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THE ROLE OF PROBABILITY THEORY AND STATISTICS IN METHODOLOGY OF THE EXACT SCIENCES

Abstract. This paper is a continuation of Part 1 of the work, with the same general title and with subtitle "The rudiments".

Majority of contemporary natural scientists manifests the two, extremely diverse attitudes towards scientific inquiry in their domains:

1. **Search for "final theories"**, theses of which constitute science in proper sense of this word. These theses never would be abolished and retracted;
2. **Search for theories useful only throughout certain period of time**, theses of which constitute science only in sense of some undefined "approximate truths". These theses (probably always) would be finely abolished and retracted.

Methodologists of various philosophical schools are striving to support, but in vain, one of these extreme positions and attitudes. Consequently, they are trying either to defend natural sciences from the positions which are already lost (long ago), or they are seeking to depreciate great value of these sciences.

The author is of opinion that these extreme positions are the results of mixing up the so called "physical certitude" with (a) certitude in an absolute sense and with (b) state of partially rational ascertainment (such a state, which happens in case of our ordinary, everyday opinions). More generally, these positions are effects of common errors concerning the role of conceptions related to probability theory.

The author proposes corrections of both extreme attitudes and endeavours to collect, make more precise, harmonize and justify selected views of contemporary founders of natural sciences, as well as their ancient predecessors.

Key words: subjectivity of first sensory data versus "extrasubjectivity" of empirical sciences; ancient conceptions about gaining knowledge by "abstraction"; proper objects of human senses and proper conditions for their proper action; perceptual opinions or "common sense" opinions; temporary contradictions in human cognitions, including "transitory results" of sciences; seemingly unrealistic and unacceptable interpretations in famous Copenhagen school of quantum mechanics.

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PART 2. CERTITUDE IN NATURAL SCIENCES

I. PROBABILITY AND CERTITUDE IN NATURAL SCIENCES

Modern physical theories often utilize ideas related to probability theory. One may even think that such dependence on probability theory discriminates physics from mathematics. This opinion is partially true, but requires precisionin formulating it. We will review this subject, while returning to the original, old conceptions of scientific thinking.

Ancient realists diversified sources of our knowledge about the material World into two large classes of objects:

(1) material things, which in order to exist (in all their parts) should "perfect themselves" by internal and external changes;

(2) figures and numbers which exist in matter, but are given as perfect, not changeable.

Material things were considered as objects of physics, figures and numbers as objects of mathematics.

Aristotle once remarked, "One should not pay attention solely to logical proofs, but rather to the facts of observation", "it is not proper to insist on mathematical certitude in all cases [*of sciences*]" and "this method [*of deduction*] is not proper for natural sciences [i.e. physics]" (see Aristotle (1984): Eudemian Ethics, book 1, 1217a, p.142; Metaphysics, book II, 995a, p.45).

At first glance, Aristotle's statements look like a convenient compromise for a doctrinarian, unable to introduce his ideals (deduction based on "syllogistics") into common practice of his epoch. However it is not so. Aristotle's opinion is reasonable, and might be justified.

Natural sciences concern all material things characterized by their changes. In our sensory experience we perceive these changes only by being subject to constant changes in our sensory organs, from whence the perceptions are initiated. From our perceptions we develop our intellectual knowledge sufficient for physical certitude.

On the other hand, without sensory data, by deduction, we are unable to create any precise copy like descriptions of events in matter. For, as Aristotle has said: "sensory attribute [*as changeable*], outside the limits of sense cognition, becomes unclear; it is not certain then, if this attribute still pertains to the [really *existing*] object". (Aristotle (1984), Topics, book V, 131b, p. 119). Hence, method of deduction for physics may be not sufficient.

In case of the mathematics (at least mathematics in the ancient sense), the first objects are figures and numbers. Such an object as not perfected by changes might be represented in one phantasm (product of internal senses – see sect. 3.2), even in cases when the person does not perceive it anymore by (external) senses.

When an object is imagined only, the person easily can stop changes in his imagination. Then, for some period of time the phantasm refers to at most one "immobile" external object. For some period of time the phantasm is a precise copy like this object. This period of time might be sufficient (but not necessary) for developing a correct judgment about the object. Therefore, by "analysis of such phantasm" one is able to achieve analytical certitude in this case. The same might be said about further objects of mathematics, defined by figures and numbers.

Ancient realists rightly concluded: since mathematics has a different subject matter than physics, it (probably) also has a different method of its development. Hence, they described separately both types of sciences.

Aristotle's views were based on observations, that man (alike other species of our World) is well adapted to his environment and can predict many events correctly in the majority of cases. Probably by analysis of such adaptations Aristotle discovered induction, a method appropriate for physics.

