The Methodology of Concomitant Variations

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PROLOGUE

Not everything that counts can be counted,
and not everything that can be counted, counts.
William Bruce Cameron

In the book The Voice of Truth" Gandhi states: "*There is an indefinable mysterious power that pervades everything. I feel it, although I do not see it. This invisible force makes itself felt and yet challenges any demonstration, because it is so different from everything that I perceive* *with the senses.*"[1]

The *Unitary Theory*[2] posits the existence of a dimension vital to life, which is invisible to us, although we can feel it in subjective and qualitative ways. But the experimental methodology requires quantitative and objective data and it is unable to account for this invisible dimension. This limit has restricted science to quantitative causal relations, and the invisible dimension is usually

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[1] Gandhi MK (1968), The Voice of Truth, Nvajivan Trust, Ahmedabad.

[2] Di Corpo U and Vannini A (2014), The balancing role of Entropy / Syntropy in Living and self-organizing systems: QUANTUM PARADIGM, www.amazon.com/dp/B00KL4SP70

considered to be out of the reach of science or non-existing. Fortunately, in 1843 the economist and philosopher John Stuart Mill formulated the methodology of concomitant variations which perfectly adapts to the study of qualitative and subjective information and allows to produce scientific knowledge in the field of the invisible dimension which is so fundamental to life.

The satirical novella Flatland, written in 1884, well introduces the aim of this book.[3]

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[3] Abbott EA (1884), Flatland, Seely & Co, UK.

"It is true that we have really in Flatland a Third unrecognized Dimension called 'height', just as it also is true that you have really in Spaceland a Fourth unrecognized Dimension, called by no name at present, but which I will call 'extra-height.' But we can no more take cognizance of our 'height' than you can of your 'extra-height.' (…) Well, that is my fate: and it is as natural for us Flatlanders to lock up a Square for preaching the Third Dimension, as it is for you Spacelanders to lock up a Cube for preaching the Fourth. Alas, how strong a family likeness runs through blind and persecuting humanity in all Dimensions! Points, Lines, Squares, Cubes, Extra-Cubes -- we are

all liable to the same errors, all alike the Slavers of our respective Dimensional prejudices."

This book offers a critical description of the experimental methodology, introduce the methodology of concomitant variations, and provides a software which makes this methodology readily available.

2

SCIENCE

Science (from Latin *scientia*, meaning knowledge) is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions. An explanation is a set of statements which clarify the relations among causes, context, and consequences of facts. Explanations may establish rules or laws which allow to formulate predictions.

Consequently, relations (among causes, context, and consequences) are at the basis of explanations and predictions and, when relations are studied in a replicable and objective way, it is possible to talk about science.

- The dawn of science

The first traces of science are found in Mesopotamia and date back to 3,500 B.C., when records with extremely thorough numerical data were kept for analyses. The eldest account on scientific methodology dates to 1,600 B.C., when an Egyptian medical text[4], a surgical treatise on trauma which describes 48 cases of injuries, fractures, wounds, dislocations and tumors, presented the following phases: examination, diagnosis, treatment and prognosis. This treatise displays strong similarities with the modern scientific method and played a significant role in the development of the empirical methodology, based on observations and experimentation.[5] By the middle of the 1st millennium B.C., the first refined mathematical

[4] in Edwin Smith Papyrus, named after the dealer who bought it in 1862.

[5] In the empiricist view, one can claim to have knowledge only when one has empirical evidence.

tools for the description of astronomical phenomena were developed in Babylonia, giving birth to the scientific approach in astronomy. All subsequent varieties of scientific astronomy, in the Hellenistic world, in India, in Islam, and in the West depend upon Babylonian astronomy.[6]

But it was in Greece, with Thales of Miletus[7], that the earliest forms of rational theoretical science were

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[6] Aaboe A (1974), Scientific Astronomy in Antiquity, Philosophical Transactions of the Royal Society 276 (1257): 21–42.

[7] Thales of Miletus (624 –546 B.C.) was a pre-Socratic Greek philosopher from Miletus in Asia Minor, and one of the Seven Sages of Greece. Many consider him the first philosopher in the Greek tradition.

developed around 600 B.C. The rational approach posits that reason alone can mark the truth or falsity of propositions. Thales attempted to explain natural phenomena without reference to mythology, supernatural and religion, proclaiming that every event had a natural cause. Thales was tremendously influential and almost all the Pre-Socratic philosophers followed him in the attempt to provide explanations without reference to mythology. Thales' rejection of mythological explanations became a fundamental element of the scientific process.

Around 500 B.C. Leucippus developed the theory of atomism, according to which everything is composed of imperishable, indivisible elements that he named atoms. This idea was elaborated in greater details by his pupil and successor Democritus.[8] They were both thoroughly materialists, believing everything to be the result of deterministic laws.

Similar atomist ideas emerged independently among ancient Indian philosophers of the Nyaya school of logic and the Buddhist

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[8] Democritus (460 - 370 B.C.) was an influential Ancient Greek pre-Socratic philosopher.

atomism school, that flourished in the Indian subcontinent during the 4th century B.C.

Around 350 B.C. Plato[9] and his most-famous student, Aristotle[10], laid the foundations of Western deductive reasoning in science. Aristotle introduced a methodology which involved both inductive and deductive reasoning. For Aristotle, universal truths can

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[9] Plato (428 - 348 B.C.) was a philosopher, as well as mathematician, in Classical Greece and an influential figure in philosophy. He was Socrates' student, and founded the Academy in Athens, the first institution of higher learning in the Western world.

[10] Aristotle (384 – 322 B.C.) was a Greek philosopher and scientist born in Stagirus, northern Greece. At the age of eighteen, he joined Plato's Academy in Athens. His writings cover many subjects – including physics, biology, zoology, metaphysics, logic, ethics, aesthetics, poetry, theater, music, rhetoric, linguistics, politics, and government.

be known from particular things via induction, but induction by itself does not account for scientific knowledge. Induction provides the primary premises to scientific enquiry, by generalization, but it does not provide a causal explanation. The methodology which Aristotle devised, for the development of causal explanations, was the deductive reasoning based on syllogisms, which allows to infer new universal truths from those already established, through intuition. According to Aristotle, induction does not provide the basis for science, whereas intuition offers solid foundations. He believed that "*intuition is the originative source of scientific knowledge.*"

Aristotle wrote that "*we do not have knowledge of a thing until we have grasped its why, that is to say, its cause.*"[11]

He held that there are four kinds of causes: *material causes*, *formal causes* determined by the context, such as ratios that cause the octave, *efficient causes* which act as agencies, for example a carpenter for a table or a father for a boy and *final causes* such as the adult plant for a seed and the sailing for a sailboat.

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[11] Falcon A. (2008), Aristotle on Causality, Stanford Encyclopedia of Philosophy 2008.

In the 3rd and 4th centuries B.C., the Greek anatomist Herophilos (335–280 B.C.) used the experimental method to record data on dissections. He considered essential to produce knowledge starting from empirical observations and comparisons.

In the Islamic world it was common for scientists to be also artisans, expert instrument makers. They used the experimental approach to distinguish between competing scientific theories, as can be seen in the works of Jābir ibn Hayyān (721–815), who left nearly 3,000 treatises and articles in fields ranging from cosmology, music, medicine, biology, chemical technology, geometry, logic and artificial generation of living beings. A total of 112 books are dedicated to the Arabic version of the Emerald Tablet, an ancient work that proved a recurring foundation of alchemical operations.

Ibn al-Haytham (965-1040), who has been described as the father of modern optics, combined observations, experiments, and rational arguments to support his theory of vision. He showed that the ancient theory of vision, supported by Ptolemy and Euclid (in which the eyes emit rays of light used for seeing), and the theory supported by Aristotle (where objects emit physical particles to the eyes), were both wrong.

Experimental evidence supported most of the propositions in his books and grounded his theories. Ibn al-Haytham used the scientific method to establish that light travels in straight lines: "*This is clearly observed in the lights which enter into dark rooms through holes. ... the entering light will be clearly observable in the dust which fills the air.*"[12] Ibn al-Haytham also explained the role of skepticism and criticized Aristotle

[12] Alhazen (Ibn Al-Haytham) Critique of Ptolemy, translated by S. Pines, Actes X Congrès internationale d'histoire des sciences, Vol I Ithaca 1962, as referenced on p.139.

for his lack of contribution to the method of induction, which he considered to be the basic requirement for true scientific research.

The Persian scientist Abū Rayhān al-Bīrūnī (973-1048) used the experimental method in several different fields of inquiry, with emphasis on repeated experimentation. Bīrūnī was concerned with how to prevent systematic errors and observational biases, such as "errors caused by the use of small instruments and errors made by human observers." He argued that if instruments produce errors, then multiple observations must be taken, and arithmetic mean values used as the true measurement.

Ibn Sina (980 - 1037), Latinized as Avicenna, studied all the books of Aristotle, then available only in Arabic, and used them as the basis of his healing methods described in his famous book Al-Qanun, (The Canon of Medicine), that was widely used until the 17th century, when the rational-mechanistic methods were introduced and promoted in the West, following the complete change in the scientific approach to nature and life.

In The Book of Healing (1027), he

diverges from Aristotle on several points: "*how does a scientist find the initial axioms or hypotheses of a deductive science without inferring them from some more basic premises?*" arguing that induction "*does not lead to absolute, universal, and certain premises.*" In its place, he advocated "*a method of experimentation as a means for scientific inquiry.*" He was also the first to describe what is essentially the method of concomitant variations.

- Duality

Although some knowledge of scientific methodology seems to have lingered in the ecclesiastical centers of western Europe, after the fall of the Roman empire, ideas on scientific methodology were reintroduced in the 12th century to Europe, via Latin translations of Arabic and Greek texts and commentaries. The lack of Latin translations had been due to several factors, including limited techniques for copying books, lack of access to the Greek texts, and few people who could read ancient Greek, while the Arabic versions were more accessible.

Aristotle's newly translated views supported the notion of a personal God, which ended in the list of the forbidden books in the Condemnations of 1210–1277.

At the end of that same period, Thomas Aquinas (1225-1274) reconciled Aristotle viewpoints with Christianity, in his work *Summa Theologica*. But, in 1277 another more extensive condemnation was issued with the aim to clarify that God's absolute power transcended any principles of logic that Aristotle might place on it. More specifically, it contained a list of 219 propositions that violate the omnipotence of God, and included in this list twenty propositions by Thomas Aquinas. Their inclusion badly damaged

Thomas' reputation for many years.

The conflict between science and the Church became clear with the results of the astronomical observations of Nicholaus Copernicus (1473-1543), which put the Sun at the center of the universe and showed the contradictions of the geocentric system, in which the Earth was placed at the center of the universe.

Copernicus' work represented a huge innovation in the astronomical field and was followed by Johannes Kepler (1571-1630), who, thanks to astronomical tables, arrived at the formulation of the three laws of planetary motion, developing the Copernican heliocentric model into a scientific model.

Giordano Bruno (1548 - February 17, 1600), an Italian Dominican friar and mathematician, famous for his cosmological theories, went even further. While supporting the heliocentric model, he proposed that the Sun is just one of the many stars moving in space, and claimed that an infinite number of inhabited worlds, identified as planets, orbit other stars. Beginning in 1593, Bruno was trialed for heresy by the Roman Inquisition on charge of the denial of several core Catholic doctrines (including the Trinity, the divinity of Christ, the virginity of Mary, and Transubstantiation). The Inquisition found him guilty, and in 1,600 he was burned at the stake in Rome's Campo de' Fiori. After his death he gained considerable fame as a martyr for science. Bruno's case is still considered a landmark in the rise of the duality between science and Christianity.

The duality between science and the Church is though symbolized by Galileo Galilei (1564-1642). Using the telescope which had just been invented, Galileo was able to empirically prove Copernicus' heliocentric hypothesis. A sequence of events brought Galileo into conflict with both the Catholic Church and the Aristotelians, for his support to Copernican astronomy. In 1610, Galileo published his Sidereus Nuncius (Starry Messenger), describing the surprising observations that he had made with the new telescope, namely the phases of Venus and the moons of Jupiter.

In 1616 the Inquisition declared heliocentrism to be heretical. Heliocentric books were banned, and Galileo was ordered to refrain from holding, teaching or defending heliocentric ideas.

Galileo went on to propose a theory of tides in 1616, and of comets in 1619; he argued that the tides were evidence for the motion of the Earth.

In 1632 Galileo, now an old man, published his Dialogue Concerning the Two Chief World Systems, which implicitly defended heliocentrism, and was immensely popular. Responding to mounting controversy over theology, astronomy, and philosophy, in 1633 the Roman Inquisition found Galileo “gravely suspect of heresy”, sentencing him to indefinite imprisonment. Galileo was kept under house arrest until his death in

1642.

In the same period Francis Bacon (1561-1626) became one of the major assertors of the experimental method, courageously attacking the traditional schools of thought which were based on Aristotelian deductive logic. Bacon starts from empirical evidence to arrive at general laws. To produce objective knowledge, Galileo's and Bacon's scientific methods separate the observer from the observed. This approach totally transformed the nature and purpose of science. Whereas previously the purpose of science had been to understand nature and life, the purpose was now to control and manipulate nature.

As Bacon said: "*Objective knowledge will give command over nature, medicine, mechanical forces, and all other aspects of the universe.*" In this perspective, the aim of science became that of enslaving nature and the organic concept of nature was soon replaced by the mechanistic concept of the world.

René Descartes (1596-1650) based his work on the idea that the "book of nature" had been written in mathematical characters. His aim was to reduce all physical phenomena to exact mathematical equations, and he believed that nature could be described using simple motion equations, in which only space, position, and moment were relevant. "*Give me position and movement*," he said, "*and I will build the universe.*"

Among Descartes' greatest contributions was his Analytical Method of Reasoning, according to which any problem can be decomposed into its parts, and then reordered. This method lies at the foundation of modern science, and has been of great importance, permitting the development of scientific theories and complex technologies.

Descartes' vision is based on the

duality between two reigns, separate and independent: the reign of spirit, or *res cogitans*, and the reign of matter, or *res extensa*. This division between matter and spirit has had profound consequences on culture, leading to the separation of body and mind which still puzzles science and provided formal recognition to the split between science (res extensa) and religion (res cogitans). According to Descartes, matter and spirit are created by God, who is the creator of the exact order of nature that we see, thanks to the light of reasoning (res cogitans). However, in the following centuries the reference to

God was omitted and reality was divided into the human sciences, linked to res cogitans and the natural sciences, which were an expression of res extensa.

Descartes' vision described the material world as a machine which has no intentionality and no spirituality; nature functions according to mechanical laws, and every aspect of the material world can be explained based on its position and movement. This mechanical vision was extended by Descartes to living organisms, in the attempt to organize a complete natural science. Plants and animals were considered simply as machines, whereas human beings were "inhabited" by a rational soul (res cogitans) linked to the body (res extensa) through the pineal gland, at the center of the brain. The human body, on the other hand, was like the body of an animal-machine.

This highly mechanistic vision of nature was inspired by the high precision that was being achieved at the time by the technology and art of clock-making. Descartes compared animals to "clocks with mechanisms and springs" and extended this comparison to the human body, comparing a sick body to a badly build clock, and on the other hand, a healthy body to a well-constructed and perfectly functioning clock.

The duality between science and religion reached its maturity in the works of Isaac Newton (1642-1728). Newton was an English physicist and mathematician, who is widely recognized as one of the most influential scientists and as a key figure in the scientific revolution.

His book *Philosophiæ Naturalis Principia Mathematica* (Mathematical Principles of Natural Philosophy), first published in 1687, laid the foundations for classical mechanics. Newton's Principia formulated the laws of motion and universal gravitation, which dominated scientists' view of the physical universe for the next three centuries.

By deriving Kepler's laws of planetary motion from his mathematical description of gravity, and then using the same principles to account for the trajectories of comets, the tides, the precession of the equinoxes, and other phenomena, Newton removed the last doubts about the validity of the heliocentric model of the cosmos. This work also demonstrated that the motion of objects on Earth and of celestial bodies could be described by the same principles.

Nonetheless, Newton was also an insightful and erudite theologian. He wrote many works that would now be classified as occult studies and religious tracts dealing with the literal interpretation of the Bible. He believed in a monotheistic God as the masterful creator, whose existence could not be denied in the face of the grandeur of all creation, and he held a Christian faith.

Before Newton the Church considered science a threat. But with Newton mechanistic science and dogmatic religion could coexisting in the same person. Mechanistic science deals with physical reality, whereas dogmatic religion deals with the meaning of life and the invisible aspects of reality. The alliance between mechanistic science and dogmatic religion soon took shape, and to guarantee the peaceful coexistence between science and religion, science had to remain within the boundaries of the mechanistic approach. Any attempt to go beyond mechanical causation was and still is fiercely rejected.

