicine evolved – these are the primary subjects of interest to those investigating the history of mentality, the history of the body and the history of medicine. A classic example in this field is Georges Vigarello's work *Le sain et le malsain: Santé et mieux-être depuis le Moyen Age* (1993), [The History of Health and Disease. Sanitary practices from the Middle Ages to the present day]. Taking a *longue durée* approach, the author presents mankind's approach to health, medicine and hygiene from the thirteenth century to the present. It tackles humoural theory, i.e. that four fluids responsible for a person's condition are present in the human body, being "bad air" (miasma), and the past methods of healing, such as bloodletting. In turn, Andrzej Karpiński (2000) analysed the effects of the epidemic on the largest cities of the Polish–Lithuanian Commonwealth. He questioned the commonly

cited victim numbers, outlined how cities were organised in the event of an impending epidemic, and described the activities of institutions providing aid to those affected by the plague. He also considered how the epidemic changed the mentality and religiosity of city dwellers.

Conducting research at the intersection of history and medicine calls for particular care and sensitivity. Approaching past treatment methods from the perspective of advanced modern medical knowledge without understanding the realities of the era and the mentality of the time is dangerously anachronistic. Jakub Węglorz encourages a balanced cooperation between disciplines in his book *Zdrowie, choroba i lecznictwie w społeczeństwie Rzeczypospolitej w XVI-XVIII wieku* [Health, disease and healing in the society of the Polish- Lithuanian Commonwealth in the 16th to 18th centuries].

History and law

The relationship between history and literature is inseparable, although the historian's use of literary texts as a source poses many problems. Poetic license – the literary fiction inherent to works – is a basic barrier here. Georges Duby broke through it by analysing the medieval poem *L'Histoire de Guillaume le Maréchal*. This work, commemorating the deeds of the most famous English knight of the reign of William II and Richard the Lionheart, was used by the French historian to portray the chivalric mentality and ethos. Alongside *Guillaume le Maréchal ou le meilleur chevalier du monde* [William Marshal: The Flower of Chivalry, 1984], the collection of essays by Stephen Greenblatt published in Poland under the title *Poetyka kulturowa* [Cultural Poetics] (2006) should be considered a key work at the intersection of history and literary studies. The essence of the method he proposes is to define the degree of influence of literature in shaping the cultural moment in which it

originated or was read. Linking the text with history allows for the analysis of the relationships linking the creation of the work with the contemporary political, social, and economic situation. Literature thus reflects the values of the cultures from which it emerges and which created it. Greenblatt does not reject any form of discourse: he sees documents, letters, literary texts and sources from other fields as equals. Their interpretation can provide an understanding of a work, from learning of the author's motives to outlining the historical moment and cultural norms reflected in the text. He made full use of these postulates in his book *Will in the World: How Shakespeare Became Shakespeare* (2004), where documents, letters and plays were used in equal measure to recreate the master's biography. Jakub Niedźwiedź undertook a similar challenge in relation to the greatest artist of the *Polish Renaissance. Poeta i mapa. Jan Kochanowski a kartografia XVI wieku* [The Poet and the map. Jan Kochanowski and the cartography of the 16th century] (2019) discovers the knowledge and imagination of Jan Kochanowski in his works about the lands, cities, and their inhabitants that he visited on his many travels.

History and the visual arts

Ekphrasis, i.e. the artistic description of a work of art, is primarily associated with rhetoric and literary studies. This was used by Homer depicting genre scenes on the shield of Achilles in the *Iliad*. In turn, Virgil showed the history of Rome on Aeneas' shield, while in the poem *Proporzec, albo hołd pruski* [The standard, or the Prussian tribute] Jan Kochanowski "painted" the history of Polish–Teutonic relations on a banner that the prince of a secular state established in Prussia had received from the Polish king. Currently, the broader visual arts, such as painting, graphic designs or film, are equal historical sources and are used by researchers of

all eras. In his book *Roman Art and Imperial Policy*, Niels Hannestad traces the relationship between Roman art and the politics of the imperial court. In his most famous work, *The Autumn of the Middle Ages* (1st Dutch edition in 1919, 1st English translation in 1924), Johann Huizinga used an analysis of literary works and images to put forward a bright and colourful vision of the Dark Ages. His proposed concept of seeing Dutch genre painting as a speculum naturale (mirror of nature), and thus a literal representation of reality, was criticised by Eddy de Jongh. This idea is further developed by Piotr Oczko in his book *Miotła i Krzyż. Kultura sprzątania w dawnej Holandii, albo historia pewnej obsesji* [A broom and cross: the culture of cleanliness in Holland, or the history of an obsession], evidencing the unbreakable relationship between the creator, the work, and the historical context. In this relationhip, a knowledge of the cultural code is key to understanding a work and its message. The flow of information between source narrative texts and iconographic representations created during the sixteenth-century religious wars has been studied by Philip Benedict (2007) and Ramon Voges (2019).

Environmental history

In the 1970s, a new subdiscipline of history established itself under the name "environmental history". It concerns itself with the relationship between man and nature, as well as culture and nature. The first works presenting this perspective appeared in the United States and concerned the significance of nature to Americans and their sense of identity (Nash, 1967). A breakthrough was made by Daniel Worster, who analysed the effects that the capitalist economy, crop monocultures, and cattle grazing on the American prairies had on soil depletion and the emergence of dust storms. Conducting his research forty years after the period in question, he

could not have known that the 1930s were exceptionally dry and it was drought that had contributed to the Dust Bowl. Nevertheless, he showed that social and economic processes affect the environment (Worster, 1979). A classic theme of environmental history is the ecological dimension of human expansion and migration, which Alfred Crosby (2003) illustrated on the example of America. The title of his book – *Columbian Exchange* – became at the same time the term to denote the intercontinental exchange of plants, animals and microorganisms via humans (Izdebski, Szmytka, 2018, pp. 10–14).

In historical and environmental research, tools characteristic of natural disciplines are indispensable. Scientists examining the history of Poland also avail themselves of such tools. In order to reconstruct climate change on the Vistula River and its impact on society and economy, pollen samples are taken from lakebeds. They can be used to determine temperature anomalies and averages for given periods (Izdebski, 2016). Palaeo-ecological data and data from other features of peatland sediments will allow a team led by Piotr Guzowski to discuss anew turning points in Poland's economic history: state building, colonisation under German law, the Black Death epidemic, grain exports from the Polish–Lithuanian Commonwealth in the 16th century, and the economic crisis in Poland in the following century. In turn, the world of ideas and imaginings of nature is featured in a book by Małgorzata Praczyk entitled *Pamięć środowiskowa we wspomnieniach osadników na "Ziemiach Odzyskanych"* [Environmental memory in the reminiscences of settlers in the "Recovered Territories"] (2019), which examines the diaries and memories of Poles who arrived in the eastern provinces of the Third Reich that found themselves within the borders of Poland post-1945.

