

Medical Skill. Understanding, practicing and teaching medical reasoning

"The order and connection of ideas are the same as the order and connection of things."

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(ETHICS PART II, PROPOSITION 7)

BACKGROUND

In recent years, Argentina, within a worldwide context in crisis, has hardly tried to keep its health care system, albeit unsuccessfully. Within this, the system of postgraduate education, whose best example are medical residencies, after a gradual deterioration is also entering in crisis.

This situation arose at a meeting of the Congress of CONAREC (Argentine Council of Residencies of Cardiology), where were discussed the current conjunctural situations in many residencies, with a detailed national survey data and thoughtful and reasonable comments.

As we all know, physicians recently graduated from medical colleges have the latest information on basic science, physiology, pathophysiology, pathologic anatomy and pharmacology, but no experience with patients, so they need some time in medical residency, where they will take medical decisions with the support of trained staff of physicians and, they will be able to gain experience with real patients and cognitive skills to develop a rational and critical thought that allows them to maintain and enhance their clinical skills after initial training period.

In addition to participating actively in the forthcoming decisions at this juncture, we should deepen and discuss what we mean by acquiring skills and clinical skills, how we define and grasp the object of our activity, which is the disease, from the philosophical history, so far from our activity but essential if we want to know the fundamentals of our business, from the current neuroscience and cognitive psychology, to recognize how is our universal model of diagnostic reasoning. How these things are related to discussing the current situation, I will try to make a trip of amateur concerned with these issues.

REFLEXIVE PRACTICE FOR THE ACQUISITION AND MAINTENANCE OF SKILLS

Nobody becomes an outstanding professional without experience, but in turn to have an extensive experience does not guarantee that someone will invariably become an expert, or a lesser degree, some develop faster than others and, moreover, continue to improve over their professional life.

The most common explanation is that the achievement is limited by innate factors, which as Sir

Francis Galton said in the nineteenth century in his pioneering book (*Hereditary Genius*), "The maximum performance becomes a rigidly fixed amount." He presented evidence that height and corporal size were determined genetically, as the mechanisms of mental capacity: "Now, if this is the case with stature, then it will be also true with respect to any other physical characteristic, -such as the head circumference, brain size, the weight of the gray matter, the number of fibers in the brain, so on.-; and there after, a step above which no physiologist will hesitate, as regards *mental capacity*." (1)

However, times of the first marathon runners of Olympic gold medals are actually got by *amateur* runners that start the annual marathon of Buenos Aires city, in a similar way, many Olympic swimmers of the early twentieth century could not qualify for the group of current swimming clubs. In these domains, improved methods of training were the main responsible for the improvement in yields.

When the novice (who may be a medical student) begins to understand an activity, he efforts and concentrates on not making mistakes, with increasing experience, -in the middle phase of learning-, the gross errors are being increasingly more rare, the performance seems more fluid without a concentration so intense. After a period of training and variable experience, an acceptable standard of skill is achieved, automated and effortless.

For most recreational activities, -driving, playing tennis or golf-, they need a standard skill, this is accomplished in less than 50 hours, while to practice medicine independently it is reached over 10 years of schooling and training from adolescence to become a concertist, chess grandmaster or highly competitive athlete, in 10 to 20 years from childhood.

However, in elite higher performance, achievements are gradual and spread over many years, which means that the best individuals do not get stuck because they engage in a practice of activity with an additional and continuous improvement in performance.

Review studies show that a gradual and consistent improvement in performance is achieved with a reflective practice with which some aspect of well-defined tasks are refined, with an immediate and detailed feedback about its performance, which is increasing to perform the same or similar tasks repeatedly over a long period of training, with enough concentration to sustain an active effort. To be engaged in practical reflected activities implies to find better methods to solve problems and perform consistently the tasks.

In a famous music academy in Berlin, the best expert violinists at the age of 20 years spent more than twice, (4 hours every day, including weekends) of solitary practice that standards experts of that age, playing themselves, following an active and thoughtful advice from their teachers.

The same consistent association between the quantity and quality of activities is thought out to reach the master in chess, studying how to solve the games published by the best chess players in the world.

The key challenge to avoid stagnation and decline of skills over the years is to counteract the trend toward automaticity by the deliberate pursuit of training situations coupled with a reflective and analytical practice.

Exposure to a greater degree of experience improves medical outcomes, as it is demonstrated repeatedly, hospitals and surgeons with a higher volume of procedures also have a higher treatment success.

The learning of diagnostic ECG is provided more reflexive and reasoned practice of each ECG in its sequential appearance, which contrasts with immediated feedback from the security of its diagnosis, as it happens in the clinic, as by the more traditional methos where several examples of similar ECG are presented together, as in formal classes.

The safety of diagnostic performance gradually decreases after graduation from medical school if it is not maintained and supported a reflective and verified practice. It is known that, for common diseases, the safety level obtained after the first year of residency, for the acquisition of patterns that allow us to recognize the condition, is comparable to the level of experienced clinicians. For cardiologic cases they are more rare and complex, by far, more precise physicians with a longer experience in the field, which rest on the ability of reasoning and systematic generation of alternatives.

Other interventions, such as surgery, are indeed complex with considerable individual differences in its performance. For the one that is initiated, for example, in a minimally invasive surgery, safety increases and the time decreases notoriously in the first 10 cases, which makes that the initial learning without patients in validated simulators will improve safety and speed when he meets with his first real patient.