This dichotomy allowed for the industrial revolution, which would have been otherwise impossible.

After Newton the Church started supporting the mechanistic vision. Institutions such as the Pontificial Academy of Sciences hold membership rosters of the most respected names in science, including Nobel laureates. While supporting the mechanistic approach, these institutions severely censored any attempt to expand science beyond the mechanistic vision.

- *Crisis of duality*

Galilean relativity states that the fundamental laws of physics are the same in all inertial systems. Galileo used the example of a ship travelling at constant velocity, without rocking, on a smooth sea; any observer doing experiments below the deck would not be able to tell whether the ship is moving or stationary. The Galilean principle of relativity says that in inertial systems, i.e., systems that move in a uniform motion, the same laws of mechanics apply: no experiment conducted within a given inertial system can highlight the uniform motion of the system, and the laws of physics are always of the same form. Galileo understood that it is not possible to detect if a system is fixed or moves with uniform motion. This principle was formulated as follows:[13]

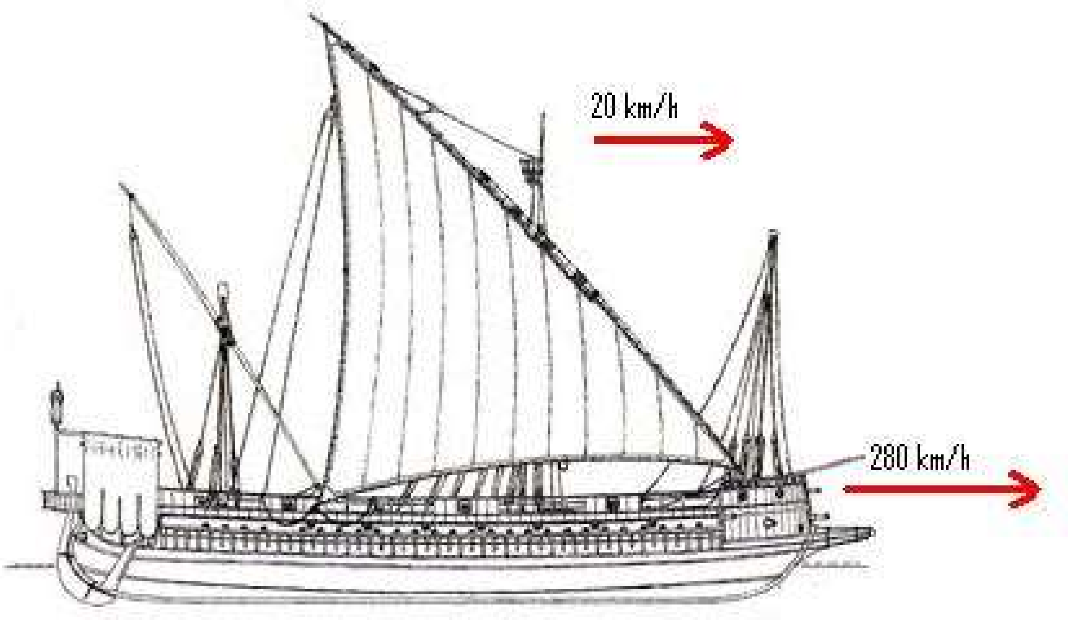
> "*Shut yourself up with some friend in the main cabin below decks on some large ship, and have with you there some flies, butterflies, and other small flying animals. Have a large bowl of water with some fish in it; hang up a bottle that empties drop by drop into a wide vessel beneath it. With the ship standing still, observe carefully how the little animals fly with equal speed to all sides of the cabin. The fish swim*

[13] Galileo Galilei (1623), Dialogue Concerning the Two Chief World Systems, Second Day.

indifferently in all directions; the drops fall into the vessel beneath; and, in throwing something to your friend, you need throw it no more strongly in one direction than another, the distances being equal; jumping with your feet together, you pass equal spaces in every direction. When you have observed all these things carefully (though doubtless when the ship is standing still everything must happen in this way), have the ship proceed with any speed you like, so long as the motion is uniform and not fluctuating this way and that. You will discover not the least change in all the effects named, nor could you tell from any of them whether the ship was moving or standing still.

In jumping, you will pass on the floor the same spaces as before, nor will you make larger jumps toward the stern than toward the prow even though the ship is moving quite rapidly, even though during the time that you are in the air the floor under you will be going in a direction opposite to your jump. In throwing something to your companion, you will need no more force to get it to him whether he is in the direction of the bow or the stern, with yourself situated opposite. The droplets will fall as before into the vessel beneath without dropping toward the stern, although while the drops are in the air the ship runs many spans. The fish in their water will swim toward the front of their bowl with no *more effort than toward the back and will go with equal ease to bait placed anywhere around the edges of the bowl. Finally, the butterflies and flies will continue their flights indifferently toward every side, nor will it ever happen that they are concentrated toward the stern, as if tired out from keeping up with the course of the ship, from which they will have been separated during long intervals by keeping themselves in the air. And if smoke is made by burning some incense, it will be seen going up in the form of a little cloud, remaining still and moving no more toward one side than the other. The cause of all these correspondences of effects is the fact that* *the ship's motion is common to all the things contained in it, and to the air also. That is why I said you should be below decks; for if this took place above in the open air, which would not follow the course of the ship, noticeable differences would be seen in some of the effects noted."*

Galileo noted that for an observer, on an inertial system, it is impossible to conclude whether the system is moving or stationary. For an observer on another inertial system, for example on the seashore and looking to the ship in motion, the speeds of bodies on the ship will add up to the speed of the ship. For example, if a ship is moving at 20 km/h and a cannon ball is fired at 280 km/h in the same direction to the movement of the ship, the observer on the seashore will see the cannon ball move at 300 km/h, 280 km/h of the speed of the cannon ball plus 20 km/h of the speed of the boat.



Galileo's relativity allowed to generalize the mechanistic vision

If the cannon ball were fired in the opposite direction to the movement of the ship the resulting speed would be 260 km/h, 280 km/h of the speed of the cannon ball minus 20 km/h of the speed of the boat (speeds are subtracted because they move in opposite directions).

On the contrary for a sailor on the ship sharing the same movement of the ship, the cannon ball would always move at 280 km/h in any direction he would fire it. Therefore, if an observer on the seashore sees the cannon ball moving at 300 km/h and the boat in the same direction at 20 km/h he can conclude that the ball was fired at 280 km/h.

Galileo's relativity states that when changing an inertial system, speeds are added or subtracted based on their relative speeds. In Galileo's relativity, speeds are relative to the inertial system, while time flows in an absolute way for all the systems. Galileo's relativity provided the way to generalize the laws of mechanics. Classical physics is based on Galileo's relativity.

In 1886 two American physicists, Michelson and Morley, conducted experiments which show that

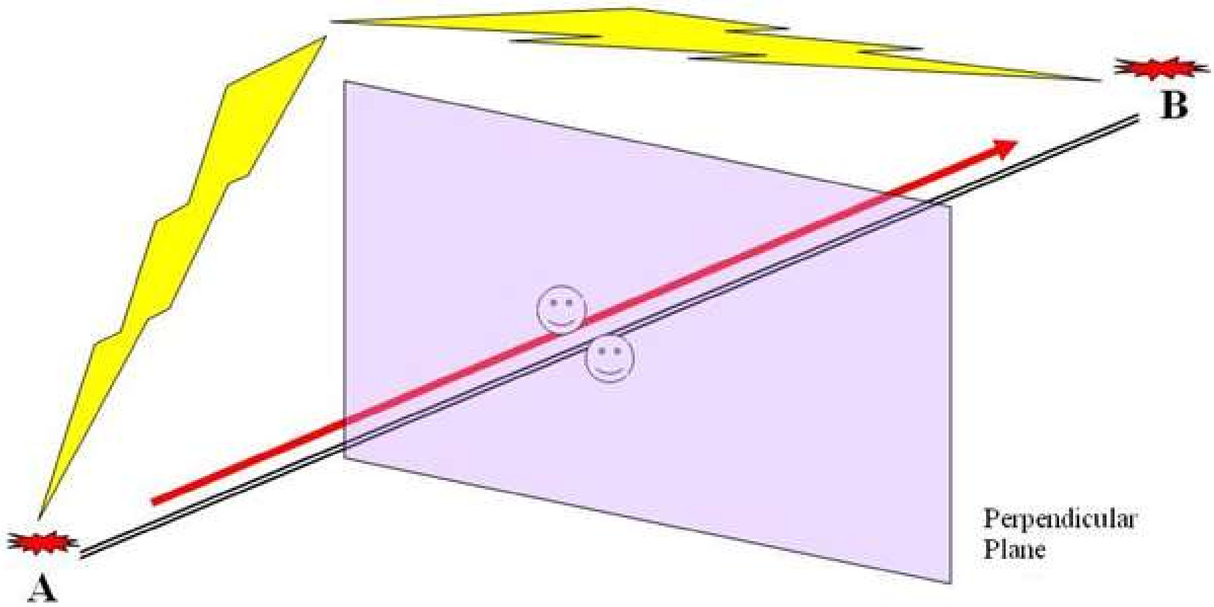
Galileo's relativity does not apply when dealing with the speed of light. They found that the speed of light does not add up to the speed of the body which is emitting it.

Let us imagine now, after 500 years, an astronaut on a very fast spaceship heading towards Earth at 20,000 km/s who shoots a laser light ray towards Earth (at 300,000 km/s). An observer on Earth will not see the laser light move at 320,000 km/s, as Galileo's relativity would predict, but it will see it move at 300,000 km/s (because the speed of light is a constant). According to Galileo's relativity, the observer on Earth would expect that the astronaut on the spaceship would see the light ray move at 280,000 km/s (300,000 km/s of the speed of light minus 20,000 km/s of the space ship) but, on the contrary, also the astronaut on the space ship sees the laser ray move at 300,000 km/s.

In 1905, analyzing the results obtained by Michelson and Morley, Albert Einstein found himself forced to invert Galileo's relativity according to which time is absolute and speed is relative. To describe the fact that the speed of light is constant, it was necessary to accept that time is relative. When we move in the direction of light our time slows, and for us light continues to move at the same speed. This leads to the conclusion that approaching the speed of light time would slow down and stop, and if we could move at speeds higher than the speed of light, time would reverse.

In other words, events which happen in the direction in which we are moving become faster, because time slows down, but events which happen in the direction from which we are coming become slower, because time becomes faster.

In order to explain this situation, Einstein liked to use the example of lightning which strikes a railway simultaneously in two different points, A and B, far away from each other.[14]



Two observers who share the same point of space at the same moment, cannot agree on the events which are happening in the direction in which the second observer is moving.

An observer sitting on a bench half-way would see the lightning strike the two points simultaneously, but a second

[14] Einstein A. (1916) Relatività, esposizione divulgativa, Universale Bollati Boringhieri, Torino 1967.

observer on a very fast train moving from A to B passing next to the first observer when the lightning strikes the two points would have already experienced the lightning striking point B, but would have not experienced the lightning striking point A.

Even if the two observers share the same point of space at the same moment, they cannot agree on the events which are happening in the direction in which the second observer is moving.

Agreeing on the existence of contemporary events is therefore linked to the speed at which the observers are moving.

Time flows differently if the event is happening in the direction towards which we are moving, or in the direction from which we are coming.

This example is limited to two observers; but what happens when we compare more than two observers moving in different directions at high speeds?

The first couple (one on the bench and the other in the train) can reach an agreement only on the contemporary existence of events which happen on a plane perpendicular to the movement of the train.

If we add a third observer moving

in another direction but sharing the same place and moment with the other two observers, they will agree only on events placed on a line which unites the two perpendicular planes.

If we add a fourth observer, they will agree only on a point which unites the three perpendicular planes.

If we add a fifth observer, who is not even sharing the same point in space, no agreement would be possible at all.

If we consider that only what happens in the same moment exists (Newton's time concept), we would be forced to conclude that reality does not exist.

To re-establish an agreement between the different observers, and in this way the existence of reality, we need to accept the coexistence of events which could be future or past for us, but contemporary for another observer. Extending these considerations, we arrive at the necessary consequence that past, present and future coexist.[15]

Einstein himself found it difficult to accept this consequence of special relativity since it is intuitive to imagine causality which flows

[15] Fantappiè L. (1955a) Conferenze scelte, Di Renzo Editore, Roma 1993.

from the past to the future, but counterintuitive to imagine causality flowing from the future to the past. Einstein used the term Übercausalität (supercausality) to refer to this new model of causality.

Yet, Einstein understood that extending the current scientific paradigm to supercausality would reopen the conflict between science and religion. He therefore found a stratagem which permitted to reduce the equations of Special Relativity to the $E=mc^2$ relation, which only deals with classical time and causality.

Few people know that the mass-energy relation $E=mc^2$, which is usually attributed to Albert Einstein, had been published by several others before, including:

- the Englishman Oliver Heaviside[16] in 1890 in his Electromagnetic Theory vol. 3.
- the Frenchman Henri Poincaré[17] in 1900.
- the Italian Olinto De Pretto in 1903 in the scientific journal "Atte" and registered at the "Regio Istituto di Scienze".[18]

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[16] Auffray J.P., Dual origin of E=mc2:http://arxiv.org/pdf/physics/0608289.pdf

[17] Poincaré H,. Arch. néerland. sci. 2, 5, 252-278 (1900).

[18] De Pretto O., Lettere ed Arti, LXIII, II, 439-500 (1904), Reale Istituto Veneto di Scienze.

In deriving this equation, Einstein's predecessors made assumptions that led to problems when dealing with different inertial systems, since the quantity of motion was not present in the equation. Einstein succeeded where others had failed by deriving the formula in a way that was consistent in all frames of reference. He did so in 1905 with his equation for Special Relativity, which adds momentum to the $E = mc^2$ equation:

$$E^2 = m^2c^4 + p^2c^2$$

where E is energy, m is mass, p momentum
and c the constant of the speed of light

This equation is known as energy/momentum/mass. However, since it is quadratic, it has two solutions for energy: one positive and one negative.

The positive or forward-in-time solution describes energy that diverges from a cause, for example light diverging from a light bulb or heat spreading out from a heater.

In the negative solution energy diverges backward-in-time from a future cause; imagine beginning with diffuse light energy that concentrates into a light bulb. This, quite understandably, was considered an unacceptable solution since it implies retrocausality, which means that an effect occurs before its cause.

Einstein solved this problem by assuming that the momentum is always equal to zero; he could do this because the speed of physical bodies is extremely small when compared to the speed of light. And so, in this way, Einstein's complex energy/momentum/mass equation simplified into the now famous $E=mc^2$, which always has positive time solution.

But in 1924 Wolfgang Pauli (Austrian physicist, Nobel Prize 1935) discovered that electrons have a spin which nears the speed of light.

Soon after the Swedish physicists Oskar Klein and the German physicist Walter Gordon proposed the Klein-Gordon equation, to describe quantum particles in the framework of Einstein's relativity. This equation uses the full energy/momentum/mass equation of Special Relativity and yields two solutions: a forward-in-time wave solution (delayed waves) and a backward-in-time wave solution (advanced waves). But since the negative time solution was considered unacceptable, it too was rejected.

Werner Heisenberg (German

physicist, Nobel Prize 1932) wrote to Wolfgang Pauli: "*I regard the backward-in-time solution ... as learned trash which no one can take seriously*"[19] and in 1926 Erwin Schrödinger (Austrian physicist, Nobel Prize 1933) removed Einstein's equation from the Klein-Gordon equation and suggested that time be treated in essentially the classical mechanical way, as only flowing forward.

Whereas the Klein-Gordon equation could explain the dual nature of matter (particle/wave), because of the dual causality

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[19] Heisenberg W. (1928), Letter to W. Pauli, PC, May 3, 1928, 1: 443.

(forward and backward-in-time causality), Schrödinger's equation was not able to explain the wave/particle nature of matter. Consequently, in 1927 Niels Bohr (Danish physicist, Nobel Prize 1922) and Werner Heisenberg met in Copenhagen and suggested an interpretation of quantum mechanics in which matter propagates as waves that collapse into particles when observed. This interpretation, in which the act of observation creates reality, implied the idea that men are endowed with God-like powers of creation and that consciousness precedes the formation of reality. When

Schrödinger discovered how Heisenberg and Bohr had used his equation, with ideological and political implications, he commented: "*I do not like it, and I am sorry I ever had anything to do with it.*"

In 1928 Paul Dirac (English theoretical physicist Nobel Prize in Physics for 1933 with Erwin Schrödinger) used the energy/momentum/mass equation to describe relativistic electrons. He was faced again with a dual solution: electrons (e-) and neg-electrons (e+, the anti-particle of the electron). Heisenberg's reaction was of outrage, since he perceived the backward-in-time solution as an abomination and in 1934 he replaced those parts of the equation which refer to negative energy, with an operator which creates unlimited numbers of "virtual" electron-positron pairs, without any energy input.