The benefits of interdisciplinary studies

Despite the passage of the decades, history remains a subjective narrative about the past, because it falls to the researcher to decide what to convey to the reader or listener, and how. With technological progress, access to new sources and research methods increases. In this context, interdisciplinarity opens up completely new research perspectives for contemporary historians. It allows one to look at known facts from a different angle, providing an opportunity to verify the state of knowledge. Thanks to tools from disciplines such as archaeology, literary studies, geography, sociology or psychology, it is possible to reflect more deeply on both microhistory and case studies, and to use a broad synthetic approach. Cooperation with other fields of knowledge can bring tangible results where classical history has already exhausted its possibilities – i.e. written sources. One example is the dendrochronological research conducted since the 1990s in Wielkopolska. It has permitted the reformulation of theses concerning the beginnings of the state of the early Piasts from the first Polish dynasty, indicating that the turning point for the establishment of the heart of the protostate came at the turn of the 1040s. It was then that the population of the Gniezno Upland built as many as five great fortified settlements and expanded another, evidencing the consolidation of a central seat of power (Jasiński, 2007, p. 14).

Interdisciplinarity and synthetic approaches to topics also play a significant role in popularising knowledge. They encourage non-specialists to reach for historical literature. Of course, a lot depends here on the "method of presentation", that is, the style and selection of content, but historians representing the so-called Anglo-Saxon school of historical writing have been won over by such writing. One of the most famous representatives of this trend, including among Polish readers, is Norman Davies. His monumental syntheses of the history of Europe (Davies, 1996), the British

Isles (Davies, 1999) and the history of Poland (Davies, 1981) have entered the canon of world historical literature and continue to captivate readers with their unconventional approach and the author's courageous forays into other disciplines (Davies, 2017).

Universal access to information and the potential to disseminate content via new media are forcing science to face a new challenge – "the democratisation of knowledge". Academic circles no longer have the exclusive right to speak in discussions or even to publish books. Images of the past in popular culture are constructed through computer games, historical re-enactment societies, comic books, and websites, where anyone can become an "expert". This liberalisation may bring with it certain threats, a basic one of which is the popularisation of ideas which have not been confirmed by research and in conflict with the state of knowledge. Interdisciplinarity in history can be perceived as an attempt to restore history's place in both scientific and popular discourse – through reliable research in collaboration with scientists from other fields, and thanks to the attractiveness of the topics addressed and the methods used to elucidate them (Napora & Woźniak, 2017).

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Interdisciplinarity in theology

Introduction

While reflecting on the history of interactions between science and theology, John Polkinghorne (2008, pp. 123n) used a number of very evocative comparisons. He observed that science sometimes served as a surgeon to theology, amputating hypertrophies which in fact did not belong to the corpus of theological reflection. At other times, it assumed the role of a hygienist, patiently and systematically questioning pretentious formulas of esoteric knowledge.

This British theoretical physicist focused on the two abovementioned aspects, but it would be worth asking him some further questions. Does theology need reflection originating from other sciences just to clear itself of errors and superstitions? Can these scientific findings serve a positive role by enriching theological research and enabling theologians to better understand the subject of their inquiries? At the beginning of my paper I hypothetically assume a positive answer to the second question and I intend to justify it in three dimensions. Firstly, I will consider whether theological reflection is possible without taking into account an

interdisciplinary perspective, or is it a core and indispensable element of a scientific reflection on the Revelation? Secondly, I will search for methodological guidelines which, in my opinion, should be followed in the dialogue between theology and natural sciences. Finally, I will refer to similar rules in its dialogue with philosophy. I have decided to single out this discipline because, as Berthold Wald pointed out (2006, p. 33): 'Theology as a science will not set off without philosophical propaedeutics', and John Paul II added (1998, no. 77): 'If a theologian does not want to make use of philosophy, there is a danger that he will subconsciously go in for philosophy and limit himself to mental structures barely useful in understanding faith.' I am aware of the theological significance of other humanistic disciplines, such as history or art, but I leave them as perspectives for future research.

Due to the research subject, the nature of my paper will be synthetic. Moreover, I do not claim the right to fully cover the topic. Especially in the last two parts, my reflection will be just a general outline, an introduction to further and more detailed analysis.

Talking about interdisciplinarity in theology calls for terminological clarification. Discourses on this topic include many religious terms which are paired and compared with 'science'. Apart from 'science and theology', the most common juxtapositions include 'science and faith', 'science and religion' or 'reason and faith'. Authors who use these different patterns in fact often search for answers to the same questions. Differences stem only from the rhetoric they use. However, it seems that such a simplification is too far-reaching, and juxtapositions like the ones mentioned above should be formulated with more care. As Stanisław Wszołek pointed out (2016, MOBI: loc. 2705), 'separation becomes (…) unacceptable when we start discussing the interaction between reason and faith. How can we separate faith from reason, if faith itself is a use of reason?'. The situation is entirely different if we talk about science and

theology. Due to the peculiarity of the research methods and subjects, separation is necessary, if we assume the general meaning of science. Otherwise, it is necessary to consider the relation of theology to other arts and sciences and not science as such, as theology itself belongs to the arts and humanities. It is this last model that I apply in my paper.

First Dimension: Interdisciplinarity as a core element of theology

Coursebook definitions of Catholic theology stress that this art is a systematic reflection on the Revelation, developed in the Church by the faithful inspired by God's grace (Dzidek & Sikora, 2006a, p. 51). It is worth analysing the elements of this definition to find traces of its interdisciplinarity.

Marian Rusecki (2007, pp. 103-116) listed and described seven modern conceptions of the Revelation: intellectual, personalistic, historico-redemptive, transcendental-anthropological, immanent, semiotic and symbolic. Especially in the transcendental-anthropological one we can clearly see grounds for the interdisciplinarity of theology. Supporters of this conception state that God has chosen to present Himself to the world in a particular form, suited to the perceptive abilities of the addressee of his message, that is the man. Therefore, the Revelation is not a manifestation of a distant and mostly objective truth, but a 'humane' impartation of the Creator (Rusecki, 2007, p. 111). Thus, theology would focus on the redemptive signs of God's presence in the world, which are a combination of the universal 'voice' of the Creator and subjective existential aspects of the creation.

Such a formulation of the subject calls for appropriate research methods. Practising theology – as Karl Rahner observed (2005a, p. 55) – should make man ask himself the question of to what

extent each object he encounters is significant in the perspective of his redemption. For example, it is not enough to say that Jesus is the centre of Christian preaching, but 'how and why Jesus is the only one on whom we can count in life and death' (Rahner, 1992, p. 75). Therefore, if the Revelation is God's presence in and for the world, non-theological sciences, which examine and describe the world, are theologian's indispensable allies.

It can be seen even better while analysing the objectives of theological hermeneutics. Edward Schillebeeckx (1968, pp. 978-981), one of the most important representatives of this strand, pointed out that there is no such thing as *nuda vox Dei* (bare voice of God). All His interventions are coded in the social, historical, geographical, and cultural context. Otherwise, God would fail to reach the man with his message and to enter into a relationship with him. Even His Incarnation, the coming of Jesus into the world, can serve as an example. He chose specific circumstances, a clearly defined reality. Although he is God, he used human language, and the metaphors and parables which he used were closely connected to the everyday life of His listeners. Taking into consideration such an approach to Christianity, one has to conclude that sharing the truths of faith is bound to depend on contexts (Heller, 1996, pp. 13-27; Liana, 2010, pp. 69-90).

