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The intuition role in scientific inventions

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Abstract
Word intuition that comes from Latin intuition is described in dictionaries as follows: feeling; clear perception that to be seized by the spirit, do not require reasoning. This meaning is also very well described in FERREIRA's dictionary (1986) as "immediate knowledge, which is independent of reasoning." To better understand the intuitive method is appropriate that the discursive method is presented; where knowledge comes to an end proposed by a series of successive efforts in order to fix and discuss ideas, statements and theses to obtain the desired concept. Intuition is exactly the opposite, that is, goes straight to the object, is the immediate knowledge which, in a single act of spirit suddenly pounces on the object and captures, in a process analogous to a vision or contemplation. The history of scientific discoveries shows that, although the reason has been used to organize, develop, and test ideas, many of them had an intuition dose at the beginning of the creative process. Some authors claim that intuition is prevalent in creativity, because, reason has no creative ability. In this sense, this study points to some traditional examples where it is verified the mentioned fact.

Keywords: Intuition, Scientific Discoveries, Chance

Introduction

Where do ideas come from? According to SCHENBERG (1990) [17] the origin of fundamental scientific ideas is quite mysterious. It is not known where they come from; it can be said that the great geniuses have intuitions. "Some fundamental ideas have unknown origin of the own authors; they also do not know where they come from. One day appears in the author's head that idea, but where it comes from, he can not explain. Others have known source and obviously comes from experience "(SCHENBERG 1990) [17]. Bassalo (1986) [2] studied the role of intuition in discoveries and inventions in physics. Initially it is analyzed the overall creative process revealed in art, in science and humor, this process consists of four basic steps classified as preparation, incubation, illumination (intuition) and verification. All processes are needed, but intuition is the predominant factor. The study of science and art in depth means being able to "feel" a finding from a state that transcends everyday reality. Article Chance, Prejudice and the Scientific Method, Pleitez (1996) [15] asks immediately the following question: How can scientists gain knowledge? It is logic, psychology, sociology research, or what? What role the random, prejudice and reason in scientific research? How does scientific imagination work?

A phrase attributed to Einstein (2004) [7], mentioned in the Galileo magazine, illustrates very well this "feeling". "I think ninety-nine times and discover nothing, I stop thinking, dive into deep silence and, behold, the truth is revealed to me." Another Einstein`s phrase: "Imagination is more important than knowledge."

The basic question that can be asked is: What is meant by intuition? The word intuition comes from Latin intuition, is described in dictionaries as follows: "feeling; clear perception that to be seized by the spirit, need not thinking." This meaning is also very well described by Ferreira (1986) [10] as "immediate knowledge, which is independent of reasoning."

To better understand the intuitive method is appropriate that the discursive method is presented; where knowledge comes to an end proposed by a series of successive efforts that consists in fixing and discuss ideas, statements and theses in order to obtain the desired concept. Intuition is exactly the opposite, that is, goes straight to the object, is the immediate knowledge which, in a single act of spirit suddenly pounces on the object and captures, in a process analogous to a vision or contemplation.

According to Bassalo`s text (1986) [2], "Plato exemplifies the kind of intuition guided especially on reason, Plotinus and St. Augustine mention the emotional intuition, while Fichte feels intuition in volitional way. In short, intuition can be triggered by a rational process, the emotion or the will to run something desired, but in any case it is an opposition to the intellect work or the systematic thought."

Intuitionists considered the human being gifted with a first intuition on the natural numbers. Therefore they advocated a reworking of mathematics from its foundations. Always starting from the intuition, the axioms, theorems, in short, all mathematics should be rebuilt. What based the intuitionistic movement was the consideration that the abstract entities exist only when they were constructed by the human mind. Thus, which did not originate from intuition, it did not represent mathematics (MONDINI 2008) [13]. According SNAPPER (Apud MONDINI, 2008) [13] in Intuitionism had the idea that abstract entities, such as mathematics, were human elaborations and not Platonic ideal objects. Unlike logicism practisers, intuitionists considered the classical mathematics fallible at some points. The paradoxes concerning set theory, for example, according to intuitionism were errors of mathematics and not mathematicians as logicism practisers thought. Many scientific discoveries or inventions arise from these types of insights.

Types of Intuition

It can be shown that many physical discoveries and inventions arise basically three types of intuition that will be summarized in the following. First there is the rational intuition, due to work conscious of their authors, as can be seen in Archimedes' experiences. Second it is mentioned the emotional intuition,

from isolated ideas which, however, are beyond the current scientific paradigm exemplified in the resulting work of Kekule`s dream. Finally, it is mentioned the volitional intuition, which highlights the strength of will, perseverance, the kind of Thomas Edson`s discovery.