In 1934 Heisenberg took this escape window and, since then, physicists ignore the negative energy solutions of the two most used and respected equations in modern physics: the energy/momentum/mass equation of special relativity and Dirac's relativistic equation.

- The dawn of non-dualistic science

The rejection of the backward in time energy solution has made the two theories upon which all modern physics rests, relativity and quantum mechanics, seem incompatible, since when they are combined together an unacceptable supercausal world arises, made of causality and retrocausality which constantly play together.

Furthermore, in the 1930s the scientific debate between special relativity and quantum mechanics was poisoned by political passions.

In April 1933 Einstein learned

that the new German government had passed a law excluding Jews from holding any official positions, including teaching at universities. A month later, the episode of the burning of books by the Nazis occurred, with Einstein's works being among those burnt, and Nazi's propaganda minister Joseph Goebbels proclaimed, "Jewish intellectualism is dead." Einstein's name was on a list of assassination targets, with a $5,000 bounty on his head and one German magazine included him in a list of enemies of the German regime with the phrase, "not yet hanged."

Einstein's treatises were burned,

his suburban villa in Berlin was raided, and his furniture, books, bank account and even his violin were seized. Hitler's ideological convictions about Jewish science had received support from the book "One hundred Authors against Einstein."[20] The theory of relativity was stigmatized as Jewish science, deliriums of a crazy Jew, whereas the Bohr and Heisenberg's Copenhagen interpretation was accepted.

Nevertheless, several scientists were working on the idea of

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[20] Israel H., Ruckhaber E., and Weinmann R. (1931), Hundert Autoren Gegen Einstein, Voigtlander Verlag, Leipzig 1931.

expanding causality beyond mechanical causation.

In 1941, while working on the D'Alembert operator, which combines special relativity with quantum mechanics, the mathematician Luigi Fantappiè[21] realized that the forward-in-time solution (i.e., *delayed waves*) describes energy and matter that diverge and tend towards a

[21] Luigi Fantappiè (1901-1956) was considered one of the foremost mathematicians of the last century. He graduated at the age of 21 from the most exclusive Italian university, "La Normale Di Pisa," with a dissertation on pure mathematics and became a full professor at the age of 27. During the university years he was roommate with Enrico Fermi. He worked with Heisenberg, exchanged correspondence with Feynman, and in April 1950 he was invited by Oppenheimer to become a member of the exclusive Institute for Advanced Study in Princeton and work with Einstein.

homogeneous and random distribution.

For example, when heat radiates from a heater, it tends to spread out homogeneously in the environment; this is the law of entropy, which is also known as heat death. Fantappiè showed that the forward-in-time solution is governed by the law of entropy, whereas the backward-in-time solution (i.e. *advanced waves*) is governed by a symmetric law that Fantappiè named syntropy (combining the Greek words *syn*=converging and *tropos*=tendency).

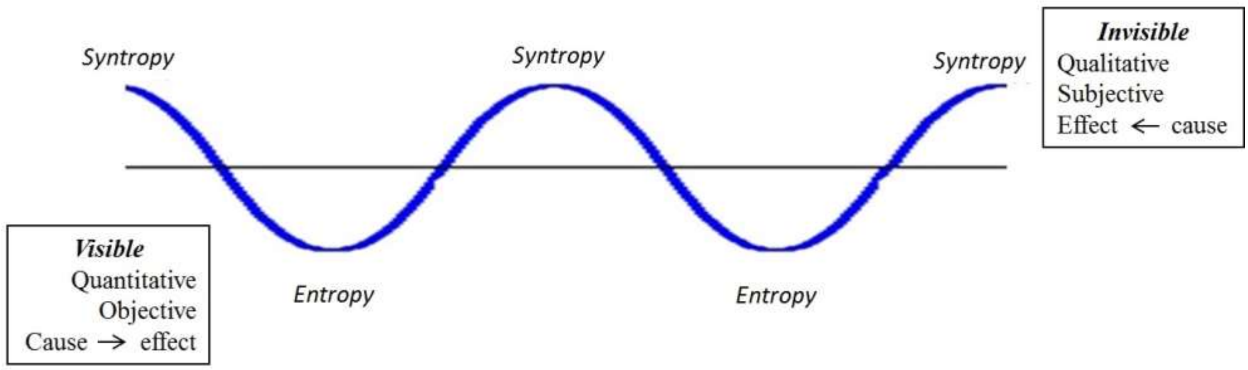
The forward-in-time solution

describes energy that diverges from a cause and requires that causes be in the past; the backward-in-time solution describes energy and matter that converge towards future causes (i.e., attractors).

The mathematical properties of the law of syntropy are energy and matter concentration, an increase in differentiation and complexity, a reduction of entropy, the formation of structures, and an increase in order. These are also the main properties that biologists observe in life and which cannot be explained in the classical (time forward) way.

This realization led Fantappiè to

formulate "*The Unitary Theory of the Physical and Biological World*", first published in 1944, where he suggests that we live in a supercausal universe, governed by causality and retrocausality, and that life is caused by the future.[22]



The Unitary Theory states that syntropy is perceived in the form of consciousness, subjective and

[22] Fantappiè L. (1942), Sull'interpretazione dei potenziali anticipati della meccanica ondulatoria e su un principio di finalità che ne discende, Rend. Acc. D'Italia, 1942, 4(7).

qualitative experiences, at the same time invisible and vital for life.

Similar considerations were reached by the paleontologist Teilhard de Chardin who pointed out the need for a law symmetrical to entropy:

> "*Reduced to its essence, the problem of life can be expressed as follows: once we admit the two major Laws of Energy Conservation and of Entropy (to which physics is limited), how can we add, without contradictions, a third universal law (which is expressed by biology) ... The situation is clarified when we consider at the basis of cosmology the existence of a second kind*

of entropy (or anti-entropy).”[23]

Teilhard de Chardin was a paleontologist and well-known evolutionary scientist and became famous after his death with the publication of his books, among which The Phenomenon of Man and Towards Convergence.

Teilhard could not see traces of Darwin’s evolutionary theory in paleontology, since the transition species are missing, and suggested a model of evolution which broadens science to a new type of causality which retro-acts from the

[23] Teilhard de Chardin P. (2008), Il fenomeno umano. Queriniana, Brescia, 2008.

future. For Teilhard life is guided by attractors which converge in the Omega point.

Teilhard considered reality organized in three main concentric spheres. The innermost sphere is the final aim of the evolution of the universe, in which all of matter will be transformed into organic and conscious matter, and it is also the closest to the Omega point. The outer sphere is the most distant from the Omega point, the realm of inanimate matter. The middle sphere is the realm of life which does not yet reflect on itself, the biosphere.

In 1958 a decree of the Holy

Office, chaired by Cardinal Ottaviani, imposed religious congregations to withdraw the works of Teilhard from all their libraries. The decree states that the books of the Jesuit "*offend Catholic doctrine*" and alerted the clergy to "*defend the spirits, especially of the young, from the dangers of the works of father Teilhard de Chardin and his disciples.*"

The hypothesis of a different type of causality had been postulated also by Hans Driesch (1867-1941), a pioneer in experimental research in embryology. Driesch suggested the existence of causes which act in a top-down way (from global to analytical, from the future to the past) and not in a bottom-up way, as it happens with classical causality. These causes would lead life to develop and evolve, and would coincide with the purpose, the biological potential.

They were named by Driesch entelechy.[24] Entelechy is a Greek word whose derivation (en-telos) means something that contains its own end or purpose, and that evolves towards this end. So, if the path of normal development is interrupted, the system can achieve the same end in another way.

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[24] Driesch H. (1908), The Science and Philosophy of the Organism, www.gutenberg.org/ebooks/44388

Driesch believed that the development and behavior of living systems are governed by a hierarchy of entelechies, which all result in an ultimate entelechy.

The demonstration of this phenomenon was provided by Driesch using sea urchin embryos. Dividing cells of the embryo of sea urchin after the first cell-division, he expected each cell to develop into the corresponding half of the animal for which it had been designed or pre-programmed, but instead he found that each developed into a complete sea urchin. This also happened at the four-cell stage: entire larvae ensued from each of the four cells, albeit smaller than usual. It is possible to remove large pieces from eggs, shuffle the blastomeres and interfere in many ways without affecting the resulting embryo. It appears that any single monad in the original egg cell can form any part of the completed embryo. Conversely, when merging two young embryos, a single sea urchin results and not two sea urchins.

These results show that sea urchins develop towards a single morphological end. The moment we act on an embryo the surviving cell continues to respond to the final cause that leads to the formation of structures. Although smaller, the structure which is reached is like that which would have been obtained by the original embryo.

It follows that the final form is not caused by the past or by a program, a project or a design which act from the past, since any change we introduce in the past leads to the formation of the same structure. Even when a part of the system is removed or the normal development is disturbed, the final form is reached, and it is always the same.

Another example is that of the regeneration of tissues. Driesch studied the process by which organisms can replace or repair damaged structures. Plants have an amazing range of regenerative capabilities, and the same happens with animals. For example, if a flatworm is cut into pieces, each piece regenerates a complete worm. Many vertebrates have extraordinary capabilities of regeneration. If the lens of the eye of a newt is surgically removed, a new lens is regenerated from the edge of the iris, whereas in the normal development of the embryo the lens is formed in a very different way, starting from the skin. Driesch used the concept of entelechy to account for the properties of integrity and directionality in the development and regeneration of bodies and living systems. Driesch argued that many of the basic problems of biology cannot be solved by an approach in which the organism is simply considered a machine.

Driesch works have been accused of implying metaphysical teleology and vitalism and have been rejected.

Wilhelm Reich (1897-1957) was an Austrian psychoanalyst, and one of the most radical figures in the history of psychiatry. He was the author of several influential books and essays, most notably *Character Analysis* (1933), *The Mass Psychology of Fascism* (1933), and *The Sexual Revolution* (1936). His work on character contributed to the development of Anna Freud's *The Ego and the Mechanisms of Defense* (1936), and his idea of muscular armor.

It was in New York in 1939 that Reich first stated he had discovered a life force, or cosmic energy. He said he had seen traces of it when he injected his mice with bions. In 1940 he began to build insulated Faraday cages that he believed would concentrate the orgone and called them orgone accumulators. These accumulators were tested on mice with cancer, and on plant growth. Reich showed that orgone can destroy cancerous growth, since tumors in all parts of the body disappear or diminish.

In 1956 Reich was sentenced to two years in prison, and in June and August of that same year over six tons of his publications were burned by order of the court. One of the most notable examples of censorship in the history of the United States. He died in jail of heart failure just days before he was due to apply for parole.

In the preface to Flatland Abbott adds:[25]

"Even I -- who have been in Spaceland and have had the privilege of understanding for twenty-four hours the meaning of 'height' -- even I cannot now comprehend it, nor realize it by the sense of sight or by any process of reason (...) I tried to prove to him that he was 'high', as well as long and broad, although he did not know it. But what was his reply? 'You say I am high; measure my high-ness and I will believe you.' What could I do? How could I meet his challenge? I was crushed; and he left the room triumphant (…) Then

[25] Abbott EA (1884), Flatland, Seely & Co, UK.

put yourself in a similar position. Suppose a person of the Fourth Dimension, condescending to visit you, were to say, 'Whenever you open your eyes, you see a Plane (which is of Two Dimensions) and you infer a Solid (which is of Three); but in reality you also see (though you do not recognize) a Fourth Dimension, which is not color nor brightness nor anything of the kind, but a true Dimension, although I cannot point out to you its direction, nor can you possibly measure it.' What would you say to such a visitor? Would not you have him locked up?"

After the end of World War II, any finding which was extending science beyond mechanical causation was censored and fiercely suppressed. The aim of science was no longer authentic knowledge and sharing, but it had become a matter of power. Digressions from the mechanistic paradigm were no longer tolerated and were punished with fierce censorship, discredit, and removal from the academic or research position. A new era in science[26] took shape where profit-seekers, scientists as well as institutions, became secretive, often inserting wrong information in their manuscripts, so that others

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[26] Bauer H. (2012), Dogmatism in Science and Medicine: How Dominant Theories Monopolize Research and Stifle the Search for Truth, McFarland, 2012

could not benefit from the knowledge of crucial details of their work.[27]

Sharing of information became a rarity[28], and fraud and dishonesty the norm.

The absolute necessity for uninterrupted flows of grant money brought enormous pressure to take on only projects that guarantee publications, on aggressively curate scientific journals. Luxury-scientific journal editors started building bubbles in fashionable fields, where

[27] Hazen R.M. (1988), The Breakthrough: The Race for the Superconductor, Summit Books / Simon & Schuster.
[28] Mirowski P. (2011), Science-Mart: Privatizing American Science, Harvard University Press.

researchers can make the bold claims these journals want, while discouraging other important works:

> *"I work in a psychiatric research group and the highest cited papers are in psychiatric genetics, where non-replication is the norm. These studies have only managed to account for a small proportion of the variance in severe mental illness. But research into social risk factors (e.g. childhood adversity, migration, poverty), which are known to be important determinants of mental health, is rarely funded by the research councils, despite its obvious utility in promoting public*

mental health, and is never published in Nature, Science or any of the highest impact journals. There is a negative correlation between the usefulness of research and its likelihood of appearing in the top journals."[29]

- Probabilities or possibilities?

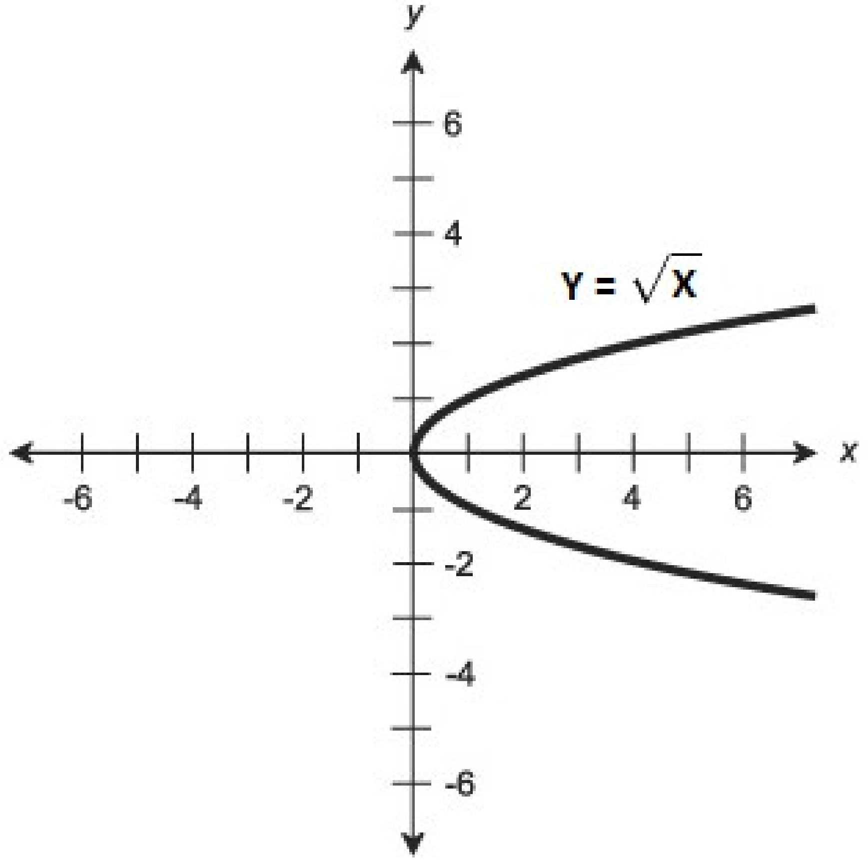
The conflict between special relativity and quantum mechanics, which can be traced back to Einstein's "*God does not play dice*" and to the rejection of the use of probability in physics, led Einstein

[29] www.theguardian.com/commentisfree/2013/dec/09/how-journals-nature-science-cell-damage-science

to the belief that a new mathematics is needed.

Einstein was accused of hardline determinist, but Wolfgang Pauli showed that Einstein was not a determinist but a realist, with the belief that the deeper forms of causality, brought to light in relativity and quantum theory, can be understood only in terms of what Einstein named *Übercausalität*, supercausality, and that supercausality requires "*an entirely new kind of mathematical thinking*."