Similar conclusions can be drawn in reference to the process of evangelisation, that is the spread of Christianity, throughout history. It is a constant search for such forms of expression that will make it possible to reach particular people and to convince them to the message of the Gospel with means that are credible in their community. Thus, the task of theological hermeneutics is realised and a new approach to the Bible, a new reading of the Tradition and a new ecclesiastical practice are brought about (Geffré, 2002, pp. 25-37). Each negligence in this field, namely any attempt to dogmatize historical forms and formulations, led and still leads to misconceived initiatives and crises in the Church. John Quinn

(1999, p. 44) clearly referred to that by saying: 'The failures of the Church in the second millennium – the loss of whole peoples to Catholic unity in the 16th century, the loss of the workers in the nineteenth, the alienation of the intellectuals in the twentieth – have been due not so much to reform within the Church as to lack of timely reform, the failure to weigh carefully enough the signs of the times, and the failure to act in time.' Walter Kasper (2016, p. 155) added that we should 'quickly release God from the cultural cages of the past, especially we – Christians who believe in transcendental God that is not limited to one culture.'

What needs to be done to save theology from becoming 'a slave to contexts'? We should examine these contexts to find universal dimensions of God's intervention and later code this message in a new culture. Both in order to decode divine initiatives in history and to talk about them in 'new languages', interdisciplinary research is crucial. On the one hand, it conditions the discernment of the nature of Revelation and helps in purifying certain doctrinal formulations from outdated images of the world, archaisms and unjustified linguistic modifications (John Paul II, 1990, p. 9). On the other hand, such research makes it easier to get to know new addressees of the Gospel and recognise new contexts which should constitute a modern 'evangelisation code'. A failure to consider research results from other scientific fields in theological reflection may contribute to a loss of credibility of Christianity, marginalisation of its position or even its relegation to the sphere of mythology.

In the field of methodology, these observations were translated into practical guidelines for theologians. Among the methods which consider contexts, one seems to be especially representative, namely the one systematised and precisely described by Karl Rahner. According to him, an accurate approach to historical contents in theology should consider the hierarchy of truths. It is a reference to point 11 of the Decree on Ecumenism *Unitatis redintegratio* of

the Second Vatican Council (2002, p. 201). It says, among others, that particular truths in the Catholic teaching vary in their relation to the fundamental Christian faith. Applying this rule, Rahner postulated that texts from the Church Tradition should be verified through the perspective of their relation to the central truth of faith, namely the self-impartation of God (Kijas, 2006, pp. 143n). Following this train of thought, all theological theses in which this most important idea is not voiced should be regarded as purely contextual. Moreover, also in these pointing to that centre there are both important theological elements but also others which are connected only with linguistic formulation (language, world model, impressions, ways of interpretation etc.). The process of distinguishing and separating them is not easy, and in many cases they were not explicitly separated neither in a given period in history by traditional theology, nor by the Magisterium, or 'due to historical reasons they could not have been separated till a specific moment in time' (Rahner, 2005b, pp. 100n).

A theologian undertaking the task of such separation has to closely examine all cultural factors in the moment when a given truth of faith was formulated, which cannot be comprehensively accomplished without interdisciplinary cooperation.

Apart from a reflection on the history of theological ideas and their evolution, Karl Rahner proposed a means of creating new interpretations of the truths of faith. It should include three research stages. He called the first one a phenomenological description. At this stage a theologian should delve into the existential situation of his contemporaries, characterise their experiences and the relationships they build. The more detailed data he gathers and interprets, the better diagnosis and therapy can be expected in the following stages of the method. That is where a cooperation with scientists dealing with the images of the world, culture, sociology and anthropology in the broad sense is crucial. The results of such interdisciplinary studies can lead to 'a discovery of subjective and

a priori conditions of our experience' (Dzidek & Sikora, 2006b, p. 156) and to the formulation of questions requiring answers which surpass human 'here and now'. This stage was called transcendental reduction. The third stage in transcendental deduction, that is an attempt to search for a theological answer to the existential dilemmas described before. It presents the Revelation as God's reaction to desires and problems which the man discovers and experiences as shortages and limitations.

The awareness of a need for cooperation between theologians and other scholars is nothing new. Already in the 16th century, the bishop of the Canary Islands, Melchior Cano (2016, p. 11), developed a division of the areas of theological cognition, in which he included interdisciplinarity. He divided all sources of theological work into two fundamental groups which can be described as proprietary and supplementary. The first one includes the Bible and Apostolic Tradition, as constituent for theology, as well as areas which serve their interpretation: the authority of the Common Church that is *sensus fidelium* (universal sense of the faithful), the voice of the councils, especially ecumenical ones, that of the pope representing the stand of the Roman Church, interpretations by ancient saints and scholastic theologians, and finally suggestions from experts in canonical law. It has to be said that although constituent areas are restricted, the list of commentators is open and new groups of authorities interpreting and explaining the Bible and Apostolic Tradition can be added. Here, we deal with interdisciplinarity within theology, that is a dialogue between particular theological disciplines. In the second category, that of supplementary areas of theological cognition, Melchior Cano listed 'natural reason, which is most widely opened by all sciences discovered with natural light', the authority of philosophers, lay lawyers, and historians. In this case we can observe interdisciplinarity in its literal sense. As José Luis Illanes Maestre and José Ignacio Saranyana (1995, pp. 138-141) pointed out, although that 16th century

image can be supplemented, its basic assumptions and shape have not lost on their relevance.

Summing up, it has to be stated that the nature of Christian Revelation, and the tasks which theology serves to it, call for a sensitivity to contexts, which in turn requires wide-ranging interdisciplinary research. It refers both to reflection on historical formulations of the truths of faith and to its revision and communication.

The Second Dimension: Selected methodological issues concerning interactions between theology and natural sciences

Reflection on the interactions between theology and natural sciences have given rise to many interesting models of such dialogue (Heller, Liana & Mączka, 2001; Heller, 2002; McGrath, 2009, pp. 274-304; Heller 2014; Drees, 2016). Among those who have greatly contributed to the study of the problem at hand was the physicist and theologian Ian G. Barbour, born in Beijing in 1923, who died at the age of 93 in Minneapolis. He endeavoured to criticise the criteria of verification and falsification as conditioning the credibility of a theory, described the ways paradigms work in religion and defined similarities, differences and basic problems in a comparative analysis of Maths, empirical sciences, and theology (Barbour, 2016).

In one of his articles (Barbour, 1993, 1994), he outlined possible meeting platforms for theologians and empirists, dividing them into four categories: conflict, independence, dialogue and integration. Taking into consideration the subject of this paper, dialogue and integration are most interesting, and that is why only they will be further analysed. The first category touches upon indirect connections between science and theology, in which border issues and methods of both disciplines are involved. Commenting

on Thomas F. Torrance's view, Barbour stressed that 'on its borders, science poses religious questions which it does not answer' and following David Tracy, he named two types of such borderline situations: 'ethical questions connected with the application of science and presuppositions or conditions of scientific research.' A theologian can help in dealing with these problems by suggesting classical religious texts and structures of human experience as sources of understanding of the world and its rationality. Among methodological parallels, he pointed to means of interpretation common for science and theology, that is interpretation within a particular paradigm and the status of an observer who influences the observed object. Making reference to John Polkinghorne, he cited 'examples of personal judgements and theorized data present in both domains (…). For a religious community, its data consists of scriptural sources, history and religious experiences. There are similarities in both disciplines as each of them allows for reform through an appropriate correlation between theory and experience, and each of them is significantly involved in entities whose inconceivable reality is far more subtle than naïve realism would like it to be.'