To illustrate the rational intuition can be cited the classic example of the discovery of buoyant force by Archimedes, "a body immersed in a liquid receives a force directed upwards, equal to the weight of the displaced liquid. When the buoyancy exceeds the weight the body floating in that fluid "(Amaldi 1997) [1]. Count the books the Greek scholar Archimedes discovered it while showering, while trying to respond to Hiero, king of Syracuse, if his crown was really pure gold. The king ordered to make a gold crown and, therefore, hired a craftsman, that getting good amount of money and the necessary gold, accepted the job.

As described DOCK *et al.* (2001), the craftsman performed the work to perfection and delivered the crown on time. However, the king suspected the goldsmith had deceived him not using pure gold, then asked Archimedes to investigate the case.

During a "revealing" bath Archimedes noted that, as his body sank into the tub, the water overflowed. He concluded, so how could solve the problem of the crown and went to the street shouting "Eureka, Eureka!" which in Greek means discovered. Thus, grabbed a holder of water and dipped a piece of gold, the same weight of the crown, recording how much water had risen. He did the same with a piece of silver, which realized that gold did not displace as much water as silver. That is, the water level rose to more the silver compared to gold. Entering the crown in the water, he noticed a rise in the water level more than gold and less than silver. The crown, the gold piece and the silver piece used by Archimedes all had the same weight. However, as the density of gold is greater than that of silver, gold piece occupies a smaller volume than the silver piece of the same weight. If the gold piece has smaller volume, so it shifted a smaller volume of water than the silver piece. The crown being made of a mixture of gold and silver had an average density between gold and silver. Archimedes found, then, that the crown was made with a mixture of gold and silver, a fact that condemned the craftsman.

Thus, the Archimedes' principle can be stated as follows. "Everybody immersed in a fluid undergoes, by the fluid, a vertical upward force whose intensity is equal to the weight of the fluid displaced by the body" When a thicker body than a liquid is totally immersed in this liquid, we observe that the value of their weight within that liquid, is apparently lower than in the air. The difference between the value of real weight and apparent weight corresponds to the thrust exerted by the liquid.

Volitional Intuition

THOMAS EDISON can be displayed as an example of scientist gifted volitional intuition. "Willpower" is the colloquial term and volition is the term scientific meaning a same mental state, in other words an "elective preference". VIOLIN (2005) [18] speculates that Edson did over a thousand experiments to be able to invent the light bulb. Someone once asked him what he thought of so many failures. Edson said:" I have not failed any time since I invented the light bulb. It was a process of 1,000 steps..." The same can be said of OERSTED (Martins, 1986) [11], at a time when it was looking for a relationship between electricity and magnetism, although there was evidence of this relationship. OERSTED noted, after many experiments, a compass suffers deflection to be placed in the vicinity of a wire conducting an electric current.

The phenomenon can be explained by stating that the electric field generated by charges moving manifests itself in objects at rest through a magnetic field; hence the deflection suffered by the compass. Somehow, part of the electric field becomes magnetic in view of motion. The OERSTED`s experiments were so simple for the year 1820 one can question the reasons were not made before (Pleitez 1996) [15]. To PESSANHA *et al.* (2009) [14], the idea of universal gravitation was suggested by Newton by the fall of an apple seems true. In 1687, Isaac Newton published his book Mathematical Principles of Natural Philosophy, in which he set the categories for the development of a mechanistic Natural Philosophy: the three laws of motion, the concepts of force, mass, and the treatment of curved paths. In the last part of the book, he formulated the universal gravitation law. A legend in the history of physics is the falling apple. Newton tried to understand why the moon does not depart from Earth; in the 1660s when he was walking in a garden, he observed an apple falling from a tree. By observing the fact, Newton gave an intuitive mental leap, because it would have made him think that perhaps the power responsible for the falling apple to act also on the Moon, which would prevent it walking away (DIAS *et al.* 2004) [5].

According Gleiser (1997) [8] radioactivity was discovered after Becquerel put in the desk drawer of his lab, samples of a mineral, a copper cross and a photographic plate wrapped all. For some mysterious reason, a week later, Becquerel decided to develop the film that had kept in the drawer when he noticed the mark of the cross printed on the photographic plate. As the mineral sample had the chemical element uranium, he called "uranic rays."