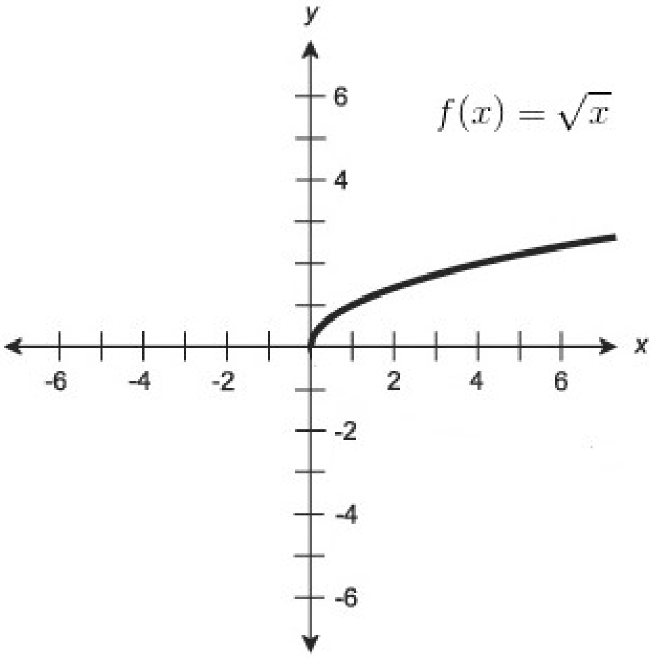
The problem with mathematics is that it must be deterministic. To guarantee determinism, functions are "injective", which means that to each value of x only one value of y can be associated. But square roots (which are at the basis of supercausality) Always provide two values for y, one positive and one negative. For example, the square root of number 4 (in the x axis) results in the values 2 and -2 (in the y axis).



Graphical plotting of square root values

This makes square roots non-deterministic and non-injective and creates a paradox within the mechanistic approach, since any x value is associated to two y values.

Mathematicians responded to this paradox in an arbitrarily way, considering only the positive values of square roots and pretending that the negative values do not exist.



Square root function. Negative values are arbitrarily omitted

Furthermore, the idea that the "*book of nature*" is written in mathematical characters and that the aim of science is to find the exact functions which govern causality, proved wrong in life and population studies.

Population studies have been taking place for thousands of years, with the first known census undertaken nearly 6,000 years ago by the Babylonians in 3,800 B.C. Records show that Babylonians undertook censuses every 6 or 7 years, counting the number of people and livestock, as well as quantities of butter, honey, milk, wool and vegetables. The oldest existing census in China took place during the Han Dynasty in the year 2 A.D. Censuses were a key element of the Roman system of administration and were carried out every five years and provided a register of citizens and their property.

The word census originates from the Latin word ‘censere’ which means ‘estimate’. The Bible’s Book of Numbers describes the counting of the Israelite population during the Flight from Egypt and of course the best-known reference to a Roman census, is when the birth of Jesus occurred in Bethlehem and

Mary and Joseph had to travel there to be enumerated. The most famous historic census in Europe is the Domesday Book which was undertaken by William the Conqueror in 1086.

Population studied brought to the development of a different approach to numbers, which in the 18th century took the name of “statistics”. Statistics was initially limited to the systematic collection of demographic and economic data, but it soon developed in the study of causality, and it is now widely applied in experimental sciences and in the field of inference, which is the process of deriving logical conclusions from premises known or assumed to be true.

Statistics uses probabilities and this makes it non-deterministic and profoundly different from mathematics.

On the other hand, statisticians generally feel an inferior towards mathematicians and tend to compensate this feeling trying to turn statistics into a highly complex mathematics.

An example is provided by logistic functions, which were developed in 1845 in the field of population forecast, by the mathematician and doctor in number theory Pierre

François Verhulst.

Verhulst was inspired by Thomas Malthus' book "*An Essay on the Principle of Population*"[30], first published in 1798. Malthus stated that every twenty-five years the population grows according to a geometrical ratio (1, 2, 4, 8, 16, 32, 64, 128, 256 ...), while the amount of food available grows according to an arithmetical ratio (1, 2, 3, 4, 5, 6, 7, 8, 9 ...); therefore, while the population doubles, food resources show a much more modest increase. Consequently, Malthus

[30] Malthus T.R. (1798), An Essay on the principle of population as it affects the future improvement of society, Reprint, London: Reeves and Turner, 1878.

forecast was that in the year 2,000 the proportion between population and food resources would be 4,096 to 13 and food resources would not be sufficient for the needs of the population. Malthus believed that, to stop this rapid growth of population, famine and disease were needed and were the two main instruments of population control. Hunger, epidemics, wars, but also the extermination of babies would contribute to control the population, thus balancing the population and the food.

Logistic functions compare growth with available resources and essentially incarnate Malthus ideology. Even though they lead to systematically wrong results, they are extensively used in fields that range from artificial neural networks, biology, demography, economics, psychology, sociology, and political science. Examples of wrong predictions are frequent in demography, financial projections (this was one of the major causes of the 2007 financial crisis), and in the field of economics.

People think of statistics as a kind of mathematics, but statistics and mathematics are used in different fields.

Statistics is mainly used in life sciences, such as demography, economics, biology, medicine, psychology, and sociology, whereas mathematics is used in deterministic sciences, such as engineering and physics.

This difference suggests that statistics is linked to life, whereas mathematics is linked to non-life.

This consideration has led the first statisticians to question the difference between organic and inorganic, to better understand the specificity of statistics and mathematics. An example was provided by the faculty of Statistics in Rome, where regular meetings were held to study the difference between organic and inorganic.

Experts from the most diverse disciplines were invited to participate.

Nonetheless, a new approach is taking shape. This approach, first named cybernetics, is used in computer programming, and involves loops that require feedbacks, which trigger choices. It is different from mathematics since it treats data in the binary (0/1) form and not in the quantitative form.

Translating all the information in bit of information (which can only be 0 or 1) the highest complexity can be achieved, whereas using the quantitative approach only few very limited applications are possible.

Similarly, in the field of statistics when translating all the information in the dichotomous form 0/1, the most complex analyses are possible. Qualitative and quantitative variables, subjective and objective, can be translated in the 0/1 form, which allows to handle together an unlimited number of variables.

This new approach is based on choices. Choices between different possibilities. Choices can be deterministic, as it usually happens with computer programs, or non-deterministic as it happens with statistics.

In both cases, the key idea is that we live in a realm of possibilities which are not governed by linear functions or logistic equations, but by complex interactions among systems and context.

- The decline of science?

In 1989, the American National Academies of Science (NAS) published a booklet entitled *On Being a Scientist*, in 1995 it added the sub-title A Guide to Responsible Conduct in Research. In the same period, the National Institutes of

Health (NIH) established an Office of Research Integrity[31], which all too often reports penalties enacted on researchers who have been found dishonest.

On the first of October 2012, The Guardian published the article "*Tenfold increase in scientific research papers retracted for fraud. Study of 2,047 papers on PubMed finds that two-thirds of retracted papers were down to scientific misconduct, not error.*"[32] A study, published on the Proceedings of the National Academy of Sciences (PNAS)[33], found that papers are

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[31] http://ori.hhs.gov/

[32] www.theguardian.com/science/2012/oct/01/tenfold-increase-science-paper-retracted-fraud

[33] www.pnas.org/content/109/42/17028

retracted mainly because of fraud. In the 5 October 2012 editorial of the New York Times "*Fraud in the scientific literature*"[34] it is suggested that researchers are competing for inadequate available resources[35] and have become grant-seekers, who continuously need to publish.

This situation is leading researchers towards deliberate fraud and dishonesty, which is now considered to be endemic within

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[34] www.nytimes.com/2012/10/06/opinion/fraud-in-the-scientific-literature.html?_r=0

[35] Freeland Judson H. (2004), The Great Betrayal: Fraud In Science; Etchells P. and Gage S. (2012), Scientific fraud is rife: it's time to stand up for good science. The way we fund and publish science encourages fraud, The Guardian, 2 November 2012.

science.[36,37]

Publish or perish is a phrase coined to describe the pressure to publish scientific works rapidly and continuously. Frequent publications are one of few methods at disposal to demonstrate scientific talent. Successful publications bring attention and sponsoring institutions and facilitate funding. Scientists who publish infrequently, or who focus on activities that do not result in

[36] Broad W. and Wade N. (1982), Betrayers of the Truth: Fraud and Deceit in the Halls of Science, Simon & Schuster, 1982.

[37] Bauer H. (2014), The Science Bubble, EdgeScience #17, February 2014, http://www.scientificexploration.org/edgescience/

publications, find themselves out of the funding tracks. It is now widely recognized that the pressure to publish is one of the main causes of poor research and fraud in science.

Scientific fraud is usually perpetrated using the experimental method, at the moment of data analysis, using complex mathematical models which allow for easy manipulation or by keeping or removing outliers.[38]

The experimental method

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[38] In statistics, an outlier is an observation that is distant from other observations. An outlier may be due to variability in the measurement, or it may indicate experimental error. Consequently, it is commonly accepted that researchers can freely include or exclude outliers from the data set, changing in this way the outcome of the results.

provides a path that, starting from similar groups, introduces a treatment and attributes the differences (effects) to the treatment (cause). This methodology is based on the study of differences. But differences can be manipulated by keeping or removing outliers.

A widespread chorus of scientists is calling for a change towards a new way of doing science, which will comprise qualitative and quantitative information, objective and subjective, and consider the context and complexity.

In the following chapter another path in the study of causality is described. It is provided by the methodology of concomitant variations, which instead of studying differences among groups searches for concomitances among variables.

3

METHODOLOGY

When applied to life the experimental method shows noteworthy limitations. First, it can study only cause and effect relations. It also needs quantitative data, since it is based on the comparison of groups, and this is done using mean values and variances, i.e., techniques which work only when data can be added. These requirements have limited the study of living systems to a reductionist approach, which holds that a complex system is nothing more than the sum of its parts, and that an account of it can be abridged to its individual constituents.

It is widespread the belief that science coincides with the experimental method and this belief has left out all what is qualitative and subjective.

The following words of Francesco Severi[39] well describe this situation:

"*About the problem of finality, I am*

[39] Francesco Severi was the founder of the National Institute of Higher Mathematics in Rome.

very embarrassed to express an opinion on what someone very close to me calls the discovery of scientific finalism. Science ceases to be science when its results do not express causal results. It is possible to speak of finality in science, but only in a metaphysical sense, having no claim to prove anything positive about it. This is because:

- *it is not possible to deduct hypotheses from the fact that life is subject to final causes.*
- *pure logic cannot be used as a scientific demonstration.*
- *finality cannot be demonstrated using the experimental method,*

because no experiment can be established, without acting on the causes prior to the effects.

Finalism, in short, is in my opinion an act of faith, not an act of science."

In 1843, John Stuart Mill described the *methodology of concomitant variations*, which provides an alternative to the experimental method:

"*Whatever phenomenon varies in any manner whenever another phenomenon varies in some particular manner, is either a cause or an effect of that phenomenon or is connected with it* *through some fact of causation*."[40]

This chapter is divided in:

- a description of the experimental method.
- a description of the methodology of concomitant variations.
- three examples.

- *The experimental method*

The experimental method is based on the *methodology of differences*, which

[40] Mill J.S. (1843), A System of Logic, University of Toronto Press, 1843.

John Stuart Mill described in the following way:

> "*If an instance in which the phenomenon under investigation occurs, and an instance in which it does not occur, have every circumstance in common save one, that one occurring only in the former; the circumstance in which alone the two instances differ, is the effect, or the cause, or an indispensable part of the cause, of the phenomenon.*"

The methodology of differences works in the following way:

- two similar groups are formed (experimental and control group).
- Treatment (the cause) is given only to the experimental group and all the other conditions are kept equal, so that the control group differs from the experimental group only for the treatment.
- Consequently, any difference observed between the experimental group and the control group can be attributed solely to the treatment, because only this condition was changed between the two groups.

To have similar groups, randomization is used in the belief that it should distribute evenly all the intervening variables, between the experimental and the control group. But no controls are performed to verify if the condition of similarity is satisfied and often the experimental and control groups are different ever since the beginning of the experiment. A single person with extreme values can produce differences which are not due to the cause (i.e., treatment), but are due to the initial dissimilarity of the control and experimental groups.

For example, to test the effect of a drug the experimental procedure is the following:

- two similar groups are formed, assigning subjects randomly to the experimental group or to the control group.
- The drug is given only to the experimental group, while all the other circumstances are left similar. The control group is therefore given a placebo, a similar substance which has no effect.
- The differences observed between the two groups can be

attributed solely to the effect of the drug.

Differences are the effect, and the drug (also called treatment) is the cause.

The following conditions are needed:

– *Adding of effects*. To study differences between groups it is necessary that the effect can be added among the experimental subjects. For example, if a drug increases in some subjects the reaction times, whereas in others subjects it reduces the reaction times, when adding these opposite effects, a null effect is obtained. The effect exists, but it is invisible to the methodology of differences.

- *Quantitative data*. Differences can be calculated only when using quantitative data, i.e., data which can be added together. For this reason, experiments are conducted using laboratory measurements. On the contrary, qualitative data cannot be added and it is unsuitable when using the experimental method.
- *Controlled conditions*. All possible

sources of variability must be controlled. It is important that nothing, besides the treatment, the cause that we administer, can influence the variability of groups. For this reason, a controlled environment, which allows to keep alike all the possible sources of variability and in which each subject is treated exactly in the same way, is needed. Controlled environments require laboratory settings, which are very different from the natural context. The need for controlled settings excludes the big picture and limits the experimental method to analytical knowledge, detached from the context and from complexity.

- *Analyticity*. It is possible to study differences considering only one cause at a time (one treatment at a time or at the fewest treatments when studying their interaction).
- *Similar groups*. When samples are small (less than 300 subjects), randomization does not guarantee the formation of similar groups, and differences between the two groups may not depend on the treatment, but on the initial diversity of groups.

Common mistakes:

– *Extreme values*. Differences can be caused by single extreme values. Just one single outlier[41] can cause statistically significant results and lead to assert effects that do not exist. Outliers are often kept or removed to manipulate results.
– *Data transformation*. In statistics, data transformation refers to the application of a deterministic mathematical function to each point in a data set which is

[41] In statistics, an outlier is an observation that is distant from other observations.

replaced with the transformed value. A common example are logarithmic transformations. In theory, any mathematical function can be used to transform the data set. Operating in this way, it is often possible to obtain differences between the two data sets, when there are no effects.

– *Invisibility of the effect*. When the effect shows in opposite directions, differences cannot be assessed, and the effect becomes invisible.

From a statistical point of view the

methodology of differences is embodied in parametric statistical techniques which compare mean and variance values, such as *Student's t* and the *analysis of variance* (ANOVA).

These techniques require that effects can be added that data is quantitative and normally distributed (according to a Gaussian distribution), and groups are initially similar and are from the same population.

But these requirements cannot be met in life sciences and parametric techniques end producing results that are inconsistent, unstable and often incorrect. Nevertheless, ANOVA has become a requirement of all the scientific journals and only results obtained using ANOVA, or the comparison of means, are published.

It is therefore of no surprise that a study published on JAMA (Journal of the American Medical Association), which revisited the results produced using the experimental method (ANOVA) and published in the period from 1990 to 2003 in 3 major scientific journals and cited at least 1,000 times, found that a study out of three was refuted by other experimental works. This finding raises serious doubts about the experimental method, when used in life sciences.[42]

In May 2011 Arrosmith published in the Journal Nature[43] a study which shows that the ability to reproduce the results from phase 1 to phase 2 decreased in the period 2008-2010 from 28% to 18%, despite results were statistically robust in phase 1.[44]

Gautam Naik in the article "*Scientists' Elusive Goal: Reproducing*

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[42] Ioannidis J.P.A. (2005), Contradicted and Initially Stronger Effects in Highly Cited Clinical Research, JAMA 2005; 294: 218-228.

[43] Arrosmith J. (2011), Trial watch: Phase II failures: 2008-2010, Nature, May 2011, 328-329.

[44] phase 1 indicates studies conducted on small groups, generally not exceeding 100 subjects, whereas phase 2 indicates studies conducted on larger groups, usually not exceeding 300 subjects

Study Results" published on the Wall Street Journal on December 2, 2011, points out that one of the secrets of medical research is that the majority of results, including those published in major scientific journals, cannot be reproduced.

Reproducibility is at the foundations of making science and when results are not reproduced the consequences can be devastating for the biomedical industry, which only in the U.S. invests each year more than 100 billion dollars in research. Naik notes that researchers, particularly in universities, need to find positive results to publish and receive funding.

In the December 23, 2010 article entitled "*The Truth Wears Off*," published in The New Yorker, Jonah Lehrer writes of a meeting of neuroscientists, held in Brussels on September 18, 2007, and in which the reducing effect of the second-generation antipsychotic drugs was discussed. During this conference it was suggested that the decline of the effect of today's best sellers' drugs, such as Abilify, Zyprexa and Serequel, is because the environment becomes accustomed to their effects, similarly to what happens with antibiotics. The use of antibiotics leads to select and enhance microorganisms which become in this way immune and "get used" to the antibiotic. However, the attempt to extend this explanation to psychiatric drugs is inconsistent as it is known that there are no microorganisms which cause schizophrenia.