Although the improvement obtained with a larger number of surgeries is lower, not only the time of the achievement of the procedure continues to decline gradually, but also are reduced surgical complications.

A very common activity, the task of tying knots and suturing is performed faster and with fewer moves by a resident of a highly trained senior year than a resident in initial training.

After the completion of an organized medical training, continued access to conditions of reflected practical, as well as feedback from the medical

practice, may allow physicians to continue improving their performance and achieve even greater levels of medical skill.

This type of learning is not possible without the full cooperation of the beginner and active participation in the learning process.

Until now we were talking about learning, which in the case of medical students and physicians refer to grasp the disease. Therefore, we need to discuss further what we call, we define and understand disease.

WHAT DO WE CALL DISEASE?

Some nosological entities that physicians sometimes try to seem that they are more disease than others. (2)

Are diseases the infectious diseases? Smallpox and AIDS

There is no doubt that although one of them disappeared from the world stage (smallpox) and other recently appears (AIDS), both diseases will be considered by the lay public and the expert physicians..

In both, a germ invades the host and stimulates a variety of processes that are manifested through the semiology of symptoms and signs, we know the cause, the pathophysiological mechanisms and how to confront them.

But there are historical gaps in this description. Smallpox was prevented with the "vaccine" a long time before the cause was known and also before the mechanisms and even the word immunity were known, with AIDS firts were known signs and symptoms and then HIV. Furthermore, given the immense variety of presentations, how can we ensure that we are talking about the same entity?

Ischemic heart disease is a disease?

If we have a previous AMI, no one would doubt that it is a disease, since the cause is a thrombotic blockage of a rugged coronary atheroma, with a standardized clinical picture and a well-established revascularization.

But if we talk about a patient with angina pectoris, the diagnosis of whether the patient has or not a coronary disease is more elusive. We should assess the symptoms of chest pain and think if it is of coronary origin or not it will depend on the skill, dexterity and experience of the physician in the inquiry, and many would not accept the diagnosis if coronary lesions are not shown on angiography, even when coronary spasm produces angina and it may kill the patient, or even when a physician may assess coronary lesions as significant and another as non significant. The more difficult it is to demonstrate the causal mechanism or functional alteration, the more difficult it is to say from someone that has a disease.

And in what case do we call sick person to a patient that we label as "asymptomatic ischemic heart disease?" , If we refer to the slow growth of plaques

of cholesterol in our coronaries we know that, after a certain age, 100% would have “asymptomatic ischemic heart disease”, or we only call so, those who have cholesterol and/or CRP above certain threshold, or would only be sick persons in those that plaques in the carotid or peripheral arteries can be demonstrated by Doppler ultrasound, or just those with calcifications or other obstructive plaques (and how much?) in multislice CAT. Which of them can we claim that he has an “asymptomatic ischemic heart disease”?

Is cancer a disease?

It is said that the identification of cancer cells makes the clinical diagnosis of cancer, but *all* of us have microscopic tumors in our thyroid, and a third of men who die of other causes have prostate cancer that is detected by pathological anatomy.

Are diseases the clinical syndromes without acceptable defined cause?

These diseases seem less disease for the lay people and are more controversial for physicians and among them there is a gradation.

For example, low back pain that has no demonstrable cause is less illness than that in which herniated disc is diagnosed by images, even when a large proportion of the population presents a herniated disc on MRI without showing any symptoms, whereby the image of a herniated disc has low specificity and a low positive predictive value.

Syndrome Gulf War in the United States, fibromyalgia, chronic fatigue seem much less a disease, since there is skepticism that certain associations of distinctive characteristics are illusory correlations and not real, as happened in the past with diseases that have disappeared from the textbooks, as the diagnosis of “psycho-asthenia.”

And there are even invented diseases (*disease mongering*) by the pharmaceutical industry to sell drugs, such as “premenstrual dysphoric disorder” or “social anxiety disorder.”

Campbell et al. (3) in his classic article of just over thirty years, “The concept of disease”, they asked clinicians and lay people to indicate which of the entities from a list they considered or not diseases. Perhaps it was no surprise that physicians, by their profession, considered tennis elbow and poisoning illness, but in others were consistent with the public. At the top of the list were infectious diseases (tuberculosis, syphilis, malaria, polio), followed them serious medical problems (diabetes, lung cancer, cirrhosis), at end were between brackets the less defined (heat stroke, tennis elbow, senility, upset after a drinking spree, drowning).

They concluded that there is more chance that they are labeled as diseases when they have an abnormality in the structure or the function, that is to say, they have a cause and mainly those entities on the list which are treated by physicians.

Norman (2) thinks that this condition “unfortunately seems tautological. Since physicians are in the task of dealing with the disease, describe a disease as something that physicians are concerned, in my view (Norman’s), does not make to advance much our understanding. “ Hilary Putnam (4) is not unreasonable that an expert defines the concept by his practice, because in everyday life an expert explains us, defines and points to which tree is a beech and which one is an elm, and when we buy or sell gold that defines us, by the experience of his practice, if the metal that we exchange for money, is gold and not bronze is the jeweler, and we accept it without question.