As far as integration is concerned, the aim is to search for common fields in natural sciences and theology, maintaining their methodological individuality, and thus discovering religious meaning in scientific theories and discoveries. The author pointed out that 'there are two types of this kind of integration. The first one, when scientific theories can contribute to a reinterpretation of theological doctrines, whose main sources lie beyond science. The second one, when science and religion can collectively contribute to the formulation of a systematic synthesis, a coherent outlook on the world, which will include metaphysics.' A radical approach to such a reinterpretation would imply using scientific notions as analogies to the communication of the truths of faith (e.g. a comparison of two natures within Christ to the characteristics of

an electron as a wave and a particle) or deriving theological theses from scientific achievements (e.g. the anthropic principle and the Intelligent Designer). A moderate approach to integration is an effort to modify traditional theological formulas so as to make them credible in the face of modern discoveries in empirical sciences (e.g. the theory of evolution and the creation of a human being). The most systematic synthesis would consist in a search for a coherent view of the world based on rational metaphysics. As an optimal solution Barbour suggested the process philosophy postulated by Alfred North Whitehead. In it he viewed a set of general interpretational categories in which both natural sciences and theology could develop a coherent argumentation. According to him, thanks to the rejection of God's omnipotence, it gives a chance of eliminating most sources of conflict between the natural and theological images of the world.

One of the most crucial methodological aspects of the discussed issue is the formulation of general criteria for a dialogue between theology and empirical sciences. While reflecting on them, it is worth mentioning a synthetic approach by Andrzej Anderwald (2007, pp. 213-221). The author listed six rules which – though often similar to each other – highlight various aspects of this interaction. The first criterion is autonomy. It refers to independence, which implies respect for methodological distinctness of different discourses. Simultaneously, it calls for rejection of historical views, according to which all specific sciences were subordinated to theology and treated as *ancillae theologiae* – servants to the "queen" of the other disciplines. However, such autonomy does not mean that an absolute line of demarcation should be drawn here. A theologian should listen carefully to what natural sciences have to say about man and the world, evaluate it with reference to his research needs, and use it to enrich his analyses of the Revelation. Generally speaking, it comes down to openness, partnership and awareness of mutual benefits, with due respect to independence.

The second criterion mentioned was that of integrity. Similarly to Barbour's analyses mentioned above, it implies an approach to various scientific disciplines as complementary in the creation of a holistic vision of the world. Application of this principle prevents various kinds of reductionism. While integrating research results, one has to be careful and resist the temptation to treat God as 'a filler of white spots' in our knowledge about the functioning of nature, which would be unacceptable from the theological point of view.

The criterion of linguistic openness in theology assumes adoption and usage of certain terms from the field of empirical sciences. Terms used by a theologian can serve as a bridge, enabling him to explain how some events are possible; and are an example of bringing together natural and theological cognition. By applying this criterion, one may avoid, among others, bilingualism and a fundamentalist reading of the Bible.

Another criterion, called cognitive-interpretative openness, prevents separatist trends in theological cognition, that is tendencies to reject the reception of any results of natural cognition in this field. As a consequence, this criterion should prevent monopolisation of theological cognition and theological exclusivism. A temptation to reject this criterion comes especially when new images of the world question traditional theological formulations and call for a reinterpretation of doctrinal theses.

The criterion of semantic caution of expressions is used in order to avoid thoughtless creation of a language out of elements originating from different cognitive sources. It refers to situations in which representatives of one discipline use technical terms of the other in a wrong way. It happens when a given term is erroneously assigned designations absent in the discourse of the interlocutor. As an example of a term which often falls victim to semantic confusion in the dialogue between theology and natural sciences, Andrzej Anderwald mentions *chance*.

The last criterion listed by the Polish author is respect for the cognitive boundaries of a given discipline. It demands, both from a theologian and an empirical scientist, acceptance for the particularity of their discipline. The importance of this principle can be appreciated if we analyse history, searching for reasons behind conflicts in the field under discussion. Most often, they were caused by extrapolation of research competencies of one side of the dialogue. An example of such situation in theology was the controversy around Galileo's beliefs (Reston Jr., 1998), and in the field of natural sciences, Richard Dawkins's (2006) atheistic interpretations based on Darvin's theory of evolution.

To sum up this part of discussion, it is worth mentioning Denis Edwards's (2013, p. 13) opinion on the value of natural sciences for theology. He claimed: 'the theology of God's agency depends also on the outlook on the world, which a theologian brings with himself, making a reflection from his or her perspective. If this world image is to be as faithful as possible to the actual world we live in, it should be shaped by the most accurate intuitions of natural sciences.'

The Third dimension: Selected methodological issues concerning interactions between theology and philosophy

Philosophy embraces a broad scope of views and currents. Before reflecting on its significance for theology, it is worth mentioning that not every philosophy will be able to enter into a constructive dialogue with the art we are discussing here. Broadly speaking, the fundamental criterion for the applicability of philosophy will be its attitude to truth. In creating guidelines for interdisciplinary dialogue of theology I only take into consideration those philosophical views which assume the existence of objective truth and the ability of human reason to explore it.

The first and main function of such philosophy in theological reflections is to facilitate the understanding of the truths of faith. Metaphysics, defined as intellectual reflection on the shape of the world as such, plays a crucial role here. If theology is 'an attempt to understand the mystery of God which surpasses everything (…), to find a clearance for human *ratio* within the world of faith then the conclusion about mutual dependence between metaphysics and theology suggests itself' (Woźniak, 2008, p. 5). Anselm of Canterbury enclosed this process in the *fides quaerens intellectum* rule, whose summary we can find in his *Monologion*: 'Some of the brethren have often eagerly entreated me to write down some of the things I have told them in our frequent discussions about how one ought to meditate on the divine essence, and about certain other things related to such meditation, as a sort of pattern for meditating of these things. Having more regard to their own wishes than to the ease of the task or my ability to perform it, they prescribed the following form for me in writing this meditation: absolutely nothing in it would be established by the authority of Scripture; rather, whatever the conclusion of each individual investigation might assert, the necessity of reason would concisely prove, and the clarity of truth would manifestly show, that is the case, by means of plain style, unsophisticated arguments, and straightforward disputation.' It was even more clearly defined and realised by Peter Abelard (2001) who created a dialogue on religious issues aimed at 'examining the truth in them without paying attention to human beliefs but following the principles of reason.' In this case, philosophy helps both in proving the rationality of the truths of faith and in defining the terms used by theologians.