In antiquity, deduction as a general method appropriate for mathematics was probably discovered also in a similar way. Old mathematicians only guessed their general assumptions in geometry which seemed to be truths (and indeed the simplest truths) about figures and numbers. With the exception of the famous 5th postulate, they considered Euclid's assumptions as analytical principles for figures and numbers, being only "practically" (so "physically") certain.

Today we know that Euclidean geometry is probably not the best system describing real figures in really existing matter and its assumptions (at least some of them) are only "accidental". Even if old mathematicians were wrong at their point of departure, they developed first deductive systems which (after reinterpretation) actually are examples of perfect analytic knowledge. In the old interpretation, Euclidean geometry should be considered as imitating analytic knowledge by a system of reasonable opinions or (as claimed many modern geometers) as a system of some physical knowledge.

Until now we have many discussions concerning the old problem: whether or not in the natural sciences, one should still insist on achieving "(physical) certitude" instead of only achieving "high probability". Many extreme skeptics and extreme dogmatists argue on this subject. Until now their indirect discussions are not ended. Such a peculiar situation occurs, because the antagonists simultaneously attack and defend not the same but different "positions".

Let us review a few opinions in order to find "the golden mean" which will be preferable among realists.

Simplicius (c. 530 A.D.) in his "physics" insisted: "Plato rightly considered "physics" as a science concluding on the basis of probability", suggesting that the famous Aristotle shared their opinion. Moreover, Aristotle himself in his writings admitted: “necessity in mathematics is **almost** of the same kind [*but not exactly of the same kind(!)*] as necessity in natural processes [*described in “physics*]” (Aristotle (1984), Physics, book II, 200a, p. 62).

On the other hand, St. Augustine, who was under the influence of Plato (and Plotinus), has warned his contemporaries, that one could not know probability (in the Polish language “prawdo-podobieństwo” i.e.“similarity-to-truth”), not knowing some truth (see St. Augustine (1951), pp.88, 96 and pp. 99, 139). So, according to St. Augustine’s views, physics should not be reduced to “probable” statements, without assuming analytically certain knowledge.

A very critical view about the role of certitude in physics is expressed by R. Feynman in his public lecture in 1955: “Scientific knowledge is a body of statements of varying degrees of certainty – some most unsure, some nearly sure, but none absolutely certain”. Similar opinions are often popular in university communities.

A leading statistician of our times C.R. Rao added the argument: “Statistical predictions may be faulty, but one may gain more relying on the value of statistical predictions, than falling in dependence on guessing and superstitious convictions” (Rao (1997), p.65).

A very well known probabilist and mathematician É. Borel apparently was even more revolutionary in his views. He proposed to call physical events which appear with sufficiently high probability “**certain”**, even if they are not certain in the ordinary sense of the word, as used commonly in mathematics (see Borel (1963)).

Many defenders of certitude, which occurs both in our everyday life and in the natural sciences, have already forgotten that “certitude” in physics should play only analogical, but not strictly the same role as certitude in mathematics. Some of the defenders of certitude in order to defend obviously lost positions, started to avoid any direct confrontation with the skeptics. One of the means of their “defense“ was the claim that physicists simply “speak another language”.

If literally taken, the extreme opinion of Borel is similar to a very well known temptation from our ordinary life: “Nothing is certain.”, “So, we are not certain generally that ‘we are more certain now than before in any special cases’.”, “Being not certain, why do we struggle to achieve something which might be impossible.”. Borel has not expressed such simplistic views, but proposed to confuse “certainty” with “uncertainty” in some cases, and the result would be the same. A “super-critical” person could resign in this way from any mathematical (or even - scientific) description of the World.

However, one may also understand Borel`s opinion, as equivalent to the conclusion, that **in natural sciences, another kind of certitude** (than in mathematics) **is required**. **This certitude is often achieved when the probability of hypothesis is sufficiently high**. Therefore, in fact, one might be in agreement with reality, calling a probable hypothesis “physically certain”. Assuming such an interpretation, Feynman might rightly maintain that in the natural sciences nothing is certain in the sense of “absolute certitude”, as required in mathematics.

No one is ever able to prove that our physical instruments always work correctly. If a car from a closed garage has some slight chance to escape (an example given by the famous physicist G.Gamov), then also electrons in an electron microscope may behave differently as well, therefore giving us false information. For instance they can show some event that never happened. And the same could be said about our senses applied to perceived distant objects, because between our senses and distant objects, always may happen something unusual (unnoticed by the observer).

The above statement does not mean that in our everyday life on Earth our senses and instruments give us a false picture of things in the “majority of cases”. Still, we do not have “mathematical” certitude during sensory observations and in sciences developed by means of such observations.

On the other hand, we may still maintain that our senses work correctly (i.e. according to their “purpose”), but not of necessity, and that by receiving from them sensory data we are “physically certain”. We might utilize modern instruments and appropriate theorems known from statistics, in order to obtain from our senses more precise and reliable information about objects which are not directly perceived.