HOW DO THE PHILOSOPHICAL TREND UNDERSTAND WHAT IS THE CONCEPT? LESSONS FOR THE CONCEPT OF DISEASE

Nominalist versus essentialist

In his article, Campbell (3) developed the concept of disease in philosophical terms, describing two basic positions: the perspective “nominalist” and the perspective “essentialist.” In the nominalist view, a disease is simply a collection of abnormalities that seem to come together. Thus, the historical conditions of hydrophy, consumption and plague were recognized long before it was detected any causal agent, although etiologies were anticipated (such as “bad moods”). Conversely, the essentialist perspective assumes that the signs and symptoms arising from pathological processes that may be identified and, hopefully, rectified. Although it is tempting to place these two views in a historical order, contemporary examples that we have discussed (*in the previous paragraph*) indicate that the two approaches represent extremes of a continuum, which, as we shall see, has parallels both in philosophy as in psychology. (1)

The question of universals in the Middle Ages

While Rene Descartes begins with modern philosophy, in the dark scholastic theology of Middle Ages the question of universals, as it is the concept of disease, was the only subject considered genuinely philosophical.

In the version of Boethius (476-524) of the book “*From the Interpretation of Aristotle*” there is a passage that defines “universals” in relation to the preaching of a proposition:

“Since things (*res*) some are universal and some other singular, I call universal to what is apt to be predicated of many, and what is not I call it singular, example “ man “ is universal, however” Plato “ is the one which is unique. “

This logic function of the universal responds to its Latin etymology. “Universal” is the adjectival form of the noun “universe” (*universus*) and in the medieval world it was used in its property of being a *unum* (unique, unit) *versus* (in respect of) *plura* (many). This is equivalent to assure that a single predicate is said of

a plurality of subjects. This plurality of subjects may be given by individuals ..., in which the species "man", being universal, is predicated of different individuals (*Socrates is a man, Plato is a man, I am a man*) ... Because the subject is singular or universal, yet the predicate is always universal, since singular, Aristotle says, are not apt to be preached by many. "(5)

But Aristotle introduced the term "thing" (*res*), one may wonder what kind of existence is the universal *res*, since we know from the sensitive experience of "singular things" (Peter, John, Robert, etc.), but obviously it is not available to sensitive experience "universal things" as the term "man." Frederick Engels already (6) said: "We can eat cherries and plums, but no *fruit*, because nobody, until now, ate fruit as such," since we can eat sensitive things but not abstractions. So how do you access to its knowledge? And what relationship is in that community that exists between the universal and singular?

Peter Abelard (1079-1142), the lover of his disciple Heloise- with whom he had a son, named Astrolabe-, with whom he married in secret and was emasculated by the uncle of his beloved, he wrote his *Ingredientibus Logic* (Logic for the ones who are initiated), which was the culmination of a long historical-doctrinal process to solve the question of universal in the Middle Ages.

Roscellino of Compiègne, one of the masters of Abelard, says that reality is made only by individuals and does not admit the real existence of anything that were not individual; and as consequence the ontological denial of things called universal (*res universalis*). In turn, William of Champeaux, the other teacher of Abelard, on the contrary, argues that the universal essence would be found simultaneously, in each one of the individual, according to the testimony of Abelard, would have held the called "community of universal "or" identity as the essence. "

Abelard examines these two doctrines that he had received from tradition with the objective to support the process that accomplishes to the attribution of universality to the terms used in language. He says that the "fact" of being a man is not a thing, but a state (*status*) that, to coincide with other specific factual situations, under the agreement allow the formation of a universal mental image. For Abelard, the instance that allows the mediation between the "language" and "state" is the universal image. "The language generalizes the *status* and to generalize them, makes them to become valid as explanatory principles of every individual of the same species." (5)

WHAT IS A CONCEPT FOR THE MODERN PHILOSOPHY?

Rationalists of the seventeenth century

Since the birth of modern philosophy with Descartes (1596-1650, *Renatus Cartesius* in Latin, because of the diagram of abscissas and ordinates of all graphs of medical journals carry the name of "Cartesian coordinates"), the great discussion is generated to interpret whether categories or concepts such as

table, tree, beauty, goodness, and even disease exist "out there" to be learned by people as they develop and mature, suggesting that individual knowledge is formed from the experience (essentialist perspective) or are essentially a product of the mind, with which we impose the order form and category where there are not, as a result of natural biological structure of the mind or brain (nominalist perspective). Casual reading of any existing text of philosophy (7) reveals that this problem has been over time a central concern of the great minds from ancient Greek with Plato and Aristotle to modern times with Descartes, Hume, Kant, Hegel and Wittgenstein.

Let us do a briefly review of this fascinating philosophical debate, which will allow us to help to form our perspective on clinical reasoning and how to learn the medical skills, helped also by the current cognitive psychology and neuroscience.

Let us start with Descartes, with his famous statement that the only safe thing he knows is *cogito, ergo sum* (I think, therefore I am). This idea has unfortunately been almost universally misunderstood, most people interpretes it as a statement that our humanity is defined in terms of our ability of rational thought. Unfortunately, the statement has for Descartes a much more humble meaning. Before the question that he asked himself whether one can justify some external reality, leads him to the desperate conclusion that the only thing he could really be sure of his thought was, "I think, therefore I am."

Descartes is particularly concerned about the foundation of science, that is to say, what sustains all things, the foundation of reality, that might form the basis of all knowledge. And then as a science from what is already known he can know what is not known yet, the problem of "method" in science, so the best-known Descartes work is titled: *Discourse on Method to guide well the reason and look for the truth in science*. (8) He understand by reason the ability that the man has to follow a demonstrative or deductive sequence for understanding the order of reality. Thus the emergence of modern science he followed the model on Euclidean Geometry, a science well based on evident truths "absolute", that is to say, which does not dependent on other truths, which has a rigorous method of deduction by which each truth is derived from the previous necessary. Scientists and philosophers of the seventeenth century hoped that science was developed following the geometric system of thought.