Secondly, philosophical analyses of the sense behind rules governing the world and human experiences may eventually lead to the creation of a bond between man and God, thus participating in what theology calls *praeambula fidei* (Di Blasi, 2008, pp.

313-325; Tanzella-Nitti, 2015, pp. 81-113). Such analyses form a basis for both cosmological arguments for the existence of the Absolute (such as Saint Thomas's arguments and the anthropic principle) and for anthropological ones, e.g. Blondel's, Pascal's or Alfaro's concepts (Dzidek, 2001).

Berthold Wald (2006, pp. 41n) highlighted yet another dimension in the analysed dialogue. Among other tasks, theology should participate in the defence, presentation, and disclosure of faith to those who want to reach it. In the first part of my paper, I signalled that in order to successfully fulfil this task, a theologian has to become familiar with the self-understanding of the modern reality and be able to reliably translate the treasure of faith endowed in him into the language of the world. It is hard to fulfil this task without exploring modern philosophical thought, which shapes, or at least reflects, cultural and social trends.

Summarising the role of philosophy in theological reflection, it is worth paying attention to the words of John Paul II (1998, no. 60) from the encyclical *Fides et ratio*. He stressed the importance of philosophical formation for the candidates to priesthood as fundamental in their future struggles with the problems of the modern world. It is philosophy that will lead them to the understanding of the reasons behind certain human behaviours and ultimately trigger the proper reactions to them.

Conclusion

At the beginning of this paper, while commenting on Polkinghorn's text, I posed questions about the theological significance of reflections originating from other sciences. I formulated a hypothesis that they not only clear rational discourse on the Revelation from distortions and outdated contextual formulations but can also creatively enrich theological research. Looking at the analyses

presented in the paper, it seems that the hypothesis has not only been proven but also reinforced. Interdisciplinarity constitutes an important element of theology. Depriving a theologian of an opportunity to cooperate with other scientists would not only impoverish his methods but in many aspects would prevent effective theological research.

If we assume that concern for the credibility of Christianity is one of the main tasks of theology, we need to admit that its realisation calls for constant effort in modifying theological formulations in a way adequate to the evolving images of the world created together with the discoveries in natural sciences. Thus, evangelical efficiency is to a high extent determined by dialogue with empirical sciences. Naturally, it is necessary to bear in mind the methodological individuality of both disciplines and caution in redefining the doctrine, so as to faithfully maintain the essence of the divine message (Toulmin, 1989, p. 240).

Pure empirical data is not enough to verify, communicate and rationally explain the truths of faith. It is necessary to analyse it, interpret and choose proper means of its presentation. A theologian is also faced with the task of searching for new terms and thought structures, as well as more convincing arguments for the credibility of doctrinal formulations. These are some reasons why a dialogue between theology and philosophy, mostly metaphysics, is necessary.

A quote from an Italian theologian Cipriano Vagaggini (2005, p. 127) seems a good summary of the above reflection and a perspective for the future: 'An inevitable necessity for the existence of innumerable monographic research from all possible perspectives and on all levels of rational exploration of faith is more obvious nowadays than it ever used to be, as rapid expansion of research and scientific knowledge in all possible directions, far beyond fairly well-defined boundaries that used to limit particular sciences, has significantly broadened the horizons which theology should

embrace. Thus, in order to come into being in its new rational apparel, theology should subject its matter to philological, critical, historical, and empirical (that is psychological, sociological, theoretical-praxeological and philosophical) analyses.'

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The pitfalls of interdisciplinarity

1. Introduction: interdisciplinarity, specialization, indisciplinarity

A strong tendency can be discerned in contemporary academia for interdisciplinary research.[1] This stems from the fact that specialization, understood as being hermetically sealed in one, narrow field

[1] In the literature devoted to the methodological problems of interdisciplinary research (see, for example, Max-Neef, 2005; Miller, 1982; Moran, 2002) some distinctions are sometimes drawn between multidisciplinarity (a simple set of research results from two or more different disciplines studying the same issue), interdisciplinarity (the attempt to integrate the conceptual apparatus and hypotheses of different disciplines, in which one is taken as the "dominant" one i.e. one which may serve to regenerate the other or to give it a more scientific character), and transdisciplinarity (an attempt to develop a new research paradigm with the help of different scientific disciplines). In our considerations, we will understand interdisciplinary research in the above sense and, to a lesser extent, transdisciplinary research (the examples provided later in this text relate to interdisciplinary research; it is difficult to find good examples of research projects that would meet the above definition of transdisciplinarity). Since that in the case of multidisciplinarity there is no genuine "dialogue" between the disciplines, it does not raise any serious methodological problems.

– and, perhaps more importantly, being focused on a particularly detailed problem within it – not only limits the cognitive horizons of the researcher (an age-old phenomenon, described in detail by José Ortega y Gasset in *The Revolt of the Masses*) but also (if it becomes a widespread or universal tendency) the development of science itself. This is because, in addition to the specialists who confine themselves to narrow fields, science also needs researchers who traverse the borders and barriers of scientific disciplines, seeking connections between them and drawing inspiration from disciplines other than their "own". This is necessary for at least four reasons. Firstly, in order to solve the "internal" research problems of individual disciplines, it is sometimes crucial to draw inspiration (whether concerning the research method itself or its substantive hypotheses) from other disciplines. Secondly, along with the development and progress of civilization, new challenges appear in the modern world that require the integration of efforts of representatives of various scientific disciplines (here it suffices to mention the problem of climate change, one which is being faced by meteorologists, physicists, chemists, biologists, oceanologists, and philosophers alike). Thirdly, there is a sense of nostalgia amongst many scientists for the ideal of the unity of knowledge, for the synthesis of research results from various disciplines (an ideal that is perhaps unattainable, but still an inspiring one. The state of modern science and its fragmentation stands in stark contrast to it). Fourthly, the humanities and social sciences suffer from a certain "inferiority complex" with regard to the natural and exact sciences. While the latter can boast a set of theories, hypotheses or statements which are commonly accepted by their representatives, scholars in the former often not only differ fundamentally in terms of what hypotheses should be considered acceptable, but also in terms of the appropriate scientific method to be adopted. Of course, in the various disciplines of the humanities and social sciences, these discrepancies may be greater or smaller (they seem

to be larger in sociology than in history, for example), but the majority of them are still affected. It seems hard to challenge the assumption that the humanities and social sciences can still only be classified as "*soft science*".[2] This is a fact which often inclines its representatives to embark on interdisciplinary research, seeking an appropriate methodological framework and concrete hypotheses in the achievements of the natural or (more rarely) the exact sciences which (after certain modifications) may be employed in their own discipline in the humanities or social sciences. All four of these reasons for embarking on interdisciplinary research is compelling: the integration of different scientific disciplines is unquestionably needed. Yet any consideration of interdisciplinarity should not overlook the traps and pitfalls which are associated with it. It is perhaps unnecessary to focus on the more obvious of these, above all the kind of interdisciplinarity which merely conceals indisciplinarity.[3] Indisciplinarity occurs when the academic in question conducts interdisciplinary research (let us assume that it spans two disciplines) despite not being a specialist in either and with only a superficial knowledge of them both (the extreme and rare case) or (an all-too-common case) is a specialist in one of them and has a superficial knowledge of the other. It seems obvious that interdisciplinary research can only be considered genuine if it is 'specialized'

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[2] This formulation is not quite strict because the humanities are not treated as "science" in the Anglo-Saxon sphere; "soft science" is used to refer to social sciences only. But, in the present context, the formulation should not be misleading: what we want to say is that at least some disciplines which belong to the humanities (e.g., history) may be justifiably called 'soft science' (given the similarity of scientific methods they employ to those used in the social sciences proper – like sociology, psychology, or the political sciences).