Emotional Intuition

NIKOLA TESLA, a Serbian-born American scientist, who intensively studied the physical sciences and mathematics, had an emotional intuition. Between his numerous inventions include a genius of alternating current systems, machinery and engines, which enabled the electrification on a large scale in partnership with Edson. Tesla was a self-taught that did not consider only the concepts, but had an infallible intuition. He intensely studied mathematics and physics, emigrated to the US, and for some years worked at Edson`s company. The writer CHILDRESS (2001) [4], the book The Fantastic Inventions of Nikola Tesla, addresses the inventions of that scientist, described by himself, mentioning he wrote about advanced concepts of antigravity, flying saucers and time travel, among many other things. According to author Tesla had visions while awake when electric appliances and other machines were seen on details of design and construction. Tesla has always been considered by the scientific community an exotic person, he was never considered a "normal" person. To illustrate one of his eccentricities Tesla had a preferred dove created as a pet. When the pigeon died Tesla believed he would have taken it all inspiration that allowed him to develop his inventions. Friedrich August Kekulé was one of the pioneers of organic chemistry, since he studied the constitution of the matter, a theme that has always intrigued men. The structure of the molecules has always been among the first philosophical speculations of science, and in these the idea of atoms and molecules has a long history. For example, around the year 1860 chemists were studying the way in which atoms combined to form molecules. This resulted in a lengthy analysis and search for structural

formulas of substances. One of the scholars was the German Kekule, who was intrigued by a major problem involving a compound called benzene. The researchers knew that this molecule consists of six carbon atoms and six hydrogen atoms, but the challenge was to find a way to group them properly to justify the properties which were exhibited by benzene. It was thought that the six carbon atoms were connected in a straight or branched, without closed links forming a normal, straight or linear chain. However, from this configuration calculations led to a more complex situation for benzene, in opposition to stability in which benzene was characterized. A common fact occur with some people is that sometimes they can have a certain perception of phenomena by unconscious processes that occur in dreams, as in the case of Kekule. It was well written by Benfey (1958) [3] in the Journal of Chemical Education number 35:

"My mind's eye, which becomes more acute by repeated visions of the same kind, could now distinguish larger structures of multiple conformations: long lines, the tighter times, all together, paired and interwoven moving like a snake. But look! What was that? One of the snakes had seized its own tail and this form whirled mockingly before my eyes. I woke up as if by a ray of light; and then also I spent the rest of the night developing the consequences of the hypothesis."

He immediately joined the cyclic form of vision with the arrangement of atoms researching, obtaining the spatial formula of benzene. With this discovery has opened up a huge field for the synthesis of new products, since a large portion of the drugs produced by the pharmaceutical industry is based on benzene.

Final Considerations

Is it legitimate to question the place of chance in scientific discoveries?

One possible answer to this question can be extracted from the article called Great Discoveries, available on the website Science and the Future. A passage, the editor says:

"Chance can be understood as a kind of deception: in search of A, B is found, and even unintentionally, it can have a major scientific impact. Chance can not be of great value to those who see science with the simplicity of a protocol, but the discovery of light bulb, x-rays, the photoelectric effect, photography, radiation and other cases mentioned in the literature, compel the viewer common to consider the other side of science: one side open to the imagination, the question of the phenomena and the flexibility of the goals to achieve. "

Above all, they are curious and restless spirits of the scientists who make the completely legitimate accidental discoveries. Perhaps it can be said otherwise, and through the words of Lewis Carroll, quoted by MORAES (2009) [12] which states: "for those who do not know where they are going any road will do." The discovery transcends the limits imposed by the disciplinary. How many scientists no longer have revealed that believe they have achieved to their theories from "dreams or states similar to the dream; under a flash of inspiration; and even because of misunderstandings and deceits."

In humanity, in general, intuition is almost entirely sacrificed to intelligence. However, it is present, but vague and above all discontinuous. These flashes coming from our consciousness can reveal us pure duration, where intelligence can only see a spatial extent. When we understand the intuition we realize that at times it may even be more important than intelligence. One should not forget that the inventiveness and the opening of new spaces is the main indicator of a scientific research environment. Many do not realize the complex needs of these new times that require new approaches called interdisciplinary or transdisciplinary. However, chance favors only those who are prepared and those often use observation, for if the researcher has the prejudiced mind, despite all the coincidences, will not amount to a few small details that could lead to a breakthrough. The discovery of penicillin is a typical example because, only became possible thanks to an incredible series of coincidences Rezende (2005) [16].

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