So they think, as Baruch Spinoza, that "order and connection of ideas are the same as the order and connection of things" (Ethics II, proposition 7), (9) and that if part of a evident truth and without error, they are rationally deduced all the consequences of that truth) from there is that he called his master piece *Ethic demonstrated according to the geometrical order*.

Rationalism of seventeenth-century was inspired

on geometry, both in science (natural philosophy) of Galileo (1564-1642), in sociology (philosophy of society) of Hobbes (1588-1679) and philosophy of knowledge of Descartes and Spinoza. For rationalism, the characteristics of the truth should be *absolute* (that it does not depend on other truths), *universal* (it is valid for all possible cases) and *necessary* (it cannot be otherwise than as it is). Therefore the Cartesian doubt is a means, is a tool, a method, not a starting point, as it was for the skeptics.

When Descartes in the *Meditations* apparently reaches that “nothing is true in the world”, he realizes that it is not possible to doubt his existence, I can doubt everything, but just because I doubt that I exist. This first indubitable evidence, “I think, I exist” is the product of all the ways of the doubt. In the *metaphysic Meditations* also exemplified by saying that I think means “I am someone who doubts, understands, affirms, denies it wants, imagines and also feels.” (8)

British empiricists

The antithesis of the rationalist position was led by the British empiricist John Locke (1632-1704) and David Hume (1711-1776). Both maintain that there is to begin of the most immediate, which is *sensitive experience*, without assuming any previous knowledge to experience, since people’s mind at birth is a *tabula rasa*, a blank sheet, on which they are being written the *impressions* of one’s experience with the world. Hume’s empiricism parts of everyday experience and observation to *induce* (inductive logic) “principles as general as possible.”

Hume calls *impressions* to our more intense perceptions, which are “clear and precise”, and therefore have the essential characteristics of Cartesian *evidence*, but it cannot be attributed “any other existence but that one that depends on the senses” (10), that is to say, it cannot have certainty of the “outside world”.

The interpretation of the empiricists seems perfectly acceptable to the sensory experience, but is much more difficult to sustain for higher concepts such as disease, or the issue of causality. In Hume, the relation of cause and effect is empiric, derived from experience, there is any logical relationship between different events and this principle of induction may only be based on a habit that is acquired by repeating similar experiences, as he says explicitly: “It is not, therefore, the reason what is the guide of life, but habit. Only this inclines the mind to assume in all cases that the future has to conform the past. By easy that this step may seem, reason would not be able to give it never ever.” (10) And he adds: “In short, all the materials of thought are derived from our internal or external perception... The mixture and composition of this corresponds only to our mind and will. Or to express myself in philosophical language, all our ideas, or more feeble perceptions, are copies of our more intense impressions or perceptions.” (11)

In the previous paragraph it was pointed out the similarity between Galileo’s mechanics, Hobbes’s sociology and Descartes’s philosophy based on mathematical reading of nature and the geometrical method or “deductive method.” By contrast, the development of “empirical method” was based on an analogous similarity the English empiricist between natural philosophy (physics) by Isaac Newton, John Locke’s political philosophy and David Hume’s philosophy of science.

Reconstruction of Kant’s analysis of cognition

Immanuel Kant (1724-1804) reformulated the problem in a way that is central to contrast it with our current knowledge of cognitive psychology and neuroscience. He acknowledged that thoughts can only occur as a result of interactions between the rational mind and sensitive experience of external reality, in some way, we reconstruct the experience.

Kant presented to himself the following problem: if Hume’s thought were correct, then, science could not have knowledge that were universal and necessary, but Newton’s physics, in which Kant believed, establishes certain principles that apply to *all* bodies, that is to sea, principles that span all the universe of natural beings. Newton says in the *Mathematical Principles of Natural Philosophy*: “All bodies persist in a state of rest or uniform motion in a straight line unless they are forced to change that state by printed forces.” “He does not say: ‘most part of bodies’, or ‘almost all the bodies’, or ‘all the bodies of those who have experience’”. It is a principle or a law, that is to say, a universal judgment. “(12)

Kant present only two options to this dilemma, or Newton is wrong and his principles are not universal, or Hume’s explanation of the science is not correct at some point. To state how can be a universal and necessary scientific knowledge on the facts of experience, Kant establishes how are possible “*a priori synthetic judgments*.”

To understand this philosophical innovation, let us go by parts. A trial is the relationship between two concepts, when they say “something” (predicate) of “something” (subject). Since Hume it is recognized that “*analytic judgments*” (in which the predicate is contained in the concept of the subject, it is independent of experience and its only condition is the consistency, for example, “the triangle has three sides”) they do not add knowledge but clarify what was already known and they are “*a priori*” (independent of experience, universal and necessary). In turn, the “*synthetic judgments*” (in which the predicate is not contained in the concept of subject and is derived from experience, for example, “the patient is Uruguayan”), of course they add knowledge and are “*a posteriori*” (they derive from particular and contingent experience).

What Kant asks himself is, how is it possible that there are *judgments* (that is to say, statements or

propositions that are relations between concepts) that are *synthetic*, that is, from experience, and *a priori*, that is to say, universal, necessary and independent of experience?