[3] We have borrowed this term from Thomas Sowell (2008, p. 269), although we have given it a broader sense:
not only the lack of specialization, but also a specialization in only one discipline in a situation where interdisciplinary research is undertaken individually.

in two ways: it concerns a precisely defined subject (interdisciplinarity cannot mean the vagueness of the research subject) and if it is carried out by those who are specialists at integrating disciplines (thus the specialist could be one person combining the appropriately high competences from various fields of knowledge, or two or more specialists from various fields of knowledge who form a research team). The apparent dichotomy of "interdisciplinarity vs specialization" is therefore a false one: only a specialist from (at least) two fields or a research team composed of specialists can conduct reliable interdisciplinary research. It should be noted that "indisciplinarity" most often occurs in the context of interdisciplinary research which is conducted at the interface between the humanities/social sciences and natural/exact sciences. Naturally, this is due to the profound differences between these fields: it is much easier for a representative of a humanities or a social science discipline (e.g. a historian) to assimilate another discipline belonging to the same branch of science (e.g. sociology) than it would be to incorporate the findings of quantum physics, higher mathematics or evolutionary biology (and *vice versa*: it will be difficult for a mathematician who is already imbued with the mindset of his discipline to fully master the legal sciences, for example, and to assimilate a particular 'legal' mindset). Yet it perhaps deserves restating: the pitfall of indisciplinarity is obvious, and no scientist who takes their work seriously will fall into it (because their scientific conscience will not allow them to speak on matters in which they have only limited competence). It is worth focusing further on some of the less obvious traps and pitfalls which even the most conscientious scientists are not always able to avoid. They concern (potentially) all kinds of interdisciplinary research, but it seems most often research at the interface between the humanities/social sciences and the natural/exact sciences.

2. Pitfall 1: the deceptive similarity of concepts and the matter of "integrating" disciplines

One of the most common mistakes made in interdisciplinary research is to rashly translate the concepts of one discipline into the language of another, and/or to prematurely assume that the subject of certain theories/hypotheses formulated within different disciplines is identical. This error, albeit in a different context, was well described by Jan Woleński, who introduced the useful concept of "interpretative consequences". It is worth citing a fragment of his work *Matematyka a epistemologia* [Metamathematics and Epistemology]:

> When the issues of determinism and indeterminism are discussed, it is very often said that classical mechanics is deterministic (has deterministic consequences), while quantum mechanics is indeterministic (has indeterministic consequences). This indeterministic nature of quantum mechanics is usually demonstrated by invoking the Heisenberg uncertainty principle (...) [But this principle] says nothing about indeterminism or determinism for the simple reason that the relevant terms do not appear at all in the formulation of the uncertainty principle. Therefore, neither determinism nor indeterminism (as specific statements) are consequences [the principle of uncertainty], since the content of logical consequences cannot exceed the content of their logical reasons. So, in order to derive indeterminism from [the uncertainty principle], quality must be linked to each other. Heisenberg himself believed that determinism comes down to the predictability of the mechanical states of physical objects. Since the uncertainty principle essentially limits the calculation of the so-called initial conditions for microworld objects, it introduces an indeterministic element, because full predictability depends on the strict determination of these initial conditions, e.g. position and momentum va-

> lues. However, in this case we are not dealing with a translation of the expression $\Delta x \cdot \Delta px$ into a statement about the limitations of predictability, but rather with an interpretation consisting in assigning a formula derived from physics – a specific term with philosophical connotations (Woleński, 1993, pp. 10-11).

Indeterminism is not a simple logical consequence of the uncertainty principle, but, as Woleński puts it, an 'interpretative consequence', i.e. a logical consequence of this principle in conjunction with some additional premises (in this case: a specific definition of determinism).

As Woleński emphasizes, "the most subtle moment" of deriving interpretative consequences is "the definition and justification of a set of these additional premises" (1993, p. 12). It should be added that when conducting interdisciplinary research, it is at this "moment" that a mistake is often made, either consisting in not noticing that (usually) additional premises are necessary in order to be able to derive any conclusions from sentences describing the research results achieved regarding the problems of the respondents within a different discipline, or assuming (often silently) premises that are themselves not very convincing. After all, Heisenberg himself carried out the operation of deriving interpretative consequences from the uncertainty principle he had formulated; he did not claim, for example, that this principle implies indeterminism in the metaphysical sense (stating the existence of events without any preceding causes constituting the conditions for their occurrence). Yet many less eminent scientists than Heisenberg make mistakes of this kind. We will consider just two examples – in the area of research into free will and rationality; however, it could be easily supplemented with many others (for example, by highlighting the differences between the understanding of 'altruism' on the grounds of evolutionary biology and that of philosophy – we will

examine this case somewhat more extensively when we turn to a discussion of Pitfall 2).

(*Free will*) In discussions about the existence of free will, Benjamin Libet's experiment in neuroscience is often referred to as a supposed scientific argument against its existence. This experiment shows that the brain activity of the respondents which allegedly leads them to taking a specific action precedes their conscious decisions about taking this action by fractions of a second (cf. Libet 2005). This is sometimes interpreted as supporting the thesis that our brain makes decisions "for us", and that "our" conscious decisions are only an epiphenomenon of the brain's decisions, without causal force, and that, as a consequence, free will does not exist. Deriving such interpretative consequences from it (in this case: philosophical) is, however, unjustified: the set of tacitly accepted additional premises that enable such an inference is not only numerous, but also includes a number of dubious premises. Firstly, it should be noted that this experiment only deals with simple decision situations in which the subject does not have to choose between various complex alternatives. It is therefore doubtful whether the results of experiments conducted in complex decision-making situations would be similar. The distinction between the different types of decision-making situations is important given that many philosophers studying free will believe that only "becomes active" in those situations where the subject must consider conflicting reasons for action. In other words, one of the premises of the above inference "from neuroscience to philosophy", namely that "free will reveals itself in every decision-making situation", turns out to be at least controversial. Moreover, it is assumed in this inference that free will must always manifest itself as *conscious* will. Whilst it is true that most supporters of free will make this assumption, it is not at all obvious. It cannot be ruled out, for example, that some decisions that have become habitual and as such are made unconsciously (although initially – before the habit was formed – were

conscious), may be treated as an expression of our free will. Besides, any case of a correspondence between the brain's "decision" and a conscious decision can be interpreted as follows: the conscious will accepts the brain's "decision", but is no way compelled to accept it – it can stop (or "veto") the brain's decision (the latter interpretation was suggested by Libet himself, who is in favor of treating free will as an exclusively negative ability), or it can also change it. Finally, doubts are raised by the tacit assumption of this inference that the activity of the brain's motor cortex (the so-called "readiness potential") recorded in Libet's experiment by means of EEG measurements has any "causative" power (i.e. that it is a sufficient condition for taking the action detailed by the experiment, i.e. making a finger movement), and not merely its necessary condition. As we can see, whether Libet's experiment actually supports the thesis of the non-existence of free will primarily depends on what specific content is accorded to this concept. This experiment can only be interpreted in this way if one accepts premises such as: "free will manifests itself in every decision-making situation", "free will cannot be unconscious", "that the brain's "decision" cannot precede the decision of the will", "Readiness potential is something akin to the neurobiological equivalent of will, i.e. it possesses driving force." We do not intend to conduct an in-depth analysis of Libet's experiment here; our intention was merely to draw the reader's attention to the problematic nature and complexity of the process of deriving specific philosophical conclusions from results. This reflection applies to most attempts to solve specific philosophical problems by referring to the achievements of neuroscience.