There we could have a paradox. For instance, a man may generally maintain being certain that “in the majority of cases” he correctly evaluates the distance to an object, e.g. that it is 2-3 meters away. Nevertheless (by his natural faculties, without miracles) he is unable to achieve analytical certitude in any given case of such evaluations.

The described paradox is probably related to famous paradoxes discovered by Gödel in modern logic. For some classes of deductive systems we can (ineffectively) prove, that they always have general sentences which are true and provable in their general form, obviously also true in every particular case, but not which are not provable in any of these cases.

So called induction helps us to obtain general convictions with physical certitude sometimes, from some examined particular cases. The general statement (if not true), might be replaced by another conviction also “physically certain”. After many changes we usually achieve truth in some areas, but we do not know analytically that it is really the truth and our final conviction. We do not have any method for achieving analytical certitude in such cases, but (finally) at some moment we reach the truth, not knowing about this fact.

It is important to realize, that in the evolution of physics, we do not replace one truth by another (which invalidates the previous one). But we replace one of our convictions by another. And from this process we see only that our previous conviction was probably false, while we were physically (perfectly) certain. The truth is an objective relation to reality, not dependent on our development and on the present state of physics. Our physical certitude has an "objective purpose" – it leads us to (finally accessible) relation of the truth.

Since the process of reducing to principles is best described in logic, after the discovery of the first perfectly formalized systems, many admirers of their simplicity expected that after proper formalization all difficulties in the sciences automatically disappear. Hence, they attempted in many sciences to substitute a play with symbolizations in place of the usual difficult research.

This naive approach to sciences failed even in the case of more advanced mathematics and logic. However, formalists` "ideology" is still "alive" in some modern thinkers. They make many efforts to embody the process of induction in empirical sciences (sometimes called "incomplete" induction) into a frame of simple deduction, known from logic. Obviously, their efforts failed.

Against such fruitless works, the very well known founder of mathematical logic, J. Łukasiewicz has remarked: "Advocates of incomplete induction refer ... to mathematical theory of probability. However in a great number of problems discussed in natural sciences ... we do not have any opportunity to obtain mathematical probability at all. ... We are of the opinion, that so-called **inductive reasoning, is not any reasoning at all, in such a sense, that it allows to admit** [*as analytically certain*] **one sentence on a basis of another asserted sentence**. .... Up to the present time, there is no scientific justification of this [*inductive*] reasoning [*as such fictitious method*]." (Łukasiewicz (1929), pp. 191–197).

Enunciations of C.R. Rao and some other excellent scientists seem to suggest that finally we do have exact sciences in a completely new sense, with no certain results, nevertheless very useful for society. Also, they seem to suggest that the exact sciences in the old sense, will finally disappear.

However, these enunciations are not as revolutionary as they appear. According to the ancient realists, **every science** (for reason of its certitude and so-called "intersubjectivity") **concerns solely "general objects"** (and not any material individuals)**. However the general theses of these sciences are often applied to the various individual cases. Such applications are not of necessity certain**.

Our applications of sciences require judgments about material individual objects given by sensory observations. If they are not about our own direct impressions and perceptions, or about the direct objects of such impressions and perceptions, they cannot be analytically certain. For instance, such is the case when a mathematician applies the general Pythagoras` theorem to a triangle, given by concrete trees on a field.

It is rather a truism, that statistical investigations of any objects in our society or in Nature are constantly supported by mathematical general statements and that the number of such useful general statements still increases. It is very likely that we are unable to completely resign from creative research in mathematics. Whatever we could say about mathematicians, they still discover entirely new theorems useful for applications.

Theorems in mathematics never describe only one concrete material unit (e.g. figure or number). And if a mathematician says something about “concrete number”, he actually is more interested in it as a “species”. For instance, he is not concerned with properties of “fifty horses” (where “fifty horses” is concrete number in the ancient sense), but he remarks on properties of the number fifty generally (or in “abstraction”).

The above opinion (which is following Aristotle’s thoughts) may be rejected on a bases of the way modern mathematicians construct their objects. It is not important for some of them (especially for “formalists’), which particular “materials” are used for constructions. They can start even from the objects of physics. Such was the interpretation of natural numbers given by the famous R. Dedekind, who defined number one as himself (!).

Such interpretations as above may prove logical features of formal systems (e.g. their consistency), but are not unique interpretations useful for this purpose. Dedekind soon utilized the empty set in the same role, and this empty set is rather a “species” than material unit.

We still use our terminology also in the old realistic sense (e.g. speaking about fifty horses). And this (our practical use and not the “abstract” interpretation appearing in logic) justifies the specific methodology of mathematics.