For there to be *a priori synthetic judgments*, if knowledge is the relationship between subject and object and if the universal *a priori* cannot be derived from the object of experience, then it can only come from the subject. Kant's proposal is that the facts are not sorted when they are known, the subject puts the *form* (the order of what is known, as if were a bucket that contains in time and space different materials) and things that affect the senses provide the knowledge *content* (different materials such as water, wine or sand are placed in spatial and temporal order by the bucket or form that are faculties of the subject). That sensitive "something" that affects us through the power of the "*sensibility*" gets unique and empirical perceptions and pure intuitions that are only two: space and time and they are subjective forms that belong to the structure of the sensitive ability own of all "rational" subjects ("transcendental subject"). The role of understanding is to transform the sensitive material, which in itself is chaotic and blind, giving it an intelligible structure.

The dialectical model of knowledge

But now, "Hegel was a step further and acknowledged that the external world can influence the categories and labels that we apply. Categories themselves, do not emerge from our minds, but are influenced by objects of our perceptions. The mind is not simply a clean slate on which it is written our experience coherently (Hume), nor it is the case that all concepts are mental inventions (Descartes), nor finally the mind imposes fixed structures or constructions on the sensorial experience (Kant). Instead, both, concepts and content, grow and evolve ("*transform*") as a result of the interaction between the individual and the environment."(2)

For Hegel (1770-1831) and also to Marx, the man science presupposes and includes the nature science; expressed in Marx's famous statement that says that knowledge of human anatomy allow us to understand better the monkey anatomy and not the reverse, since what is not yet developed in monkey has been shown in humans. Both transform the conception of science to try to understand not the essence but the processes.

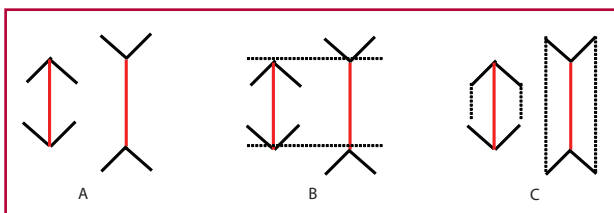


Fig. 1. Müller Lyer's optical illusion.

Marx expresses it in the Sixth Thesis on Feuerbach (13): "... But the human essence is no something abstract inhere to each individual. It is, in fact, the set of social relations..."

For the dialectic method, reality is a product of what men do, they are shaped by action and knowledge, are the product of culture and the changing historical relationships.

"From the Hegelian perspective can no longer say, as Kant, that knowledge is a synthesis of what is *given* by experience and what the individual *gets* from his own powers of knowledge, ... it is not only *what* is done, but also *who* does it, because there is no pre-established subject, but that the subject also becomes in the course of its action, in the process of making ... is a *relationship* in which both *the object as the subject are transformed through the relationship.*"(14)

Wittgenstein and the "language game"

Finally, in the twentieth century, Ludwig Wittgenstein (1889-1951) proposed that not only concepts are not fixed, but also they are not definable by any set of logical rules.

To emphasize that language is involved in the world with many different links, Wittgenstein coined the term "language games." Imagine any linguistic game, Wittgenstein says, is to imagine an activity that is a way of life.

"Looking even concepts that are commonplace as 'dog', he realized that any attempt to invent rules is sentenced to death. A dog has four legs, but if one is amputated it is still a dog. A dog barks, except an Egyptian. Basenji. A concept -either an abstract concept as truth or mundane as a dog, fork or tree-emerges as an issue of 'family resemblance'. Robins are more similar to a bird than penguins, malaria is more similar to a disease than alcoholism. Wittgenstein proposed that the concepts or categories are derived from family resemblance, not fixed groups of defined attributes."(2)

CRUCIAL OBSERVATION OF PSYCHOLOGY TO UNDERSTAND WHAT IS A CONCEPT

To understand how psychology informs and relates to philosophy, we will use a simple example, the Muller Lyer illusion. (2)

As many should know, in Figure 1A it is showed two parallel vertical lines, where the right seems longer than the other. Even if to measure them (in Figure 1B between the two horizontal dotted lines) the two vertical lines are the same length, it is impossible to escape the illusion that the right is larger. This is a beautiful example of how our mind imposes the order on the external world, in this special case, even if an order is slanted. It seems to confirm the Kantian mental categories.

But you can go further, as the psychologists did, and wonder *why* the illusion occurs. One hypothesis is that we have that illusion because our *mind* is seeing

in three dimensions (Figure 1C), so that the symbol on the left is seen as an outside corner of the wall closer to the observer, while the right is seen as an inside corner of the wall further distance from the observer. Although the two lines are objectively the same size, as the left line is seen more closely than the right because of the three-dimensional perspective, the line on the right is “really” longer.

What makes it even more interesting is that this optical illusion that Derogowsky showed this image to Zulus, who spend their entire lives in round houses, and he found that it does not appear the illusion and they see the two lines of the same size. Thus, it is not an illusion because our Occidental brains are genetically programmed (innate *a priori* Kant`s categories), it is an illusion for our particular experience with the world, which is different from that of the Zulus, which makes us see the perspective of a third dimension of a representation in the retina in two dimensions. It coincides with the Hegelian perspective, in which the experience provides the *contents*, but thoughts and concepts, which give *shape* to contents, also evolve and change as a result of interactions with the external reality.

THE VIEW FROM THE EXPERIENCE OF NEUROSCIENCE

The argument about the impact of specific experience on the development and brain anatomy comes from the phenomenon of neuronal plasticity described by neuroscience.