(*Rationality*) Within economics (and more precisely within one of its branches – the theory of rational choice) we understand rationality in a purely instrumental sense. Moreover, the latter is understood very restrictively – as maximizing a utility function. The question arises as to whether economists are right to treat such an understanding of rationality as an explication of its "ordinary"

sense. This seems doubtful. In the traditional image of man, rationality is understood as two different abilities: the ability to formulate reasons and arguments, to react to the reasons and arguments put forward by others, and to act under the influence of reasons and arguments (the rationality of this kind may be termed "'argumentative"); and the ability to choose the right means to achieve one's goals (instrumental rationality). It may be easily discerned that the understanding of rationality which is typical of the theory of rational choice constitutes a double narrowing of the traditional approach. It omits the argumentative aspect while treating instrumental aspect extremely restrictively. Thus we are confronted here with a somewhat deceptive similarity of the concepts used by economics and common thinking (and also, generally speaking, by philosophy).4 Taking the technical conception of rationality (as proposed within the framework of rational choice theory) as a correct explication of its colloquial understanding may have far-reaching consequences. Considering that psychological experiments (including those conducted as part of the cognitive sciences) seem to undermine the thesis that man maximizes his utility function, scientists adopting such an understanding of rationality will be inclined to preach a thesis about human irrationality. However, to repeat, this is unjustified: rationality does not mean only instrumental rationality, and the maximization of the utility function does not have to be an adequate explication of instrumental rationality (I will discuss another aspect of this – whether empirical research actually undermines the thesis that man maximizes their utility function – in the context of Pitfall 2).

[4] We made the reservation of "generally speaking", because in the works of some philosophers fascinated by the theory of rational choice, the concept of rationality (and especially instrumental rationality) has a narrow sense – precisely the maximization of the utility function.

3. Pitfall 2: incorrect reductionism

In his work *Explaining Social Behavior* Jon Elster proposes an intrguing typology of incorrect scientific reductionism, one which encompasses premature, crude and speculative varieties of reductionism. Elster does not provide, however, their precise definitions (cf. 2007, pp. 258-9). Therefore, the definitions presented below are very much my own proposal, although (with the exception of the definition of speculative reduction) consistent with Elster's rather general characteristics. Before we present them, however, let us add that each of these reductions can be either ontological, i.e. those which "eliminate" phenomenon of a "higher order", and thus show that "items of a certain type are limited only to items of another type (...), e.g. that chairs are nothing more than collections of molecules (Searle, 1999, p. 157)", or causal, i.e. they provide a full explanation of a "higher order" causal phenomenon.[5]

Premature reduction occurs when scientists are mistakenly convinced of the possibility that they can replace an explanation from a "higher level" with an explanation from a "lower level" (one more basic, deeper): the theory underlying the reduction, and thus providing an explanation from the "lower level", contrary to what scientists believe, is not sufficiently confirmed, or its concepts are not sufficiently strict enough, or it has not developed a single paradigm which is widely recognized by its representatives. To put it a bit more generally, it can be said that premature reduction consists of explaining a given phenomenon, thus far explained by a certain higher-order theory, by means of another theory, admittedly of "lower order", but either not fully scientific (e.g. not meeting

[5] Without delving into a deeper analysis of the notion of reduction, we would add that ontological reduction (A is nothing more than B) may apply to objects (e.g. genes are DNA molecules) or properties (e.g. gas temperature is the average kinetic energy of the movement of molecules) and that ontological reduction usually leads to definitional (logical) reductions.

the requirement of falsification, at least due to the low level of precision of its conceptual apparatus), or scientific, but poorly confirmed or not yet having a commonly accepted "core" of hypotheses. As an example of premature reduction, Elster supplies the mechanistic physiology of Descartes. More contemporary examples might include the research on human rationality conducted within the framework of cognitive sciences. As we mentioned in the discussion of Pitfall 1, one can often find the assertion that the cognitive sciences undermine the assumption of human rationality (according to rational choice theory) understood as acting in a mathematically modellable way as maximizing utility functions, because they reveal that people do not follow the principle of utility maximization, but act as 'shortcuts', using various heuristics in their decision-making processes (e.g. availability, representativeness, anchor), which exposes them to various biases and illusions (e.g. the error of excessive optimism, self-confidence error, hindsight bias, or the illusion of control). Apart from the fact that rationality is a complex concept that cannot be reduced to the maximizing of utility, it should be noted that the cognitive sciences have developed other models of rationality – ones more optimistic in terms of human rationality (even those which are understood narrowly – such as utility maximization) – than the *Heuristics and biases model* of Daniel Kahneman and Amos Tversky described above. One such model would be that of ecological rationality. It was developed by Gerd Gigerenzer (2007), who reinterpreted various experiments intended to support the thesis of human irrationality (e.g. concerning the processing of probabilistic information), arguing that these experiments were carried out in artificial laboratory conditions and as such cannot be invoked to support this theory. According to Gigerenzer, people are actually very good at rationality tasks, as long as these tasks are carried out in realistic situations (especially those that do not differ significantly in terms of structure from those in which the cognitive abilities of

our ancestors were shaped in the distant past). A "reduction" of the concept of rationality on the basis of the achievements of the cognitive sciences would therefore be premature, because cognitive scientists themselves do not occupy a unified position on human rationality. More generally speaking, the cognitive sciences have not yet developed a unified paradigm, as evidenced not only by the fact that they do not offer a unified theory of rationality, but also they have not proposed a unified theory of mind; instead, several significantly different models of the mind (e.g. computational, connectionist or embodied; cf. Załuski, 2014) have been developed under its auspices. For this reason, any attempts to draw strong and unequivocal conclusions about ourselves from the cognitive sciences would appear to be illegitimate and constitute examples of premature reduction.