In the January 3, 2011, article entitled "*More Thoughts on the Decline Effect*," Jonah Lehrer answers readers' letters and notes that the reduction effect occurs in biology, medicine, and psychology (i.e., in life sciences).

Lehrer quotes a passage of a letter from a university professor, now an employee of a biotechnology industry:

"When I worked in a university lab, we'd find all sorts of ways to get a significant result. We'd adjust the sample size after the fact, perhaps because some of the mice were outliers or maybe they were handled incorrectly, etc. This wasn't considered misconduct. It was just the way things were done. Of course, once these animals were thrown out [of the data] the effect of the intervention was publishable."

Lehrer continues:

"Of course, once that basic research enters clinical trials, there's plenty of

evidence that the massive financial incentives often start warping the data, leading to the suppression of negative results and the misinterpretation of positive ones. This helps explain, at least in part, why such a large percentage of randomized clinical trials cannot be replicated."

- Experimental dogmas

In the paper "*Challenging Dogma in Neuropsychology and Related Disciplines*"[45] Prigatano emphasizes the concept of "scientific dogma."

[45] Prigatano G.P. (2003), Challenging dogma in neuropsychology and related disciplines, Archives of Clinical Neuropsychology, 2003, 18: 811-825.

A dogma is a belief that is imposed by an authority and is believed true even if it is not supported by any empirical evidence. Dogmas are typical of religions; however, they can be found also in science.

When the truth is imposed by an authority the risk of facing a dogma is high.

Within the field of scientific research Prigatano emphasizes the following dogmas:

– the law of causality according to which causes must always precede their effects (law of cause and effect).

– the belief that scientific knowledge can be produced only by using the experimental method.

Prigatano begins his article challenging one of the certainties of neuropsychology, namely the fact that experimental studies which use randomized groups provide the most compelling evidence of the effectiveness of treatment.

Prigatano believes that the practice, common today, to focus almost exclusively on the methodological aspects that make a study “experimental” (and therefore scientific) neglecting, however, careful clinical observation and understanding of the phenomenon, is leading to the production of studies which lack theoretical and practical value.

On the contrary, the discoveries of great scientists such as John Hughlings-Jackson and Luria were based on careful clinical observations and on remarkable intuitive abilities that led to their famous discoveries about the relationship between brain and behavior, today confirmed by modern neuroimaging techniques.

Prigatano states that, in order to

produce scientific knowledge useful in therapy, the work must be based on quality clinical observations and not just on randomized trials.

Randomized experimental studies make it possible to consider only a small number of variables, while quality clinical observations, though limited to few subjects, allow to keep track of the complexity of multiple variables. In this way, clinical observation of patients, who achieved benefit from rehabilitation programs compared with those who do not improve, is according to Prigatano, the most important method in the advancement of knowledge in this area.

A polarization is observed:

- on the one hand the dogmatic use of the quantitative experimental method that Prigatano calls *scientism*.
- on the other hand the use of the qualitative clinical approach, which leads to results of great theoretical and practical importance, but which are currently being rejected as unscientific.

The careful and qualitative observation of the phenomenon under study is, of course, the first step in any scientific discovery, as it has been shown by the fathers of the experimental method, such as Galileo Galilei, Bacon and Newton.

However, at the same time, it is necessary that observations are made controllable and repeatable, using effective statistical or mathematical methods that can keep track of the complexity of the phenomena.

Despite the great importance and utility of the experimental method, this method has limitations which is important to know to choose, when necessary, other scientific methods.

It is important to remember that this methodology allows to study only few causes at a time and requires objective and quantitative data.

For this reason, it is impossible to use the experimental method when the information can be collected only in a qualitative and subjective way, and when the interest is for the complexity and the role of the context.

Prigatano states that:

"*Because of scientific beliefs imposed by* *authorities as true an orthodoxy is created which supports only a few scientific conclusions, even if these are not confirmed at the end or are later contradicted by empirical facts.*"

The experimental approach of neuropsychology and cognitive psychology has spread the belief that qualitative and subjective research is of no interest to psychology.

Prigatano points out that:

– The idea that the material that emerges during psychotherapies of patients with brain dysfunction is not of any interest in neuropsychology is a dogma. This dogma stems from the fact that the experimental method requires quantitative data and consequently withholds information that is qualitative and subjective, such as the material that may emerge from psychotherapy sessions.

– The idea that, because of their subjective nature, the disorders of self-awareness cannot be studied scientifically is a dogma. Prigatano shows that, in patients with head trauma, the presence of anosognosia, i.e., patients' unawareness of their cognitive and behavioral deficits, is related to slow finger-tapping in Halstead's test. In patients with traumatic brain damage and anosognosia, with slow finger-tapping, performance in the activation of the associative cortex is missing, when compared with controls. These results demonstrate that an objective parameter, such as finger-tapping performance in Halstead test, can be used for the scientific study of self-awareness which is a subjective aspect.

– The idea that the study of lateralization of brain functions is the most important aspect for the advancement of neuropsychological science is another dogma. The brain is an integrated system and, especially in everyday tasks, it is always accompanied by bilateral activations. For example, even when considering language, which is probably the most lateralized function, it has been shown in PET studies, that the preparatory process of speaking, and language itself, always involve bilateral activation of the brain.

– The idea that psychotherapy is ineffective with people who have brain damages, and the assumption that their dysfunctional behavior is caused solely by deficits which underlie neural circuitry is also a dogma. This dogma is based on the vision of man as a machine, as a system of organized and integrated physical and molecular reactions. However, the qualities of the human being go far beyond this mechanistic description and require the integration with all those aspects represented not only by the mind and conscious thought, but also by the mysterious reactions, attitudes, fears, and subjective strategies of adaptation represented by the unconscious aspect of the mind. Especially when dealing with a disability, subjects show adaptation problems that do not always derive solely from the underlying neuropsychological dysfunction, but have to do, for example, with the coping style of the subject itself and its ability to face the truth, which sometimes can be so tragic as the physical disability that suddenly makes the individual unable to carry out activities which were before automatic. Neuropsychological deficits have the power of changing our lives, forcing us to use all our energies to meet the new situation. In many cases it is necessary a psychological support that helps the patient to become increasingly aware of his problem, increase the compliance with the rehabilitation activities and drug therapy and contain negative behavioral manifestations, such as changes in personality which often occur, especially with brain injuries.

- *The methodology of concomitant variations*

In 1992 physicists at LEP (Large Electron-Positron Collider in operation at CERN in Geneva) could not explain some annoying fluctuations in the beams of electrons and positrons. Although very small, these fluctuations created serious problems when the energy of the rays must be measured with great precision. The experimental method did not provide any clue and to solve the dilemma the methodology of concomitant variations was used to test different hypotheses. Results showed the concomitant fluctuation in the energy of the particle beams of LEP and the tidal force exerted by the Moon. A more detailed analysis showed that the gravitational attraction of the Moon distorts very slightly the vast stretch of land where the circular tunnel of LEP is recessed. This tiny change in the size of the accelerator caused fluctuations of about 10 million electron volts in the energy rays.

The methodology of concomitant variations uses double entry tables of dichotomous variables. For example:

	Males	Females	Total
No accidents	50	105	155
Accidents	200	45	245
Total	250	150	400

Concomitances between sex and car accidents
(Data invented for this example)

In this table the concomitance of the variable sex and car accidents is difficult to assess, since the total value of each column differs. When the absolute frequency values are converted into column percentage it becomes easy to compare the columns "Males" and "Females":

	Males	Females	Total
No accident	50	105	155
	20%	70%	39%
Accidents	200	45	245
	80%	30%	61%
Total	250	150	400
	100%	100%	100%

Concomitances between sex and car accidents
(Columns percentages)

We now see a strong concomitance between "*Males*" and "*Accidents*" (80%) and between "*Females*" and "*No accidents*" (70%). Concomitances are assessed according to the differences between observed frequencies (column percentage) and expected frequencies (column percentages of the total column). For example, the expected percentage for "*no accidents*" is 39%, whereas in the "*females*" column 70%.

Since being male is determined before car accidents take place, we can fall in the error of stating that being male is the cause of car accidents.

However, the methodology of concomitant variations allows to check for intervening variables by splitting the table in two.

For example, we can split the previous table according to those who drive little and those who drive a lot.

	Drive little		*Drive a lot*	
	Males	Females	Males	Females
No accidents	70%	70%	20%	20%
Accidents	30%	30%	80%	80%
Total	100%	100%	100%	100%

Concomitances between sex, km driven and car accidents

We now see that the concomitances between sex and accidents vanish.

The correlation "*males-accidents*" is therefore mediated by the number of kilometers driven, which is therefore an intervening variable. Consequently, the relation becomes "*males drive a lot and consequently are involved in more accidents.*"

Crossing three variables at a time

allows to identify intervening variables and to study the context within which relations are valid.

Therefore, when a concomitance is found between drug and healing it is possible to study if it is true always, or only at certain conditions, such as specific age groups, sex, habits, and other conditions.

The advantages of the methodology of concomitant variations are:

– It uses dichotomous variables. Any information, quantitative or qualitative, objective, or subjective can be transformed into one or more dichotomous variables. As a result, it permits to produce studies which keep track of all the elements of the phenomena.

– It allows the study of many variables at the same time, thereby it can consider the complexity of the phenomena. In contrast the experimental method can study only a limited number of variables at a time, thereby it produces knowledge which is detached from the context and complexity of natural phenomena.

– It allows to perform controls for intervening and spurious variables, and this is done after and not before. Therefore, it does not need controlled environments such as a laboratory and it is possible to carry out studies in natural contexts.
– When using subjective variables people often respond using masks. For example, even when we feel unhappy, lonely, depressed, usually we try to give an image of ourselves (a mask) which is positive. With the experimental method masks

constitute a problem which is insurmountable, and which is solved only by removing qualitative and subjective variables from the analyses. On the contrary, the methodology of concomitant variations can correctly handle responses which are masked.

Let us discuss this last point. A property of masks is that they are used not only on one variable, but on all those that express the trait that we are trying to mask. For example, if a person responds by saying no to "*I feel depressed*," when he is depressed, he will also say no to "*I feel unhappy*," when he is unhappy. The concomitance between depression and unhappiness remains unchanged because both responses have moved in the same direction and continue to remain associated. This is the reason which allows the methodology of concomitant variations to use direct questions, such as: "*do you feel depressed?*"

	Depressed	Not Depressed	Total
Unhappy	15	3	18
Happy	2	***180***	182
Total	17	183	200

Concomitances between masked answers

This table shows that the two modalities, "*I feel happy*" and "*I do not feel depressed*", are concomitant.

When using psychological tests, which produce "objective" measurements of depression and happiness which are not distorted by the effect of masks, answers shift from the positive to the negative side. But the result remains unchanged:

	Depressed	Not Depressed	Total
Unhappy	***158***	10	168
Happy	2	30	32
Total	160	40	200

Concomitances obtained when using "objective" information

Results continue to show the concomitance between the variables depression and unhappiness.

This means that if a concomitance exists it will show also when responses are masked, since masks are applied in a coherent way to all those variables which are correlated. This is a fundamental point, as the problem of masks is ubiquitous in psychological, social, and economic sciences. The methodology of concomitant variations solves this problem and allows in this way to widen science to subjective and qualitative data.

- *Example 1: Simulating the experimental designs with concomitances*

The experimental method uses two similar groups and handles them in the same identical way except for one element, the cause. Any differences between these two groups are then interpreted as the effects. Classically the analysis is done comparing the mean values or the variances between groups.[46]

[46] Analysis of variance (ANOVA) is a collection of statistical models in which the observed variance is partitioned into components: treatment variability (between groups) and error variability (within groups). The ratio of the treatment variability and the error variability produces a value, F, of which the statistical distribution is known and from which the

Both these statistical techniques assume that when an effect exists the means or the variances of the two groups diverge.

When the analysis is done following the methodology of concomitant variations the first thing, we do is to choose a "statistical unit". This choice is strictly linked to the aim of the research. For example, if the aim of the experiment is to assess if a drug given to patients reduces blood pressure, the unit will be "the patient". We will collect information using a form, which

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statistical significance of the effect is obtained.

could be:

- Record progressive no.:
- Blood pressure before:
- The patient received. Drug / Placebo
- Blood pressure before:
- Blood pressure after:
- Difference before-after in the blood pressure:
- Sex
- Age
- Habits……

The same form will be used each time we give the drug or placebo.

Each provision or treatment becomes a record in the statistical datafile. In each record we will have blood pressure measurements before and after the treatment. The hypothesis is that a reduction in blood pressure is concomitant with the provision of the drug and not of the placebo.

The methodology of concomitant variations can handle an unlimited number of variables. For example, we can add in the record sex, age, habits, place where the person lives, mood, etc. Results could show that the effect is associated to specific conditions. For example, that the drug is effective only on the male population, or only on young people, or only on people who do not drink alcohol or smoke, etc.

The methodology of concomitant variations can be used to analyze data gathered with the experimental approach (control and experimental groups) and the results tend to be robust and replicable. There is no need to throw away the outliers, it can handle unlimited numbers of extra variables, which keep track of complexity and context and it allows to control intervening variables "afterwards", reducing in this way the need of randomized groups.

When working with the methodology of concomitant variations fraud becomes difficult or impossible, since when a specific result is manipulated, all the other correlations become inconsistent and contradictory.

Furthermore, a controlled setting is no longer needed; it is possible to consider all the intervening variables, which the methodology of differences tries to control "before" using the laboratory setting and the randomization of the sample. In this way experiments become simple, and it is possible to shift from the lab to the field.

Results are also easier to understand and interpret.

- *Example 2: Immaterial needs*

In a study conducted in 1984 with the concomitant variation methodology, aimed at studying what could explain the persistence in heroin addiction the statistical unit was a questionnaire which was divided into:[47]

– *Key items* that express the

[47] Associazione Ricerca (1984), First Study based on the relational methodology, Syntropy Journal, 2005(1):134-139.

persistence in the state of drug addiction, such as: "*I think I will continue to use drugs forever*" and "*I think that my addiction to heroin is irreversible.*"

– *Explicative items*, relative to the hypotheses which were tested in this study.
– *Structure items* such as sex, age, education.

Explicative items were suggested from different experts: psychoanalysts, family and relational psychologists and the Vital Needs Theory.

The questionnaire was distributed

in a center which provides methadone (S.A.T. RM 5 – Rome, Italy) between the 2nd and the 13th of July 1984. More than 60 questionnaires were returned, but only 58 were completed in all their parts and used in the data analysis. The sample was of 48 men and 10 women. The average age was 25 years, and the average period of addiction 6 years. Only 17 persons had a high-school degree, 23 had a 8th grade degree, 17 a 5th grade degree and 1 had no degree; 26 were employed or working, 32 were unemployed.

Data analysis was carried out calculating the concomitances among each key item and all the other items of the questionnaire, using the Chi Square statistical test.

The key variable "*I think I will continue forever to use drugs*" was concomitant (correlated) mostly with: "*Heroin provides me with feelings of warmth*", "*Heroin provides me with feelings of love*", "*I did not have stable friendships*", "*Heroin is the reason of my life*" and the higher number of years of drug addiction. The strongest correlations appeared with the items suggested by the hypothesis "*need for love and need for meaning*". The strongest one was with "*Heroin provides me feelings of warmth*". The item "*Heroin is the reason of my life*" suggests that heroin addicted satisfies the need for meaning through addiction.

The following items are ordered according to the number and strength of significant correlations obtain with the key items: "*Heroin is the reason of my life*", "*If I have a dose of heroin I feel calmer*", "*I feel in love with heroin*", "*Heroin provides me with feelings of warmth*", "*I like the moment when I am preparing the dose*", "*Heroin provides me with feelings of love*", "*I am always right*", "*It is important to share heroin with the one you love*", "*I feel very guilty for the problems that my drug addiction is giving to my family*" and "*My father was often kept out of what* *was happening in the family*".

The item "*Heroin is the reason of my life*" obtains the highest number of correlations. This supports the hypothesis that when the substance becomes the reason of one's life it satisfies the vital need for meaning and therefore becomes vital (developing in this way addiction). Without heroin the person is missing a purpose and feels the lack of a meaning. The same conclusion was reached analyzing other correlations. For example, between working and the feeling of being able to come out of heroin suggests the importance that work can have in the treatment of drug addictions.

Correlations obtained with the items "*I feel in love with heroin*", "*Heroin provides me with feelings of warmth*", "*Heroin provides me with feelings of love*" and "*It is important to share heroin with the one you love*" point to the vital need for love. Heroin provides feelings of love, satisfying in this way the vital need for love and obtaining its power from this vital need.

- *Example 3: Dissatisfaction among teenagers*

In this section the results of a research work conducted on a sample of 974 teenagers, aimed at studying the reasons of their dissatisfaction, are briefly described to show how the methodology of concomitant variations works.