Neuroscientists know that people do not see the single impression of the retina as a photographic dark camera, but what we finally see is extremely influenced by the so-called “up-down processing,” a term that describes how the cerebral layers are projected down and have influence on our real visions. The retina captation is sent along two differenced routes, fast and slow, to the prefrontal cortex, the fast track conveys a rough and blurry picture, meanwhile, the slow route, through a winding itinerary, arriving 50 milliseconds later for a second vision, from the “high part” of the brain quickly decides what it has

seen the “low part” and the external world is forced to conform to our expectations. (15)

The neurologist Oliver Sacks once tried on a patient who had a lesion on the route of the cortical “high part”. He saw the world only in his unprocessed form, as light labyrinths and color masses. When a rose was given to him, he described his mental conscious process in this way: “It seems to be about six inches long. It is a twisted red form with a green lineal grip.” (16) But despite to use that and other details so accurate he never finished in the idea of a rose, only when he smelled the rose he could identify its form: “...he saw nothing as something familiar. Visually, he was lost in a world of inert abstractions.” (15) When we open our eyes, we enter in the stage of world, which is shredded by the retina (*content of the experience*) and recreated by the cerebral cortex (forms of categories).

It is known that children with congenital cataract, these should be removed before 10 years of age, because otherwise they would be unable to recognize shapes and patterns, even when they are able to learn colours. In children of 9 months of age to whom cataracts were removed, Maurer (17) found that after surgery they looked as a newborn and improved rapidly visual acuity after admission of the images, allowing them the learning due to neuronal plasticity. The Kantian categories and concepts are also developed and changed by external expertise, such as Georg Wilhelm Friedrich Hegel postulated.

A UNIVERSAL MODEL OF DIAGNOSTIC REASONING

The medical expertise in diagnostic reasoning is the most critical skills of a physician.

The amount of times we fail in this aspect of clinical performance remains surprisingly high and stable, despite significant improvements in medical technology in recent decades and the repeated invocation of an evidence-based medicine. The contribution of diagnostic errors in morbidity and mortality of patients remains highly significant.

After the introduction of basic and fundamental

Table 1. Comparison of cognitive styles of the processes type 1 and type 2

Main characteristics of the type 1 (intuitive) and type 2(analytical) processes Adults		
Cognitive style	Type 1 Intuitive (heuristic)	Type 2 Analytical (systematic)
Cognitive principle	Associative	Based on rules
Logic	Experience (inductive)	Hypothetical (deductive)
Cognitive rationality	Low	High
Reasoning	Heuristic	Normative
Automaticity	High	Low
Speed	Fast	Slow
Though	Unconscious, reflex	Reflexive, with purpose
Effort	Low	High
Reliability	Low	High
Error	More common	Rare
Emotional liking	High	Low
Scientific rigor	Low	High

aspects of knowledge of the disease concept in medicine, by the analysis of philosophy, cognitive psychology and neuroscience, we will try to describe, in an organized way, how our mind works when we try to think clinically and how it influences the way of passing that skill.

“Intuitive” and “analytical” processes

To begin to understand the process of diagnostic reasoning we should recognize two great groupings that follow the thoughts, reasoning and decisions, which are historically divided into an *intuitive* line and other *analytical* one, that allow us to describe the shape of our thought and generate a practical proposal of how clinical useful decisions are taken. (18)

The “*intuitively*” line relies strongly on the experience of making-decision and, therefore, uses an *associative* reasoning, by similarity with a prototype or, -even more feasible-, by the examples of previous cases that we store in our memory, and therefore, it depends on an *inductive logic* (Table 1).

As in a passive thought, *reflection of high automaticity, fast speed, unconscious type and, low cognitive effort*, it can be triggered by the context, images and emotions. It is linked to the oldest part of the evolution of our brain adaptation, designed to confront the needs of survival.

It has a low *reliability* because it uses a *heuristic* reasoning (mental shortcuts or rules of thumb), where the error is more common, because it has a *high emotional attachment* that depends on the context of learned example. This makes the *scientific rigor* to carry out diagnosis is low (Table 1).

The “*analytical line*”, by contrast, is activated in

more ideal conditions because it uses a *rule-based* reasoning, using a *hypothetical-deductive logic*, so that active thought is null or *low automaticity, slow, thoughtful* and with an aim or purpose, *high effort* and conscious mindfulness. Additionally, the area of the brain that is believed to be the neuroanatomical substrate of type 2 reasoning system –the anterior cingulate cortex, the prefrontal area and the medial aspect of the temporal lobe-, is the same zone that suffers the neurocognitive compromise due to lack of sleep. It is *highly reliable* because it uses a *normative reasoning*, which is a more objective thought that tries to have a low *emotional attachment* to commit *lesser possible errors*. It does all this of *high scientific rigor* in order to reach an accurate diagnosis (Table 1).