Nothing prevents us to have, besides statistics as a mathematical science, one or many empirical sciences of the same name. **We may also have a few other “sciences” in a broad sense, allowing reasonable opinions instead of mathematical theorems. The same applies to other exact sciences.**

In every exact science, there is a place for introductory works, where the results are not certain. For instance, there were discovered simple and fast algorithms that determine for any $p < 1$, whether or not a natural number in the interval $\langle 1;a \rangle$ is prime with probability p. Hence, introduction of a few closely related meanings of the same term (e.g. “statistics” or “geometry” in many senses) does not really change anything. **Under one condition, namely: that one is really conscious in what sense the research is conducted and should be finished**.

We may easily agree with the following statements of modern realists: “a scientist ... has to remember, if he concludes about something from a hypothesis [*including not proved opinion*], that he ceases to be [*at this* *moment*] a scientific investigator [*in the strict sense*]" and "hypothesis remains only and exclusively an auxiliary means for easier arrangement [*of statements*] or sometimes for a discovery of some laws" (see Krąpiec (1959) p.105).

Summarizing, **various exact sciences and even sciences in a modern broad sense, do not exclude each other (even in rare cases of contradictory results (!)) and do not disturb each other as** kinds of relations in human habits**. Their representatives might cooperate in some sense and make their investigations easier.**

At one time, the statistical theory of gases and temperature was a great achievement in the old physics. Strictly speaking, it is a theory of some mathematical objects called "ideal gases" and imitating behavior of some real gases. Therefore, it had two kinds of conclusions – about ideal and real gases. Only the first (about ideal gases) were mathematically and analytically certain. This theory however, in its concrete applications leads to statements about (really) existing material objects, which are only probable in their existence; sometimes these statements are false. But this unequivocally does not change the veracity of original general statements.

As we know, the statistical theory of gases finally led to modern quantum theory. Then, forgotten ideas of the old philosophers have been finally rediscovered.

N. Wiener (founder of cybernetics) while commenting on the introduction of modern probability conceptions into physics, expressed the following opinion. He stated that as a result of this "break through" (introduction of modern probability conceptions into physics), **physics ceased to lay claims to be concerned only with that which happens for sure**. I**t is rather concerned with what happens with an enormously great probability** (see Wiener (1988), p.12).

On the other hand N. Wiener continued: "the major change consists in this that **we ceased to be busy** [*only*] **with quantities of the unique real** [*material*] **World, but we started to ask the questions, for which one could find answers** [*only*] **in a great number of similar** [*possible*] **"Worlds"** (see Wiener (1988), p.12).

An almost identical opinion about mathematics, was expressed by the distinguished contemporary thinker G. Klaus: "**Mathematics is not a science about real** [*i.e. existing at this very moment*] **mathematical structures of being, but it is about** [*actually*] **possible structures".**

The last two statements are reinforcements of the old opinions, common in the school of Aristotle, that **objects of mathematics** (and the more so, objects of physics) **do not exist** (in the realistic sense) all at once, but they may be constructed and destroyed in a realistic sense.

II. REMARKS ABOUT THE OLD AND THE MODERN PHYSICS

2.1. Initial difficulties with accumulated facts

In the XIII century Averroists (e.g. Boethius of Dacia) commented on discrepancies between opinions concerning the notions of certainty and truth in the old sciences. Averroists implicitly assumed that physical certitude guaranties the truth of a statement. From this false assumption, they automatically obtained their false conclusions that: (1) sometimes truths are contradictory and (2) truths (not convictions (!)) of physics and religion contradict each other. Today we may easily answer that at least one of the contradictory "truths" never was true, but unclear ideas of Averroists were popularized and even today many educated persons are perplexed at this point.

Nevertheless, Averroists contributed a few ideas worth noticing here. For instance, they maintained that **a physicist should consider the World not only in its real duration which has a beginning in time, but also in its possible duration [*which does not have such a beginning*].** Also, that a physicist [*as a physicist*] should not investigate the very moment of creation of our World [*having no conceptual means for such a research(!)*] (see Boethius of Dacia (2006), On the Eternity of the World 365, p.77).

Obviously our strong conviction about final correctness and permanency of our scientific cognition in the natural sciences, in the last centuries has been shaken up for other reasons than past discussions between theologians, such as Averroists, St. Thomas or Duns Scotus.

From antiquity until the present time, people gradually discovered that our senses (as well as many other real material things) are far from perfect in their actions. The so-called, proper objects of our senses, originally, have been considered as kinds of qualities in the perceived bodies, qualities corresponding to the impressions in the acting senses. On the other hand, very often, these proper objects were described as substances in a spatial medium rather than qualities, for instance: objects of smell – as chemical substances diffused in the air or water and objects of hearing – as waves of higher density propagated through medium. Whereas, proper objects of sight were still described as colors – qualities in the distant enlightened bodies.