Among the various theories and models on youth dissatisfaction, the Vital Needs Theory[48] suggests that unhappiness is caused by depression and anxiety, where depression informs about the dissatisfaction of the need for meaning and anxiety informs about the dissatisfaction of the need for cohesion and love.

Depression and anxiety, although

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[48] Di Corpo U. and Vannini A., The Theory of Vital Needs, Kindle Edition, www.amazon.com/dp/B006M0L0R4

different in their etiologies, are always perfectly related, since according to the "Theorem of Love" when loneliness increases also depression increases, and when depression also increases loneliness increases.

The Vital Needs Theory can be studied only using qualitative and subjective information and not with quantitative information.

Hypothesis of the Vital Needs Theory are:

– *Hypothesis number 1*. Among all the items suggested by the different theories, it is expected that those which describe the dissatisfaction of the need for love and the need for meaning (*I feel depressed*, *I feel anxiety*, *I feel useless,* and *I feel lonely*) will obtain the highest concomitance values with the variables of dissatisfaction and unhappiness.

– *Hypothesis number 2.* The Theorem of Love suggests that depression and anxiety should correlate in a nearly perfect mathematical way. Consequently, the concomitance between *I feel depressed,* and *I feel anxiety* should be the strongest among all the items of the questionnaire.

In order to test these hypotheses a questionnaire was devised with direct questions such as *I feel depressed*, *I feel anxiety*, *I feel dissatisfied*, *I feel satisfied*, *I feel happy*, *I feel unhappy*, *I feel content*, *I feel discontented,* and variables suggested by experts in different fields of psychology, psychiatry and social sciences.

The questionnaire was divided into:

– *Key questions*, which deal with the purpose of this study which was to investigate what is related to the wellbeing and to the dissatisfaction of young people. The key questions where *I feel satisfied*, *I feel unsatisfied*, *I feel happy*, and *I feel unhappy*.

– *Explanatory questions*, which were formulated by various experts. For example, Melanie Klein theory suggests that suffering is linked to traumas experienced in childhood; these traumas cause a failure to remember childhood (this hypothesis was translated into the items *I remember very little of my childhood and I have beautiful memories of my childhood*). The family-relational theory suggests that suffering is linked to the difficult relations among teenagers and their families. The psychoanalytical approach suggested items relative to attachment in the relationship with parents. The psychiatric approach suggests items relative to contagious behaviors among unhappy teenagers.

The questionnaire had 195 items (questions) and was answered using scores from 0 to 10, where 10 equaled *Yes*, 0 *No,* 1 very little, 5/6 average and 7/8 a lot. Answering the questionnaire required less than

40 minutes and the context was high-school classes.

The supervisors received the following instructions: no explanations about the meaning of items should be given; the questionnaire had to be completed in the same context, it was not permitted to take it home and hand it back the day after.

The aim was to ensure that the mask remained constant.

Answers were translated in the dichotomous form (Yes/No), using the median value which tends to maximize the concomitances. The methodology of concomitant variations requires dichotomous variables and studies concomitances using 2x2 tables in which the column and the row variable have 2 modalities (Yes/No).

	Anxiety	No Anxiety	Total
Depressed	*463*	79	542
No Depressed	56	*376*	432
Total	519	455	974

Absolute values

These tables are called 2x2 since the columns variable (in the example *I feel anxiety*) has two modalities (Yes/No) and the row variable (in the example *I feel depressed*) has two modalities (Yes /

No).

Concomitances are assessed when observed values differ from expected values. That is when column percentages differ, in the Yes/No columns, from the percentages in the total column.

Transforming absolute values in column percentages the previous table becomes.

	Anxiety	No Anxiety	Total
Depressed	***89.21%***	17.36%	55.65%
No Depressed	10.79%	***82.64%***	44.35%
Total	100,00% (519)	100,00% (455)	100,00% (974)

Columns percentage values

This table shows that 89.21% of the subjects who answered Yes to *I feel anxiety* also answered Yes to *I feel depressed*, and only 10,79% answer No to *I feel depressed*.

If no relation exists between, *I feel depressed* and *I feel anxiety* the same values should have been observed between Yes and No columns and the column of totals.

Percentages in the column of totals are the *expected* percentages, whereas the percentages in the Yes and No columns are the *observed* percentages. The differences between observed and expected percentages are assessed using the Chi Square (χ^2) test, which tells the strength of the concomitance and if it is significant.

Many statistical tests allow to study concomitances and the χ^2 test is one of the most widely used: the higher the value of χ^2 the stronger is the relation. When no relation exists the χ^2 value is equal to 0. With 2x2 tables the highest χ^2 value coincides with the sample number, in this case 974. The χ^2 value is compared with probabilistic tables which allow to assess the equivalent statistical significance value (p).

Statistical significance tells which is the risk that we accept when we state that the relation exists. As a convention, all those relations with a risk probability inferior to 1% are considered true. In 2x2 tables the 1% value is reached with a χ^2 of 6.635. The higher the value of χ^2 the more significant the relation is among the two variables.

Relations can be of two types: direct or inverse. If the relation is directing the two dichotomous variables are concomitantly true or false, whereas if the relation is inverse one variable is true when the other is false. Inverse relations have negative sign (-) whereas direct relations are shown without sign (positive sign).

Since the maximum value of χ^2

varies depending on the size of the sample, it is useful to standardize it, making it range between 0 and 1. This transformation is known as rPhi and is obtained as the square root of the value of χ^2 divided by the sample size. When using quantitative variables rPhi values behave similarly to the Pearson correlation index.

Values of rPhi higher than 0.35 typically identify relations that are known without resorting to statistical analyses. Values below 0.35 identify relations which are not trivial. To study non-trivial relations, it is necessary a sample size that exceeds 100 units.

In the study of concomitances data is translated in the dichotomous form (High/Low, Yes/No; +/-; 0/1, True/False), using thresholds. Dichotomous data allow great flexibility and richness of results, similarly to what happens with digital computers based on binary information compared to analog computers. The advantages of dichotomous statistics are countless: it does not require the normal (Gaussian) distribution of data, it can handle any type of data (quantitative and qualitative), it allows the study of any kind of relation, whereas parametric statistical indexes can be used only when relations are linear or logarithmic.

Let's now see the results of this research work.

Hypothesis number 1. Among all the items suggested by the different theories, the Vital Needs Theory expects that those items which describe the dissatisfaction of the needs for love and meaning (*I feel depressed*, *I feel anxiety*, *I feel useless*, and *I feel lonely*) will obtain the highest concomitances (relations) with the variables of dissatisfaction and unhappiness.

In order to provide an answer this

first hypothesis, each key variable of wellbeing and unhappiness, was crossed with all the other dichotomous variables of the questionnaire. The following table shows the highest values of χ^2 obtained by the key variables of dissatisfaction.

I feel unhappy	I feel discontent	I feel dissatisfied
χ^2	χ^2	χ^2
193 I feel depressed	200 I feel depressed	181 I feel anxiety
182 I feel lonely	172 I feel anxiety	179 I feel depressed
166 I feel useless	133 I feel useless	139 I feel useless
165 I feel anxiety	126 I feel lonely	99 I feel lonely
76 I am often refused by friends	75 When in a group I feel lonely	54 I am often refused by friends
46 I am often emarginated at school	66 I am often refused by friends	52 When in a group I feel lonely
39 I am often criticized	50 I am often criticized	35 I am often emarginated at school
35 Family economical problems	43 I am afraid of judgments	33 I am afraid of judgments
23 I am afraid of judgments	21 Family economical problems	18 Family economical problems
		15 I don't remember my childhood
Inverse correlations:		
-55 My family is very united	-40 My family is very united	-38 My family is very united
-39 My father is very affectionate	-37 My father is very affectionate	-34 My father is very affectionate

Strongest Chi Square (χ^2) values obtained by the key variables

As it was expected by the Vital

Needs Theory the 3 key variables which describe dissatisfaction show the strongest concomitances with, *I feel depressed*, *I feel anxiety*, *I feel useless* and *I feel lonely*, followed by *I am often refused by friends*, and *I am afraid of judgment* (which supports the idea that others people's judgment is a key strategy used in order to give a meaning to life).

The first direct relation with an item different from those suggested by the Vital Needs Theory is with the item *I don't remember my childhood*, suggested by Melanie Klein's hypothesis that distress is linked to traumas experienced in the early stages of life. Two items suggested by the systemic-relational approach: *My family is very united*, and *My father is very affectionate* obtain inverse relations.

The concomitances with the items which support the Vital Needs Theory obtained χ^2 values between 100 and 200, whereas the highest χ^2 value obtained by a different theory (systemic-relational theory) was 50 and Melanie Klein's hypothesis obtained a value of χ^2 of 15.49.

In the questionnaire 4 items were intended to study the risk of drug abuse. These items show the highest concomitances with the items of anxiety, depression, feeling useless and loneliness, suggesting that drug abuse is a strategy used to respond to the unsatisfied needs for love and meaning.

χ^2	
78.15	I feel depressed
64.83	I feel anxiety
63.76	I feel useless
53.53	I feel lonely
34.48	Even when in a group I feel lonely
34.23	I am often refused by friends
19.75	I am often criticized
15.81	My family has big economic problems

Highest χ^2 values obtained by the items which are relative to the risk of drug abuse

Hypothesis number 2. The theorem of love suggests that depression and anxiety should be related in a nearly perfect mathematical way.

Consequently, the concomitance between *I feel depressed,* and *I feel anxiety* should be the highest observed among all the items of the questionnaire.

The highest relation obtained by items different from the Vital Needs Theory was χ^2 55.32. The hypothesis that *I feel depressed,* and *I feel anxiety* will show a nearly perfect relation. This fact is well known among psychiatrists, however no theory or model, beside the Vital Needs Theory, explains why this concomitance should exist. On the contrary the different etiology of depression and anxiety is often underlined. For example, depression would originate from loss, whereas anxiety from fear, suggesting a low concomitance in consideration of the fact that the origins of these two forms of suffering are different. The Theorem of Love of the Vital Needs Theory tells that the concomitance between depression and anxiety should be nearly perfect.

The following table shows the highest concomitances obtained by the item *I feel anxiety*. The first one is with *I feel depressed*, with a χ^2 value of 507.08.

"*I feel anxiety*" correlates with:

507.08 I feel depressed
231.06 I feel useless
204.17 I have little self-esteem
197.24 I feel lonely
188.33 I have little hope in my life

Highest χ^2 values of I feel anxiety with the items of the questionnaire

Considering all the possible 2x2 tables, among the 195 items of the questionnaire (195 x 194/2 = 18,915) and ranking the χ^2 values, the concomitance between *I feel depressed*, and *I feel anxiety* (χ^2 507.08) is by far the strongest one, with χ^2 values considerably higher than the next one in the rank, which still supports the Vital Needs Theory, and is the relation with *I feel useless*.

In this study the highest possible

χ^2 value is 974 (the sample size), but in any social research a noise factor always reduces the strength of relations.

To assess how strong, the noise factor is, and how much it could reduce the χ^2 values, identical items were introduced in the questionnaire. The highest χ^2 value obtained by identical forms of the same item was 293.86. Consequently, values greater than 300 can be considered perfect relations. The value 507.08, obtained by *I feel anxiety* and *I feel depressed*, is therefore a perfect concomitance.

The reason why these two items

show values higher than those shown by identical forms of the same item can be explained by the fact that, on these items, masks tend to be extremely coherent. According to the Vital Needs Theory, people tend to mask specifically the fact that they feel depressed and that they feel anxiety. In those items in which the mask is less coherent, the statistical error increases, lowering concomitance values between identical forms of the same item.

It is therefore possible to conclude that, considering the noise factor, the concomitance between depression and anxiety can be considered perfect, supporting in this way the hypothesis that these two different forms of suffering are linked together in a nearly perfect mathematical way. The χ^2 value of 507.08 observed between *I feel depressed*, and *I feel anxiety* is the strongest among the 18,915 possible 2x2 tables.

The Vital Needs Theory considers loneliness the highest empirical expression of the dissatisfaction of the need for love and uselessness as the highest "empirical" expression of the dissatisfaction of the need for meaning. Consequently, the nearly perfect concomitance which has been observed between *I feel depressed* and I feel anxiety should be observed also between *I feel useless* and *I feel lonely*.

The next table shows the first three χ^2 values with *I feel useless*. The strongest concomitance is with *I feel lonely* with a χ^2 value of 317.04, which is higher than that obtained by identical forms of the same item, and which can therefore be considered perfect.

"*I feel useless*" correlates with:
317.04 I feel lonely
231.06 I feel anxiety
229.19 I feel depressed

χ^2 values obtained by the item I feel useless

It is therefore possible to state that *I feel useless*, and *I feel lonely* relate in a perfect, nearly mathematical way. Coherently with the Vital Needs Theory *I feel useless* relates with *I feel anxiety* and *I feel depressed*.

4

STATISTICS

When using the methodology of concomitant variations, the first thing we must do is to define which is the "statistical unit." Statistical units allow the study of concomitances among variables and the choice of the statistical unit is strictly related to the aim of the research. Units can be persons, animals, plants, manufactured items, organizations.

With the methodology of differences units are in a one-to-one correspondence with the data values, whereas with the methodology of concomitant variations there is a one-to-many correspondence since unlimited data values can be collected for each unit.

Sample requirements differ according to the methodology and aim:

– When the aim is to make inferences about the population the sample must be representative of the population. This is usually achieved using a randomized sample.

– When the aim is to study differences among the experimental and the control group the sample must be homogeneous. This is usually achieved by randomly distributing the units across the experimental and control group. For example, if an experiment aims to assess the effect of a new drug against a placebo drug, the subjects should be allocated to either experimental or control group using randomization. Randomization reduces biases by equally distributing factors that have not been explicitly accounted for. When randomization does not allow for the formation of homogeneous groups, the alternative are laboratory animals, purposely bred to guarantee homogeneity. Laboratory animals are euthanized after being used once, since the involvement in an experiment makes them different and unsuitable to guarantee homogeneity in other experiments.

– When the aim is to study concomitant variations, the sample must be heterogeneous. For example, if the aim is to study drug addiction, we will include in the sample subjects with different levels of drug addiction. The composition of the sample is strictly related to the aim. With the methodology of concomitant variations, it is important to keep track of all the possible intervening variables.

In this chapter we will consider the last two conditions: homogeneous samples for the study of differences and heterogeneous samples for the study of concomitant variations.

- *Homogeneous samples for the study of differences*

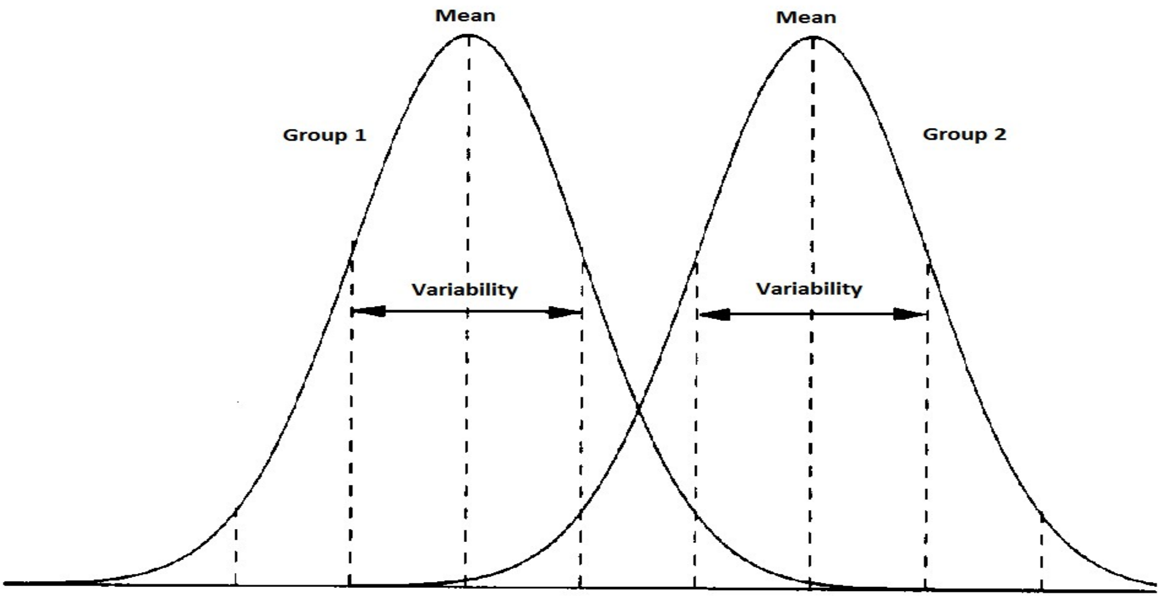
The methodology of differences assesses statistical significance by:

– comparing the difference between mean values of the experimental and control groups with the variability of the values in the sample.
– or by comparing the variance

between groups with the variance within groups.