How works the model of clinical reasoning

The linear process of Two Systems

The first step in the process of diagnostic reasoning is the “presentation of symptoms and signs of the patient” to that one who goes to make the decision. Even if it were a direct contact between physician and patient, the physician always makes patient’s disease history choosing those findings in which he will support the diagnostic search. The approach may be less forthcoming if the signs, symptoms and investigations are relayed through an intermediary, such as a medical resident to a plant one, or a family doctor to a consultant one. In my experience, in this passage at second hand, sometimes it is lost some of fidelity of the information, because it is inevitable that the first observer commits bias of interpretation (because, fortunately, he thinks) in his account and

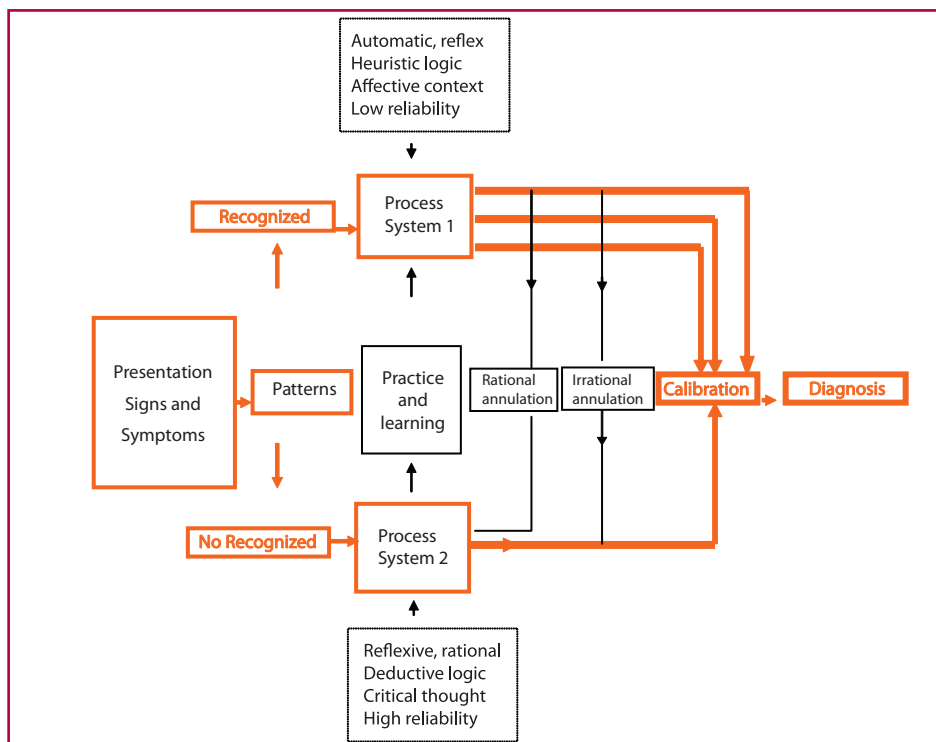


Fig 2. Diagnostic model in a dual-process theory (modified quoted 18)

also for the loss of direct printing and the context in which is presented the patient. Therefore it is necessary that after hearing the physician instructor, he has first-hand contact and examines the patient (18) (Figure 2).

Automatically processes "System 1" are activated before the immediate recognition of the salient features of presentation. In that way it can be recognized the visual representation of a herpes zoster, the typical position of shortening and external rotation of the leg with hip fracture, alcoholism (also by the sense of smell), Cushing's disease and many others, which recall examples of previously known cases. Or it activates the pattern recognition outgoing combination of different findings, such as acute pulmonary edema, Parkinson's disease, thyrotoxicosis, and so on, which triggers the recognition of "prototypes." How much more pathognomonic is the presentation, more feasible is the reflex and unconscious response of the System 1.

If it is asked to a dermatologist how he made the diagnosis of herpes zoster, he would respond embarrassed "because it seems a herpes zoster." This appears that states that the mechanism is to retrieve from memory direct experiences, as the British empiricists claimed, however, an elegant and simple test, questions it.

If it is made flashing four letters on a computer screen for a few milliseconds and it is asked to identify the fourth letter, when the fourth letter is part of a real word as "lion" or a pseudo-word as "clone" is recognized in a faster and safer way than when it occurs in a non-word such as "reen." This says something fundamental about the nature of memory, that even in the perception and recognition of individual letters, in a process that is taking place in milliseconds and without the possibility of introspection, identification is facilitated by the memory of higher-level concepts such as the words themselves.

It illustrates that what we see may be influenced by what we believe to see, as for example under the fact, not so rare, that reading fast through a newspaper we confuse one word for another that maintains the consistency of the text.

We note that, similarly, the context influences the intuitive diagnostic reasoning when an incorrect clinical history that describes pathognomonic pictures of a medical text leads us to misinterpret a sign for another: puffed parotids of a mump become the face of full moon of Cushing's disease and, in turn, the moon face of Cushing's disease becomes periorbital edema when it is jointed with a history of nephrotic syndrome.

Hatala et al. (19) showing a pack of 10 electrocardiograms (ECG) -each one with a brief suggestive history of the correct diagnosis of the ECG, or the most plausible alternative diagnosis, or no history-, "to seniors, 2nd year residents of Medicine or collegiate cardiologists, he found that in physicians

of any skill level, medical history had an influence on ECG diagnostic accuracy, either improving safety when the history suggested the correct diagnosis or reducing it when history suggested the alternative diagnosis. These results reveal a limitation of the Bayesian method of diagnosis, in which each new piece of information, such as ECG, is considered independent of each other and the physician should not be influenced by the prior history in order to believe that he notices in the ECG consistent characteristics with the diagnosis that is being considered.

This phenomenon where a higher level of information, either that is provided or that is already "encapsulated" in the memory (for example, when he does not remember a patient who was previously admitted and the resident comments that it was that patient who had been in the war in Ethiopia and then as if by magic, the characteristics of the disease are remembered, the number of angioplasty procedures and even the detail of the operated arteries), it can influence the basic process of perception and it is demonstrated at all skill levels, from freshman to the most skilled cardiologist, since it is not a naive and simple bias that can be erased by the experience.