The apparent difficulties in the classical descriptions of our sensory experience and of the proper objects of our senses stimulated discussions about infallibility of our senses and reliability of our empirical knowledge. Some realists tried to give simple answers at once: "original data of our sensory consciousness are never invalidated and never stated more precisely by the language of contemporary [*exact*] science; but they are [*only*] interpreted in mathematical language" (see Krąpiec (1959), p.66). We will not assume here such positions, which seem to be "partially not true" and "simplistic", but we will postpone our better formulations to the time of further studies.

Quite unexpectedly, modern discoveries in physics enlightened many of the old problems, and contributed new materials for epistemology and methodology. Obviously, we should analyze them and utilize in our elaborations.

Firstly, we are now accustomed with the idea that all material objects (even large material bodies and sounds or light) have the double nature of being a particle and a wave. Therefore, the difference between objects of smell and hearing or smell and vision is not as great as it appears.

Secondly, we already know very well that light is not spread immediately and that light while traveling in "empty" space is often disturbed (or even exchanged between particles). Also, we know that light is a great assembly of photons or "something else" in an "empty" space and that the "empty" space is full of appearing and disappearing "virtual" particles (appearing only for a very short period of time).

Hence, because of this knowledge some corrections in the description of sense experience were necessary, including slight changes in terminology. For instance, one should decide whether or not the proper object of sight is the color of a distant body, the color of some distant light, the color of photons absorbed in the eyes, or the color at the same time in all of them.

Even if the traditional description of the object of senses needs corrections, one still may maintain what seems to be a very proper formulation of the old realists` views. Let us repeat this once again: "**every [external or internal] sense, acting under conditions normal for this sense, is in its action basically infallible** [*i.e. at least in the majority of cases*]**, with respect to its proper object** (see Krąpiec (1959), p. 344 and the following pages).

2.2. A glance over contemporary dificulties

As it is already perfectly known, so-called complementary quantities cannot be measured together accurately. Such are, for a given particle (in pairs: quantities of position and momentum, and quantities of time and energy). The exact measurement of one quantity, excludes the exact measurement of the other. Such a fact suggests that these are not real quantities at all and they appear only for a moment of measurement.

An often discussed paradox "EPR" was premeditated by Einstein, Podolsky and Rosen, and originally (in 1935) given as evidence against quantum theory. They assumed a situation when complementary quantities of one pair are at the same time measured separately on two identical particles. At first they assumed that these measurements of both quantities are accurate. Unfortunately the experiments of A. Aspect (in 1982) show that even these measurements (on separate particles) disturb each other. Hence, many participants in the discussions started to think that both particles involved in the experiment, with the speed higher than light “know” what the other is doing.

To avoid such paradoxes, statistical (classical) interpretations of quantum mechanics were created (see for example: Ballentine (1970) and Blokhincev (1968)). Their idea was that we do not have any separately given particles, but only some assemblies. Therefore, the measured quantities are applicable (strictly speaking) to any individuals.

However, it was proven, that even one photon behaves like a wave. And that these statistical theories are unable to explain a very mysterious dualism between waves and particles. So, the interpretations failed.

In the Copenhagen School of Physics, when and where the quantum theory has been initiated, it has been stressed that experimental knowledge alone about particles cannot describe both components from the complementary pairs. The School, however, never excluded some objective characterizations, not known by any humans.

It was often emphasized: “not actual processes, but just the possibility of them – potency [*in the Aristotelian language*] ... is subjected to the exact laws of Nature”, "Such an argument [*that in the time interval between two observations, an electron had to be located somewhere*] would be meaningful in the classical physics; “imaginary” presentations, which are useful for our experimental common knowledge, are valid only for a very limited range of experiments”, “if one descends to the level of atoms, then there is no...objective World in space and time [*described by physics, without any concepts of probability*]” (Heisenberg (1971), pp. 35, 30, 34, 110).

In order to avoid such subjective consequences (as they seem to be), a more “realistic” hypothesis of “hidden parameters” was invented (see Bohm (1983)). According to this hypothesis (if we understand his idea correctly), in the language of physics: there is possible the exact description of one kind of objects of our experience (including complementary quantities), by our conceptions about deeper structures, etc., to infinity. This interpretation also failed.

However, one may still maintain the “golden mean opinion” (never taken under consideration). The eminent physicists of the Copenhagen School are perfectly right if they consider solely our experimental knowledge. At the same time one may search for a “philosophical – (not purely experimental language)” in which we could mathematically (“ineffectively”) prove existence of models for our material World, without any opportunity to determine the “parameters” of the models. Such types of models might perfectly satisfy our need for objectivity in realistic philosophy.

The Copenhagen interpretation of quantum theory has been criticized for its anti- realistic conclusions (only probabilities everywhere; lack of determinism), by Einstein and admirers of his great theories, among them – excellent contemporary scientists. However, one might easily note, that similar (seemingly) anti-realistic conclusions may be obtained (and sometimes it really happened) also on the grounds of relativity theories of Einstein.