Initial similarity between groups is a fundamental requirement, without which it is impossible to state that the difference observed between the experimental and the control group is a consequence of the cause. Randomization tends to distribute all the intervening variables in a similar way, thereby making groups similar.

Increasing the sample size allows even small differences to become meaningful. But, in clinical trials the variability of subjects can be so great that even increasing the sample does not lead to statistically significant results.



Comparison of mean and variability of two groups

When this is the case laboratory animals are used. Laboratory animals are all very similar and decrease the variability of the sample, allowing small differences to become statistically significant.

There is now mounting evidence

that animal experimentation constitutes an artifact.[49] The reason is very simple. Statistical significance is stronger when the variability is smaller. Consequently, when the effect size is small, the only way to obtain statistically significant results is to reduce the variability of the sample. When using animals, which are all very similar, the variability of the sample tends to be null, and consequently also very small differences become statistically significant. But animals

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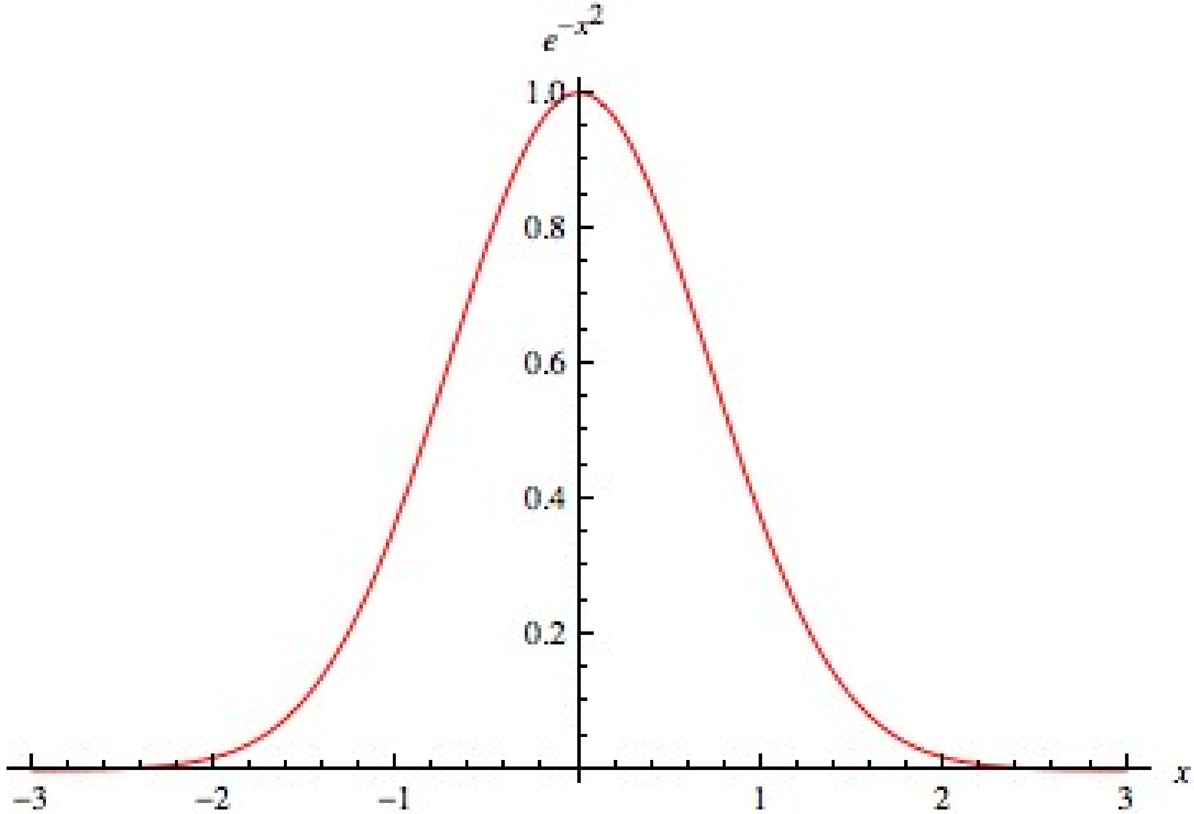
[49] In experimental science, the expression 'artifact' is used to refer to experimental results which are not manifestations of the natural phenomena under investigation, but are due to the experimental arrangement, and hence indirectly to human agency.

are too similar and in this way differences that have no actual value become significant. Furthermore, one of the fundamental rules in science is to use samples that are representative of the population to which results will be generalized. It is obvious that laboratory animals are not representative of humans and that the effects observed using laboratory animals are difficult to generalize to humans.

Finally, the methodology of differences uses parametric statistical techniques, which require data distributed according to the Gaussian curve. This condition is usually not met. Nevertheless, researchers go on and interpret results.



Gaussian distribution

- *Heterogeneous sample for the study of concomitant variations*

Concomitant variations require variability, heterogeneous samples, where variability is maximized. Whereas the methodology of differences requires homogeneous samples, the methodology of concomitant variations requires heterogeneous samples.

In a study that aims to compare the growth of 5 different types of crops in 5 different types of fields, all the combinations will be considered and at least 30 measurements will be taken for each combination. Since the aim is to compare growth rates, the statistical unit will be the height of the crop after a fixed interval of days (or a similar type of measurement). For each measurement an array of information will be traced. First, the type of field and the type of crop, secondly information that we think can be related to the growth of crop. At the end for each combination, we will have measurements of the growth rate and an array of other information.

When answers tend to concentrate in one modality, wider measuring scales are needed. For example, when we ask, "*Do you feel depressed?*" yes/no, most people answer no and concomitances cannot be studied, since the answers tend to be constant. In order to restore variability it is necessary to use wider scales, such as "*How much do you feel depressed?*" *0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10*. Most answers will concentrate in the low values, 0 to 3, and the median cut-off point will probably be between the values 1 and 2. The aim of the methodology of concomitant variations is to study relations and this is done maximizing variability.

In the simplest studies the recommended sample size is of 120 records. But, in many clinical studies only one subject is available. When this is the case, measurements can be repeated in different moments, trying to maximize the variability. For example, if we want to study what is concomitant to our headaches, we keep track at regular intervals of all what we think might be related to this situation. For example, each evening we fill a form in which we provide a subjective measurement of the headache, plus what we ate, what we watched on TV, our feelings, etc. When enough forms (120) are filled, we can proceed to the data analysis. Exercising with the analysis of personal data can be a good training.

- Data

Data can be collected in various ways: nominal, ordinal, interval, and ratio.

- *Nominal* or categorical data are made of mutually exclusive modalities. For example: marital status, nationality.
- *Ordinal* data are variables where the order matters but not the difference between values. For example, when we ask to express the amount of pain using a scale from 0 to 10. A score of 7 means more than a score of 5, and 5 is

more than 3. But the difference between 7 and 5 may not be the same as that between 5 and 3. The values simply express an order, a progression.

– *Interval* data are variables where the difference between two values is meaningful. For example, the difference between 1 meter and 2 meters is the same difference as between 3 and 4 meters. Numbers are spaced always by the same measuring unit.
– *Ratio* data have all the properties of interval variables but have also an absolute zero value.

Variables like height, weight, enzyme activity are ratio variables. Temperature, expressed in Fahrenheit or Celsius, is not a ratio variable. A temperature of zero degrees on either of those scales does not mean no temperature. Kelvin degrees correspond instead to a ratio variable since zero degrees Kelvin corresponds to no temperature. When working with ratio variables, but not interval variables, it is possible to use divisions. A weight of 4 grams is twice a weight of 2 grams. A temperature of 100 degrees Celsius is not twice 50 degrees Celsius, because temperatures in Celsius are not a ratio variable. The Celsius scale is an interval variable, whereas the Kelvin scale starts from absolute zero and allows for ratios.

The mathematical operations which can be performed are:

– in the case of nominal/categorical variables the value is a modality of a list, for example Italy France, Germany. With this it is possible only to count the occurrences of each modality.

– In ordinal variables the value is a sequence: First, Second, Third; Elementary education, High School, University. It is possible to divide the sequence into high and low, for example high education, low education, or treat each value as a modality (nominal variable). For example, it is possible to count how many people have reached secondary or higher education. It is possible to find which is the level of education attained at least, for example, by 50% of the population. There is an order, a progression, which can be used to create new categories (i.e., low education and high education) or to order the population.

– Interval variables differ from ordinal variables, which allow counting and sorting, since they permit the use of additions and subtractions and calculate mean values and variabilities.
– Ratio variables differ from interval variables since the value zero coincides with the absolute zero. This allows the use of divisions and multiplications.

Data can be transformed in one or

more dichotomous variables in the following way:

- In the case of nominal variables, the single modality (i.e., single province, nationality, color) can be translated into a dichotomous variable. For example, Italy becomes the Italy dichotomous variable for which the answers can only be yes or no.
- Ordinal variables follow a progression. These variables can be treated in the same way as the nominal variables by translating each modality in a dichotomous variable, but it is also possible to

translate the information in the form high/low. It is important to note that there is no objective criterion for defining when modalities are considered high or low. For example, in a study concerning university professors the lowest degree of education might correspond to the highest degree in another study which considers the poor population of developing countries. The division of an ordinal variable into a dichotomous variable, must always consider the context and purpose of the study. If no criterion suggests how to divide between high and low the cut-off point is chosen by balancing the two groups. This is done using the median value.

– When dealing with interval or ratio variables cut-off values, that mark the transition from low to high values, are generally used. The aim of the researcher and the purpose of data analysis is usually to identify these cut-off values. It happens frequently that the same variable can be translated into multiple dichotomous variables to test which cut-off value best allows to identify a critical value, i.e., a value that indicates the transition from one state to another.

Data is the raw material, but not all data is suitable for concomitant variations analyses; only data which can be transformed in the dichotomous form and is gathered in a systematic way can be used. Information which cannot be coded or transformed in the dichotomous form is of little use.

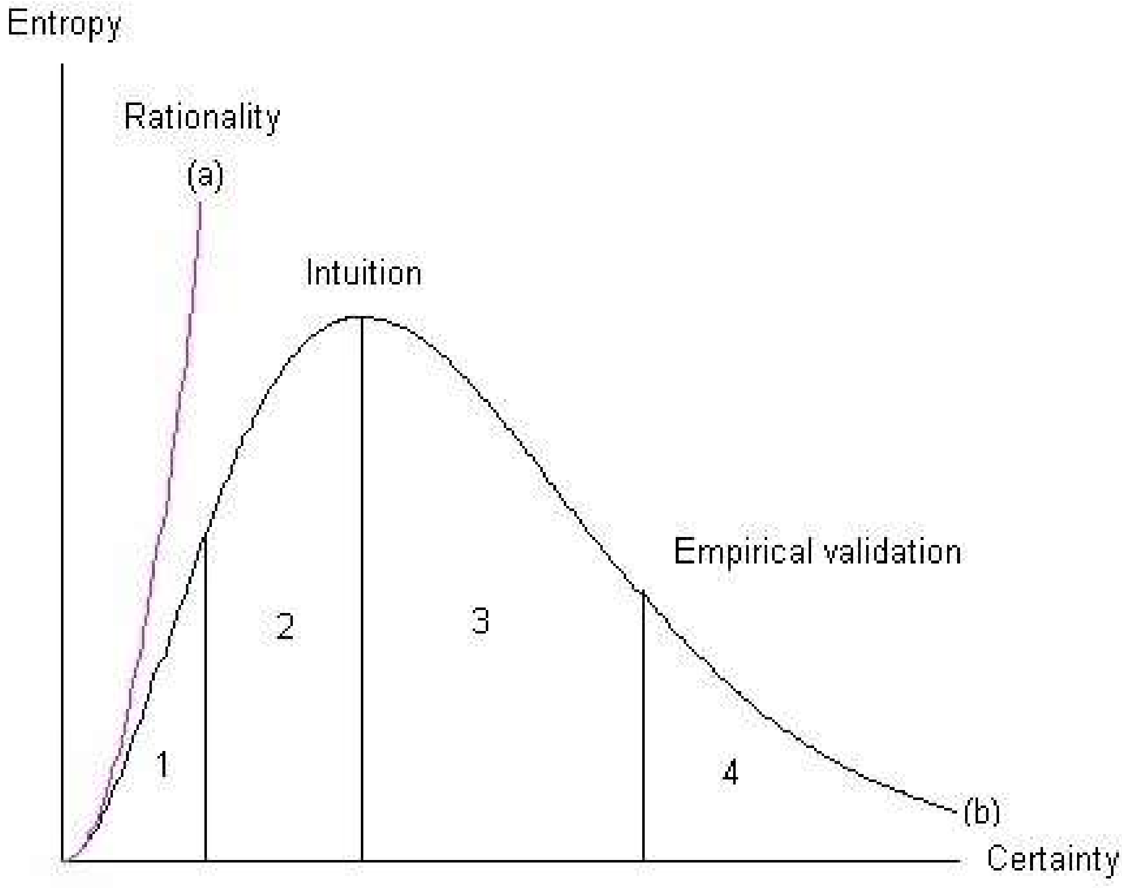
- *How to choose the items*

In the late 19th century, Charles Sanders Peirce proposed a schema that would turn out to have considerable influence in the further development of scientific method generally. In "*How to Make Our Ideas Clear*",[50] Peirce placed induction and deduction in a complementary rather than competitive context. Secondly, and of more direct importance to scientific method, Peirce put forth the basic schema for hypothesis-testing that continues to prevail today. Peirce examined and articulated the fundamental modes of reasoning that play a role in scientific inquiry, the processes that

[50] Peirce C.S. (1878), How to Make Our Ideas Clear, www.amazon.it/dp/B004S7A74K

are currently known as abductive, deductive, and inductive inference:

- During the *inductive* phase we consciously review the know-how and unsolved problems.
- During the *abductive* phase unconscious processes take place and lead to an intuition which highlights new hypotheses and solutions.
- During the *deduction* phase hypotheses are translated into items.
- During the *validation* phase data is gathered and hypotheses and solutions are tested.



Phases of the process of discovery

One of the most delicate phases is when we translate hypotheses into items (phase 3).

Hypotheses always state relations between two or more variables. To test these relations, it is required to gather data separately. For example, if the hypothesis is that loneliness causes anxiety it is wrong to ask: *Loneliness causes anxiety*? because the concomitance between loneliness and anxiety is already given in the item and data analysis will not be able to tell if this concomitance exists. To study the concomitance between loneliness and anxiety it is necessary to formulate two different items: *Do you feel lonely*? *Do you experience anxiety*? Data analysis will tell if these two items (loneliness and anxiety) vary in a concomitant way and are related. It is also important to ask information in a clear and direct way, avoiding negative forms. Each item should contain only one information.

For example, the following item is incorrect:

Did the family receive State Aid?
☐ Yes,
☐ No,
☐ It is a one parent family, It is a two parents family

since it combines State Aid (Yes/No) with Family type (one parent family, two parents family).

The correct formulation is:

Did the family receive State Aid? ☐ Yes, ☐ No

Family type: ☐ One parent, ☐ Two parents

Each item (i.e., each variable) must be relative only to one type of information. During data analysis information will be combined and concomitances will be studied. Items can be divided into key items, explicative and structure items:

– *key items* are all those variables which describe the topic under investigation, for example if the study is relative to cancer, key variables will be relative to cancer.

– *explicative items* are all those variables which might be correlated (linked) to the key variables, for example in the case of cancer it could be the environment, stress, food, and so on.
– *structure items* are variables such as age, sex, education, profession; variables which are usually used to describe the sample and the context.

To choose relevant explicative

variables, it can be useful to ask the help of experts who have a good knowledge of the topic. It is also useful to compare different hypotheses. Scientific research is a process of continuous evolution of knowledge which requires the disposition to change and eventually abandon our beliefs.

Designing a form can be divided in the following steps:

– declare which is the aim of the study (*key variables*).
– list all those variables (*explicative variables*) which might be

correlated (concomitant) to the key variables. It is very important to keep track of the hypotheses, in this way the interpretation of the results will be straightforward, otherwise it is easy to fall in the trap of paying too much attention to secondary information and produce interpretations which are totally irrelevant and of little scientific value. It is always a good habit to use more items for the same information (redundancy).

– prepare the form (questionnaire, observation grid, …) and test it to assess if it works well or if it can be improved and optimized. It is necessary to continue testing the form until it reaches a standard which we consider acceptable.

- *Statistical tests*

Parametric tests assume that the variables data in the population are distributed according to the normal (Gaussian) distribution, which in probability theory is a continuous distribution, a function, which allows to calculate the probability that any real observation will fall between any two limits.