In the system 1, unconsciously, multiple response may be generated simultaneously in parallel, for example, among the first doctor's automatic responses are his feelings toward the patient, which vary in intensity and the polarity can be positive or negative as they are preconscious can have a significant role in medical decisions.

If the presentation is ambiguous, "not recognized" or there is uncertainty, then the "System 2" is compromised. Now the process is analytical, in an attempt to make sense of the presentation through a systematic and objective examination of the data, applying the rules of hypothetic-deductive reasoning. It is a normative system. slower, more investment of resources, relatively free of emotional influences, but much more reliable and less prone to error (Figure 2). If there are no further changes in the processing of System 1 or System 2, the individual or mixed output determines the "calibration" of the response and the eventual correction of the diagnosis.

Inquiries and modifiers of process

In first place, the System 1 and System 2 may interact each other and the final product is a synthesis of both.

For example, a vesicular eruption may trigger in the System 1 the diagnosis of herpes zoster, but the unexpected observation that crosses the midline produces the conscious activation of System 2, slower, with a normative logic, which produces the "rational nullification" of System 1 and forces a reassessment of diagnosis (Figure 2).

It is important to recognize that the distraction, fatigue and sleep loss produces a cognitive indolence that allows greater laxity than the necessary of System 1 and increases five times the misdiagnosis.

Metacognition, which is the act of “thinking about thought and feeling of own and someone else’s, allows the ability to step back and reflect on what is happening in a clinical situation, forcing the essential monitoring by System 2.

Sometimes, the System 1 may annul correctly System 2 reasoning, when in spite of the normative recommendations of the guidelines the intuitive appreciation of the situation of that particular patient is appropriate in that particular situation. This is a very exact strategy.

Of course, most “irrational nullifications” of System 2 by System 1 produces the high variability of medical behaviours and occurs for multiple reasons: emotions, beliefs, trust, historical, situational, and many others (Figure 2).

Physicians in training and those already are in clinical practice need tools that facilitate them the understanding of their own decisions to improve patient safety. Because it is a persistent need for the requirement of clinical reasoning, to have a critical thought, to decide and diagnose as best we can.

CONCLUSIONS

Does the increasingly rapid development of Internet information make this discussion obsolete?

There is no doubt that the electronic search, with definite purpose, has enhanced the possibility to find information on complex clinical cases, without the need, as it was three or four decades ago, tedious manual search, long and pompous terms of the innumerable volumes of *Medicus Index* at hospital library.

The presence of a patient with heart failure due to non-compact cardiomyopathy an in turn, polycystic kidney failure, allowed almost instantly, through Pubmed or Google Scholar; in an astonishing way, to find the few quotations of similar cases.

But although Internet has democratized availability to the original data from clinical trials or other original studies, Kassirer (20) has noted that physicians in training “usually cite electronic compiled sources, guidelines of practice, and decision compiled rules and rarely seek and communicate original sources. As training people rely more and more in instantly available information that has been extracted, summarized and reorganized, they are increasingly learning the minimum that they need to know when they need it, that is to say, the minimum amount of essential knowledge for a particular task”. Therefore, Kassirer is worried in that his clinical knowledge is superficial and that his clinical reasoning ability suffers and proposes that “the immediate availability of compiled and summarized information (especially in electronic format) is doing to young physicians, without intentionality lazy, as others have noted it on undergraduates”.

He found in his own experience, that there is an

inverse relationship between access to electronic information and the contents of memory, because since the phone allows you to store numbers or drive you to places, you remember less phone numbers and addresses, it is very useful and more efficient to have them electronically, but he highlights that we should not confuse worldly numbers and addresses, which do not need to remember, with the complex clinical information, which should be entrusted to the memory for optimal resolution of clinical problems.

The images and diagrams created as patterns for the application of the decision making by System 1 in the brain, when they are produced in the brain of a novice physician possibly are primitive, but with time and repeated application of an effort of observant and reflective thought of System 2, they are refined and become encapsulated complex concepts that are easily accessed by working memory, thereby reducing the requirement of conscious thought. Developing richer thoughts and encapsulated schemes of problems, signs and represented symptoms, we developed our clinical skills, since the best “experts know more, remember more, earn more and become more effective problem solvers than the beginners do. “

Kassirer wonders “whether during training the quick and easy accessibility of compiled and summarized information eliminates substantial information from the memory and the emphasis is on practice guidelines and evidence compiled strategy, are the integrated complex and encapsulated schemes that facilitate thought developed? Will we create a generation of physicians who depend on the so-called quick and dirty summaries?”

We are not blameless when the explanation of clinical decisions are simply based on the guidelines, without assessing whether residents appreciate the quality of the evidence, or quote superficial information of electronic searches without criticism, or repeat as parrot the severity of risk score without understanding the fundamental components of the model and if it is appropriate to our population. Even though they can do it better, we should also do it better.

Before new information sources fast available, of which influence is deep and presumably positive, it does not surprise that we have not found the right balance yet.

For some, these changes seriously affect the shape of our concentration, contemplation, reflection and critical thought.

To have the clinical skills to solve medical problems is not enough to learn how to find information, because we also need to remember the information and know how to use it.

Neither more nor less, we should produce physicians who may be able to think for themselves.

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