Certainly, the constant speed of light in the void, as a result of observation, was sheer nonsense for some traditionally "realistic" scientists. But Einstein has taken this fact as an assumption. Even now, present descriptions of the void contain details that could be rightly suspected as "nonrealistic", for instance that some objects in the void could have negative energy. Nevertheless, very few physicists are of opinion that for such reasons, theories should be rejected.

Some conclusions of the Copenhagen School, such as lack of real orbits inside the atoms, do not seem nonrealistic at all. Nonrealistic were planetary models of the atom. Our strong desire to have visual explanations, shaded the undesirable conclusion that electrons in such an atom should fall onto its nucleus. Physicists abandoned the idea of the orbits (allowing trajectories for free movement of electrons outside of atoms), when they noticed that with this "there is automatically eliminated ... the contradiction related to the problem of instantaneous jumps of an electron from one orbit to another" (see Miakishev (1976) p. 46).

III. SUPPLEMENTARY INFORMATION ON REALISTIC EPISTEMOLOGY**

3.1. Information about analytic principles

According to the Aristotelians every faculty may have at most one act (like a "form") at a given moment (including the passive intellect of a man). However some of the faculties at a given moment, may also have several "partial acts" – habits. Some of these habits may be completely permanent, some others – temporary and removable.

Aristotelians were of the opinion that our analytic general principles, especially the general law of not contradiction, **are "always" present (as habits) in any human intellect**. However, there were slight differences among them, in understanding of the word "always" in this traditional formula. These

** For the first reading, this section might be omitted. It is useful for further, more thorough studies.

slight differences caused further differences in the old tradition, regarding the important subject of principles.

One may find the literal interpretation of the word “always” in a paper of S. Wierzchoński (c.1590–1642). He claimed that at least some analytic principles are really present in human intellect from the very beginning of its existence and they are “inborn”. He provided a clear reason for this interpretation, arguing that **we really need inborn habits of analytic principles**, **because human intellect** (without habits) **is equally open to assert any [analytic] statement and its negation**. Further, the only reason for final determination of human intellect to one side [*by action of its active “part”– intellectual light*], is its enforcement by the aforementioned habits (see Wierzchoński (1979), p. 358).

Following the lines of such an interpretation, one could face a difficult problem: if we are in possession of such habits, then why do we do not express them in act for a long period of time, and why are we unable to do so. After all, Aristotle himself characterized habits as allowing us to perform action in an easy manner and with pleasure.

One could answer, that such a delay appears, because we are unable to immediately develop phantasms necessary for performing intellectual operations. Nevertheless, such a kind of explanations is not fully satisfactory. The more so, the argument of Wierzchoński is invalid, because the intellect is determined to perform its actions not only by itself, but also by the presence of sensory perceptions, which vary.

We will, and should follow the more common (not literal) interpretation i.e. the views expressed by St. Thomas.

According to this not literal interpretation **some of the habits of analytic principles are caused by the intellectual “light” (i.e. “active intellect”) usually after a period of time. This happens when the intellect has developed its direct (simple) concepts of material things and (sometimes) has formed some other concepts, among them “constructive concepts”, such as sentences.**

Human intellect is really a “tabula rasa” (“blank table”), at its beginning (with the exceptions of additional infused knowledge, cases discussed mainly in theology). All natural knowledge of human intellect is developed from sensory experience, including “analytic” principles. However, (according to St. Thomas) there is a passive potency in human intellect to receive some “infused” concepts (directly from God, just after “biological” death).

Every habit of a concept in human intellect (in the range of human natural knowledge), **begins its existence while this concept is in act** and not before, because it is caused with the help of this very concept.

Obviously it is possible to express a contradictory statement: “{[(This is not warm) and (This is warm)]}.” in our sounds, but if we understand what

we are really saying, we are unable to have any analytic certitude in such a case.

No one is ever able to lose his habits of analytic principles, acquired during his life. The reason for this is as follows. In a person`s intellect, any contrary statement in act to any of analytic principle can not be as analytically certain. **Any habit in a subject might be destroyed (internally) only by its "contrary" in act**. However other analytic convictions than principles may be lost. They (as habits) may be (wholly or partially) lost, when by emotions (or for other reasons) we form in act contrary convictions to some of them (see for example St. Thomas (1996), Q. 53, art.1),

One may not be able to use (or to properly use) his own habits, both of intellect and will. In such cases, habits are still preserved internally, but they **are useless at a given moment.** Such situations happen if one does not hold phantasms under control by intellect and will, for instance: when one has fallen asleep, one is drunk, one is in great pain or one is permanently mentally ill, etc. **The reason is that at the present life a man may properly use habits in act, only by means of appropriate phantasms**, **being kind of "mirrors" in which man's intellect "sees" material objects**.

According to St. Thomas, **natural knowledge acquired by a man during his life, is not entirely useless to him even after his death (whether he was an atheist or not)**, but we will not discuss this subject here.