We are confronted with the *primitive* form of reduction when, even though the "lower order" theory underlying the reduction is scientific and well confirmed, it does not constitute an adequate explanation of a given phenomenon, because it is – despite some superficial similarities – significantly different from the phenomena that were the original subject of this "lower order" theory. An example of this type of reduction, according to Elster, would be explaining human political behavior by means of a "territorial imperative",[6] whose existence biologists have confirmed in other animals, or using sexual selection as the universal key to unlocking an explanation of human (and especially male) behavior (allegedly only acting to impress and win over the opposite sex). Generally speaking, it seems that the most common examples of primitive

[6] In the 1966 work *The Territorial Imperative*: *A Personal Inquiry Into the Animal Origins of Property and Nations* Robert Ardrey argued that animals have a territorial instinct which is a particular kind of ownership instinct. This thesis is not particularly controversial. However, the ease with which Ardrey generalizes human behaviors on the basis of something originally formulated for animals most certainly does.

reduction are (some) biological explanations of human behavior (e.g., some of the explanations proposed by sociobiologists), as they ignore the motivational complexity of these behaviors. It is particularly discernible, for example, in analyzes of the 'altruistic' behavior of animals and humans; sociobiologists often explain them collectively in terms of 'biological altruism', i.e. certain cooperative dispositions trained by natural selection, ignoring all the psychological complexities of human altruism which make it irreducible to biological or at best only partially reducible (we will return to this topic later when discussing Pitfall 3 – *pars pro toto*).

The third type of incorrect reduction identified by Elster would be *speculative* reduction. Elster defines it narrowly – as the creation of various types of "just so stories" by scientists that are intended to explain how a given behavior *might have arisen* (and therefore what function it can perform), whilst not being accompanied by any attempt to show that they *actually developed in this way*. In light of this definition, the allegation of speculative reductionism again strikes primarily at any attempt to explain the phenomena traditionally studied in humanistic and social disciplines from the grounds of biology. However, this definition should be refined, otherwise it will fall under the definition of premature reductionism and also be generalized. We note that the charge of speculative reduction will have a different weight depending on whether or not the reduction is carried out in a way that is accompanied by a degree of awareness of its speculative nature (whether "just so stories" are treated as only "possible stories") or not ("just so stories" are considered "real stories"). In the first case, this objection is basically unfounded (speculative reduction is not an inappropriate reduction), because the scientist is aware of the speculative nature of his considerations, treating them only as something akin to a thought experiment; Speculative reduction turns out to be an anomalous, *self-conscious*, and thus justifiable, and a sometimes called for (as a way to broaden research horizons, i.e., the

field of possible hypotheses) form of premature reduction. The latter case is, so to speak, a normal (i.e., *unconscious*) form of this type of reduction. Speculative reduction, if it is to be at least a separate type of reduction to some extent, must therefore only include *self-conscious* premature reduction, and it does not seem advisable to limit it only to explanations using "just so stories". According to the definition we propose, it follows that speculative reduction is not an inappropriate reduction, but rather a legitimate scientific practice. Let us note that the difference between a speculative reduction understood in this way and a premature reduction (in the strict sense, i.e. *unconsciously* premature) lies in the researcher's attitude to the reduction they propose: in the first case, they treat it solely as scientific speculation, admittedly bold but with a high degree of being false; in the second, they regard it as a true hypothesis or at least with a high probability of being true. It is therefore difficult, for example, to say in advance whether a researcher who claims that the mind is identical to the brain on the basis of neuroscientific research makes an unauthorized/inappropriate reduction – whether it is premature or primitive[7] – or if they are merely engaging in speculative reduction (to determine this, we would need to know their attitude towards the hypothesis they are proposing.)

[7] We would consider it premature if we defend the thesis that in the present development of neuroscience there are no grounds for proclaiming the thesis that they are identical. We would consider it primitive if we defend the thesis that for some essential reasons (e.g., differences in the ontological character between mind and brain) the thesis of identical nature is necessarily false. Which of these positions is correct is a question that goes beyond the scope of our methodological considerations, and thus beyond the scope of the considerations examined in this text.

4. Pitfall 3: pars pro toto

Let us assume that the reduction carried out by an interdisciplinary researcher (or interdisciplinary research team) is neither premature nor primitive. The scientist who has done so has certainly been successful. However, their enthusiasm for the successful use of the results of discipline *a* in the area of discipline *b* may cause them to overlook the fact that the subject of discipline *b*, although aptly explained in terms of the achievements of discipline *a*, has not been exhaustively explained, i.e. that discipline a clearly showed only one aspect of it (even if it was particularly important). In other words, it may fall into the trap of *pars pro toto* – considering a partial reduction to be complete. Evidently, this type of error can only arise when the subject of discipline *b* is actually more complex than suggested by its approach to discipline *a*. The complexity of the subject of discipline *b*, as well as the limits of the explanatory power of discipline *a*. Yet competence itself is not a sufficient safeguard against such an error: the academic whose original sphere of competence is discipline *b* must also be able to restrain their excessive enthusiasm (if any) towards the new discipline a that they have learned, and this occurs most often during the initial stages of interdisciplinary research. As an example of a *pars pro toto* error, we would offer some of the interpretations of the law which appear in the interdisciplinary research conducted within the trend of *Law and Economics*. Its representatives have undoubtedly made considerable contributions to the study of law (recognized, among others, by the Nobel Prize committee; Ronald H. Coase, on of the founders of this approach was awarded the Nobel Prize in Economics in 1991). Nevertheless, many of them (especially in the early days of the existence of this approach) seemed to assume that the economic approach provided a complete description and explanation of the phenomenon of law. For example, they presupposed that all legal agents act like *homines oeconomici* (egotistically

and in a rational manner, in the sense that they always maximize their expected utility) and that the goal of law is to maximize the social good. This approach did not permit them to see the diverse motivations of different legal agents (for example, those stemming from a desire to follow the rules, those connected to personal autonomy or those of a purely moral nature) and also left out of the scope of their research a whole range of important legal aspects (the role of the conception of justice in its creation, the existence of which they simply denied). However, this mistake is becoming increasingly rare in the research conducted within *Law and Economics*; in their research most of its representatives share and employ the view expressed in the famous article by Guido Calabresi and Douglas Melamed (eminent representatives of this trend) 'Property Rules, Liability Rules, and Inalienability: One View of the Cathedral' that the economic approach provides only one of many possible "cathedral views" as to what is law.

5. Conclusion

It is worth dwelling for a moment on the fact that the double meaning of the word '*One*' in the title of Calabresi and Melamed's article (which can mean both "single/uniformity" and "one of many"/"certain") was used deliberately by the authors. It accurately reflects both their satisfaction with their own achievements, which consisted of providing a *coherent/uniform* view of the cathedral, one grounded in a respectable (economic) theory, and the humility resulting from the awareness that it is only *one of many possible* views. Considering that it is difficult to expect a full reduction in the humanities and social sciences due to the complexity of their subject, the phrase "One View of the Cathedral" can be treated as a methodological directive addressed in particular to representatives of these sciences, and requiring of them uniform/

coherent explanations (guaranteed by some "lower order" theory), but at the same time being aware that the subject of research which this explanation provides is one of many (or at least several) possible. This directive is just as important as the other two – calling for the avoidance of Pitfall 1, and therefore caution whenever engaging in the "translation" of concepts from different disciplines (this caution would manifest itself in the correct selection of premises to create a potential "bridge" between the results of one discipline and the scientific problems studied in the other), and avoiding Pitfall 2, i.e. indulging in premature and/or primitive reduction.

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