The opinion of S.Wierzchoński mentioned at the beginning, could help one to understand the famous "preconditions of experience" propagated by the Copenhagen School of Physics. Those "preconditions" (mainly general properties of time and space) were described as inborn principles, specific for physics. This idea would be in agreement with classical realism, and should not be automatically rejected as "ideology". However, the purely "empirico-rationalistic" approach of the main stream of Aristotelian realism (after necessary corrections in its conceptual structures) seems to be more in conformity with the other views of modern physicists.

In accord with the Copenhagen School, "preconditions of experience" could be interpreted as some acquired analytic, general statements about matter, necessary for an exact description of any experience. Such a knowledge might be obtained from advanced metaphysics of material objects called "philosophy of Nature".

There is a reason for constant returns (throughout the centuries) of the old conception that our knowledge is inborn. This reason may be summarized as follows.

Even if our whole knowledge is derived with the help of our senses, **our judgments depend on our sensory cognition and this cognition** (in turn) **partially depends on inborn, not intellectual habits.** We could mention here the inborn organic habits, as well as the inborn habits of our sensory evaluations, called instincts**.** We easily observe them in various animals, which in some cases are well adapted to their environments, without at first learning. For instance: just hatched turtles instinctively head towards water. **Human infant children have some instincts, whose actions may almost disappear in time**, for instance a babe is sucking the breast of its mother (or even its own thumb); in rare cases also adults may react almost fully instinctively, for instance a drowning man instinctively clutches at a plank. Instincts influence us, especially at our first steps for acquiring knowledge.

3.2. Classical conception of abstraction and moderate views on "common sense" convictions

Aristotle described four so-called **"internal senses"**, gathering information from our external senses and transforming it in a concrete – material way, and (according to his followers) **located in our brain and our nervous system**. These are:

(1) **"common sense"** (or "integrating sense"), responsible for acts of perception on the basis of data present to many external senses;

(2) **imagination**, responsible for acts imitating perceptions, even at the time when external senses are not active (it retains "traces" of perceptions (!));

(3) **estimative sense,** responsible for sensory judgment with the help of instincts (e.g. that this concrete object is [concretely, not in a general sense] harmful, past, etc.).

(4) **memory,** responsible for "automatic" recollections (it retains "traces" of sensory judgments (!)).

Sometimes, all these four internal senses taken together are called "imagination" and their effects are called "phantasms".

Until now, we do not have enough experimental data from biology, required to explain in detail how "internal senses" act and where their organs are located. Therefore this subject is not completely elaborated by realists yet, and even simple questions are left unanswered. For instance, it is not sufficiently clear, what the "proper objects of internal senses" are. Nor is it clear which sensory judgments about external objects are "infallible".

According to the old realists, these four faculties together with our intellect create what we today call our **thinking**, which is obviously initiated from the data of our external senses. We are unable to notice their actions as completely separate, because these four senses with intellect really need each other.

In our present life, every concept being in act in our intellect **needs a phantasm located in our brain. This phantasm is a "part" of an object**

understood by means of this concept. The phantasm is a representation of the whole object which exists at the very moment, present in us in our brain.

These classical views of Aristotelians were completely misunderstood by many modern thinkers. Since the whole realistic epistemology and methodology is founded on these classical views, they require a few words of elaboration.

When somebody has a concept, it is a quality in his intellect and at the same time it has a natural relation to its designates (called its designation). By this concept in act, the man usually understands not only its designates, but also some phantasm, which is in "act" in his internal senses. However by "reflection" he can have a new "reflective" concept which designates his phantasm.

An analogous occurrence happens when we observe a distant object indirectly in the mirror of a car. Our attention is at first usually focused on this object. So, our perception "naturally" designates this object; but still our perception (as a quality) is a sensory knowledge of both: the distant object and something in the mirror. Next, in a new act we can focus our attention on the mirror, seeing some qualities in it, instead of qualities of the original object. Hence, our new perception will "naturally" designate something else in this mirror and not the previously observed object.

This analogy has been evident even for uneducated ordinary people about 2000 years ago: "For now [*i.e. in our present life*] we know imperfectly ...**For now we [*intellectually*] see [*i.e. we understand*] as in a mirror**..." (see New Testament, St. Paul, I Letter to the Corinthians, XIII, 9).

Our first concepts are not "constructed" (as is of necessity constructed any "empty (contradictory)" concept) and they must have an actually existing object, present in us (by this concept), during cognition. **Since our concepts of the external objects** (at least some of them) **are not inborn in us, they should be developed by us with the help of these objects**. **This can take place only when some of these objects act on the sensory organs of our body, causing physical changes in them**.

According to Aristotelians the aforementioned processes have many stages (as happens in many other real processes too). From the changes indicated above, arise: (1) "**impressions" of our senses** and (2) the acts of our senses called **"sensations"**. Then, after some changes in nerves and brain arise: (3) a **"percept"** of external objects and finally (4) the other **"phantasms"** in our internal senses. In the phantasms (when they are in act) the external object of our senses is already present in us "intentionally" but yet it is still not present in our intellect. Then we have another process called **"abstraction"**.

Abstraction starts when our "intellectual light" (so-called "active intellect") changes our phantasm into an improved form called (5) **"enlightened phantasm"**. By means of this "enlightened phantasm" our "intellectual light" causes (6) an **"impressed form"** in our passive intellect. (Note that one is not aware of these impressed forms (!)). From such "impressed forms" which are already present in our intellect arises an **(7) an "expressed form"** called a simple **"concept"** of the outside object**.**

Since our "natural" intellectual knowledge appears in us and is developed with the help of our senses, in order to plainly understand the status of our first convictions, we must pay attention and analyze how human and animals` senses work.

We do not go here to many details. We only note that animals work partially guided by their instincts and they constantly correct their sensory observations in case of apparently wrong evaluations. Human beings also act in this way gaining their sensory information from both: external and internal senses.

An animal's sensory observations (including a human's sensory observations) of not very distant objects are usually sufficiently correct for everyday life. However, the animal's senses are not exact in all details, because they are unable to perceive both: unexpected changes between them and distant objects, and even some small unexpected changes in their bodies. If some noticeable (for them) but small unconformities with reality happen, animals instantly correct their behavior struggling for survival or better life. In this way, under new "normal conditions" their internal senses again develop an almost correct "sensory knowledge". A human being is not an exception in case of his "sensory knowledge", although humans can use many instruments (like glasses), and analyze or correct actions of senses and instruments by means of their intellects.

Some of human convictions about the distant bodies seem to be caused by internal senses only; so one may describe them as "common sense" convictions. However, even in this situation a man (often) accepts the "normal" process of obtaining probable information from senses. It is usually done by an act of will and then constantly by habitual intention of the will. Such **"common sense" convictions (**in comparison with analytic convictions) might be called **"**reasonable opinions" only. One might also call them "**perceptual convictions".**

One can also guess reality without taking sensory data under consideration. This might be useful for fast decisions or in cases when for different reasons one persists in his opinions (including various prejudices and superstitions). Strictly speaking such convictions are not common sense convictions. Against glorifications of false "common sense" convictions A. Einstein struggled, saying "<the common sense [*convictions*]> is this layer of prejudices which we accumulate [*mostly*] before the 16th year of our life".

The above described **"perceptual convictions"**, however, are practically necessary assumptions for our "physical" knowledge.

There still remains an open question: can any analytic knowledge about the nature of our body (and the natures of material objects acting directly on our body) be obtained in metaphysics from our **introspections**. Probably, after necessary changes, even such extreme conceptions as Descartes` might be utilized and should be utilized in future sciences.

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ROLA RACHUNKU PRAWDOPODOBIEŃSTWA I STATYSTYKI W METODOLOGII NAUK ŚCISŁYCH. Część 1

Niniejszy artykuł stanowi kontynuację części 1 pracy o tym samym tytule ogólnym, zatytułowanej szczegółowo: „Ustalenia podstawowe” (po angielsku - “The rudiments”).

Większość współczesnych przyrodników cechują dwie, krańcowo różne postawy:

1. **Poszukiwanie „teorii ostatecznych”**, których tezy dopiero stanowiłyby naukę we właściwym sensie i których tezy nigdy nie mogłyby już być obalane i odwoływane;

2. **Poszukiwanie teorii tylko na pewien czas pożytecznych**, których tezy stanowiłyby naukę tylko w sensie zbioru jakichś bliżej nieokreślonych, „przybliżonych prawd” i których tezy (być może zawsze) byłyby obalane i odwoływane.

Metodolodzy z rozmaitych szkół filozoficznych i ich odcieni, bezskutecznie starają się wesprzeć jedną z tych krańcowych postaw, w konsekwencji zaś – obronić nauki przyrodnicze z pozycji zwykle dawno już przegranych, bądź też – deprecjonować wartość tych nauk.

Autor pracy sądzi, że owe skrajne postawy i związany z nimi zamęt spowodowany został pomieszaniem koncepcji tzw. pewności fizycznej (a więc – pewności w sensie relatywnym) z (a) pewnością w sensie absolutnym oraz ze (b) stanem częściowo racjonalnego upewnienia się (takim, jaki występuje przy wydawaniu zwykłych opinii). Ogólniej, – że został on spowodowany błędami, co do roli koncepcji związanych z rachunkiem prawdopodobieństwa.

Autor pracy proponuje korekcję obu skrajnych postaw oraz stara się zestawić, doprecyzować, zharmonizować i usprawiedliwić wybrane poglądy współczesnych twórców nauk przyrodniczych i starożytnych początkodawców tychże nauk.