On the contrary, nonparametric methods make no assumptions about the distribution of data. Their applicability is much wider than the corresponding parametric methods and, due to the reliance on fewer assumptions, are more robust and simpler. Even when the use of parametric methods is justified, nonparametric methods are easier to use and more reliable. Because of their simplicity, results leave less room for improper use and misunderstanding.

In the 1960s Simon Shnoll and co-workers were probably the first scientists to show that the assumption of the normal distribution is only mathematical, and that in life sciences and also in physics it is false.

In a review of studies performed over more than forty years, Shnoll[51] shows the non-randomness of the fine structure of the distributions of measurements, starting from biological objects and moving into the purely physical domain. The implication is huge: tests based on the assumption of normal random distributions, such as those in the field of parametric statistics, are

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[51] Shnoll SE, Kolombet VA, Pozharskii EV, Zenchenko TA, Zvereva IM and AA Konradov, Realization of discrete states during fluctuations in macroscopic processes, Physics – Uspekhi 162(10), 1998, pp.1129–1140.

fundamentally biased and produce results which are often unstable and difficult to reproduce.

In the context of the methodology of concomitant variations studies are carried out using nonparametric statistics, among which the Chi Square (χ^2) is today one of the most widely used statistical indexes. χ^2 calculates the differences between observed frequencies and expected frequencies. In the absence of concomitances χ^2 is equal to 0, whereas in the case of maximum concomitance it is equal to the size of the sample.

The comparison with the χ^2 probability distributions allows to know the statistical significance of the concomitance. Statistical significance indicates the risk which is accepted when we state the existence of the relation. Conventionally concomitances are taken in consideration when the risk is below 1%. With dichotomous variables concomitances can be accepted with a risk lower than 1%, with χ^2 values greater or equal to 6.635.

When using the methodology of concomitant variations all variables are translated into the dichotomous form. Crossing two dichotomous variables produces a 2x2 table. If we take, for example, the following variables **A** and **B**:

	A		
B	Yes	No	**Total**
Yes	18,340	3,241	**21,581**
No	5,118	29,336	**34,454**
Total:	**23,458**	**32,577**	**56,035**

the χ^2 value is obtained by comparing the observed frequencies and the expected frequencies.

Expected frequencies are calculated by dividing the product of the total values of row and column by the general total. For the expected frequency of the first cell (Yes / Yes) is:

21,581 x 23,458/56,035 = 9,034

Following this procedure for all the cells of the table we have the following expected frequencies table:

	A		
B	Yes	No	**Total**
Yes	9,034	12,547	21,581
No	14,424	20,030	34,454
Total:	23,458	32,577	56,035

The Chi Square formula is the following:

$$Chi\ Square = \sum \frac{(f_o - f_e)^2}{f_e}$$

where f_o indicates observed frequencies and f_e expected frequencies

For each cell we calculate the square of the difference between observed frequencies and expected frequencies divided by expected frequencies and we sum the results together.

In this example we obtain a Chi Square value of 26,813, well above the value 6.635 from which the statistical significance of 1% starts.

Since the maximum value of χ^2 varies depending on the number of cases, it is useful to standardize it between 0 and 1. This transformation is known as the rPhi and is obtained as the square root of the value of χ^2 divided by the sample size and behaves similarly to Pearson's correlation index.

Correlations/concomitances can be of two types: direct or inverse. If the correlation is direct the two dichotomous variables are concomitantly true or false, whereas if the correlation is inverse one variable is true when the other is false. Inverse correlations have negative sign (-), whereas direct correlations are shown without sign.

- Example 1: Retrocausality

Fantappiè's *Unitary Theory* implies the existence of retrocausality. However, in the laboratories of physics it seems impossible to perform experiments that can demonstrate the existence of retrocausality. During her PhD in cognitive psychology Antonella Vannini formulated the following testable hypothesis: "*if life is sustained by syntropy, the parameters of the autonomic nervous system that supports vital functions should react in advance to stimuli.*" And indeed, an impressive number of studies had already shown that the autonomic nervous system (as measured by skin conductance and heart rate) can react before a stimuli is shown. Vannini conducted experiments using heart rate (HR) measurements to study this retrocausal hypothesis. A review of the experiments and a detailed description of four experiments can be found in the book "*Retrocausality: experiments and theory*."[52]

In her experiments, Vannini divided the trials in 3 phases:

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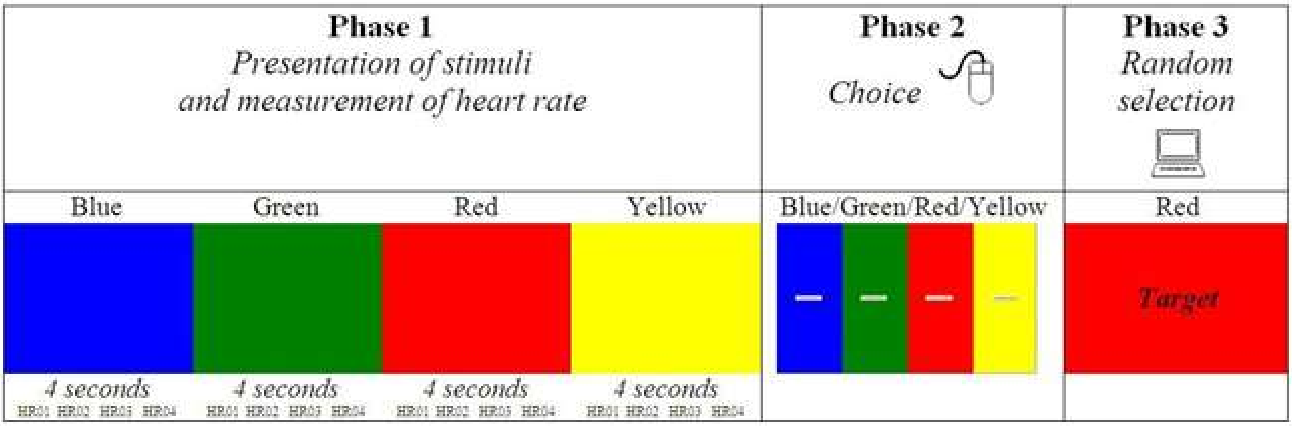
[52] Vannini A. and Di Corpo U. (2011), Retrocausality: experiments and theory, Kindle Editions, ASIN: B005JIN51O. A brief video presentation is available at http://youtu.be/5lvwlt1oBbQ

– *Presentation phase*: 4 colors are presented one after the other on the screen of the computer. Each color is shown for exactly 4 seconds. The subject is asked to look at the colors and heart frequency is measured at fixed intervals of 1 second. For each color 4 measurements of the heart rate (HR) are saved: one each second. The presentation of the color is perfectly synchronized with the HR measurement. When necessary, the synchronization is re-established showing a white image before the presentation of the first color in phase 1.

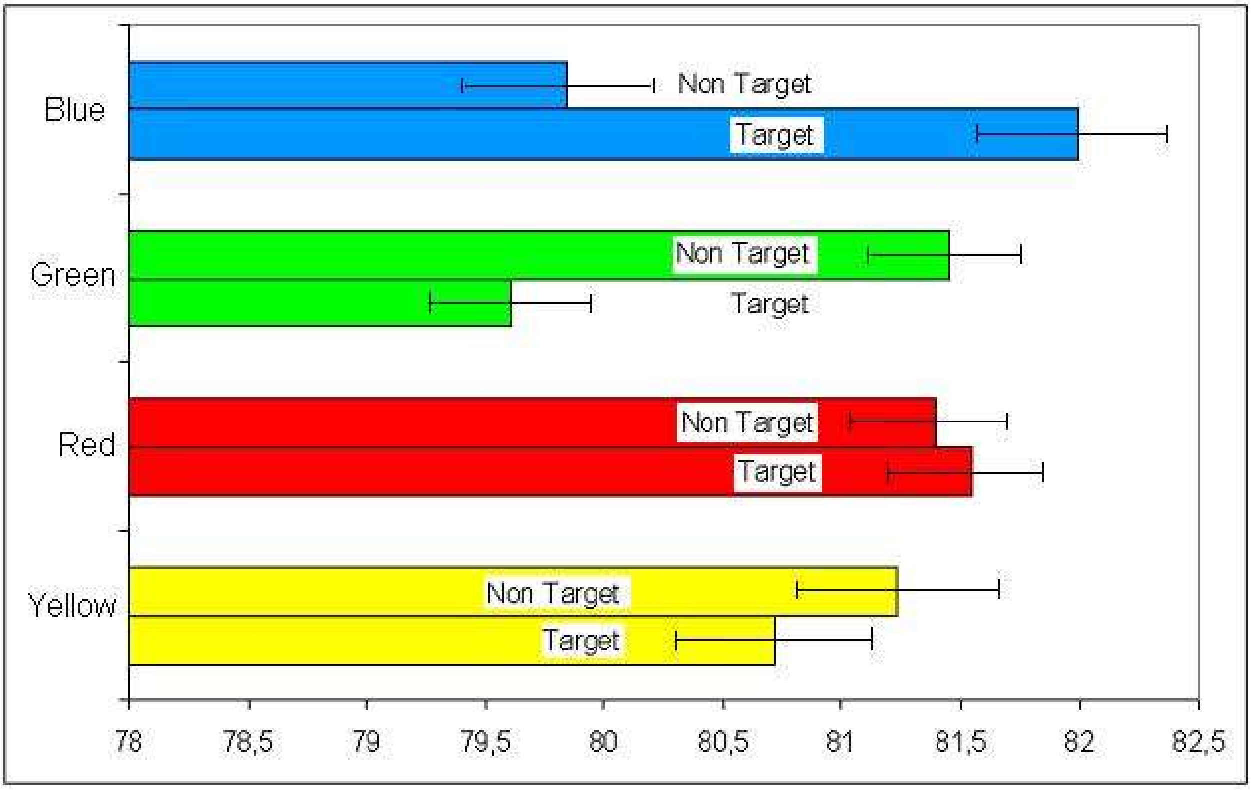
- *Choice phase*: an image with 4 color bars is shown to allow the subject to choose (using the mouse) the color which he thinks the computer will select. The subject is asked to guess the color which the computer will select.
- *Target phase*: the computer randomly selects the target color and shows the selected color full screen on the computer.



Experimental trials

Hypothesis: in presence of the retrocausal effect differences should be observed between HR measurements in phase 1 in concomitance to the color shown as the target color in phase 3. The presentation of the color in phase 3 is the cause of the HR differences observed in phase 1.

Trials were repeated 100 times per subject. Subjects were assisted only during the first trial and left alone for the remaining 99 trials. The first trial was therefore considered a test trial and not used in data analyses. The first experiment which was conducted on a sample of 24 subjects showed the retrocausal effect only when the target color was blue or green.



Mean heart rate frequency per color of the target

Data analysis was carried out

using parametric statistical tests, such as Student's t test and ANOVA.

The paradox was that when analyzing the data within each subject the effect showed on all the colors, but when the analysis was carried out considering all the subjects together, the effect was visible only with blue and green colors.

After a careful investigation it became clear that the retrocausal effect cannot be added, since it shows in opposite directions in different subjects. On the contrary, ANOVA and Student's t require additive data. When effects are non-directional, the use of ANOVA and of Student's t leads to type II errors, which consist in stating that an effect does not exist when it exists. ANOVA and Student's t are particularly vulnerable also to errors of type I, which consists in stating that the effect exists when it does not exist. Errors of type I happen, for example, when a single outlier, out of scale value, produces a statistical significance.

In the fourth experiment data analysis was performed using the methodology of concomitant variations. For each subject a table showing the observed effects was produced. This table consisted of 16 lines, one for each of the 16 heart rate frequencies measured in phase 1 of the experiment (phase 1 was repeated 100 times for each subject). Each column was relative to a target color (selected by the computer in phase 3). For each cell two mean values were calculated: when the color was target and when it was non-target. The value which is shown in the table is the difference between these two mean values.

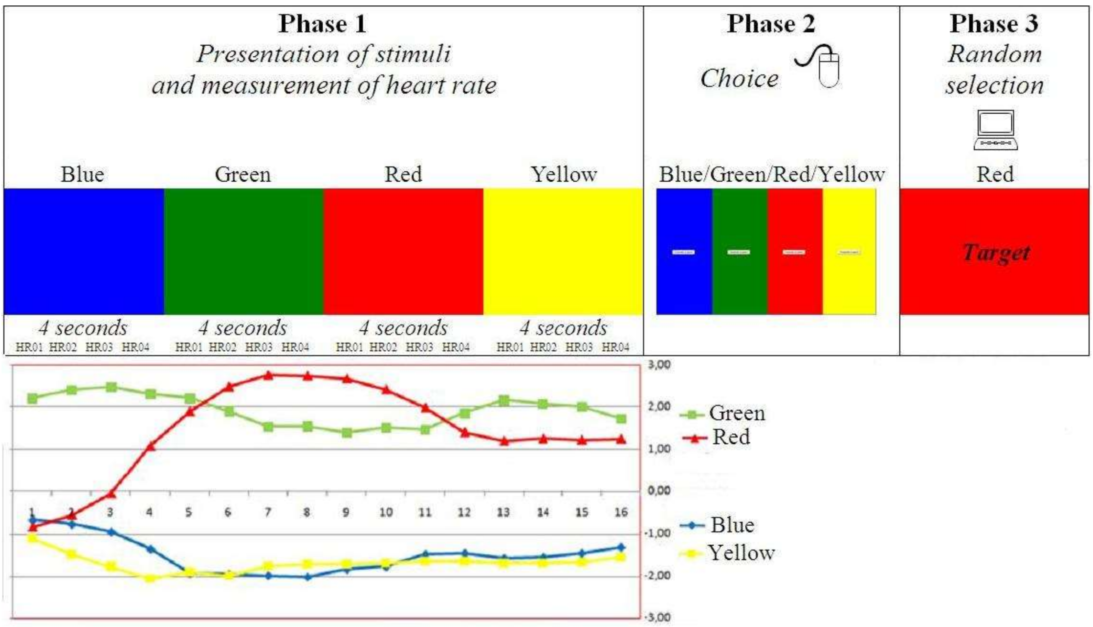
For subject n. 21, in the first line (HR 1) the difference of the mean value of the heart rate frequencies, when blue is target and non-target, is -0.671 heart rate beats. The second line is relative to the second heart rate measured during phase 1 and the difference is 0.772.

The greater the difference, the greater is the retrocausal effect. Only values over 1.5 were considered, since these values reach statistical significance of 0.01 ($p<0.01$). A general total value of statistically significant differences was calculated (considering only the absolute value). In this way, random fluctuations were removed from the general total. This table shows a general total of 83.764, for subject n. 21 and a general total equal to zero for subject n. 7.

Subject n. 21					Subject n. 7				
	Blue	Green	Red	Yellow		Blue	Green	Red	Yellow
HR 1:	-0.671	2.200	-0.840	-1.103	HR 1:	0.276	-0.775	0.040	0.378
HR 2:	-0.772	2.399	-0.556	-1.471	HR 2:	0.231	-0.750	0.133	0.298
HR 3:	-0.950	2.467	-0.056	-1.766	HR 3:	0.210	-0.862	0.173	0.414
HR 4:	-1.353	2.310	1.080	-2.054	HR 4:	0.150	-0.913	0.187	0.560
HR 5:	-1.928	2.204	1.894	-1.892	HR 5:	0.117	-0.850	0.187	0.545
HR 6:	-1.954	1.897	2.474	-1.993	HR 6:	0.048	-0.875	0.227	0.640
HR 7:	-1.982	1.535	2.752	-1.755	HR 7:	-0.067	-0.688	0.320	0.491
HR 8:	-2.015	1.543	2.733	-1.704	HR 8:	-0.077	-0.763	0.373	0.524
HR 9:	-1.831	1.397	2.665	-1.704	HR 9:	-0.129	-0.712	0.427	0.482
HR 10:	-1.770	1.508	2.407	-1.691	HR 10:	-0.109	-0.700	0.467	0.375
HR 11:	-1.482	1.468	1.981	-1.641	HR 11:	-0.174	-0.625	0.467	0.402
HR 12:	-1.458	1.853	1.404	-1.637	HR 12:	-0.249	-0.650	0.600	0.378
HR 13:	-1.572	2.154	1.199	-1.679	HR 13:	-0.259	-0.625	0.573	0.402
HR 14:	-1.544	2.079	1.260	-1.676	HR 14:	-0.296	-0.525	0.573	0.348
HR 15:	-1.452	1.994	1.226	-1.661	HR 15:	-0.283	-0.513	0.507	0.405
HR 16:	-1.311	1.727	1.255	-1.541	HR 16:	-0.220	-0.525	0.413	0.438
General total:	83.764				General total:	0.000			

Table of the retrocausal effect per subject

The distribution of the effect for subject n. 21 is represented graphically in the following table.



Graphical representation of the feedback table for subject n. 21

In the absence of a retrocausal effect lines should vary around the base value, the 0.00 line.

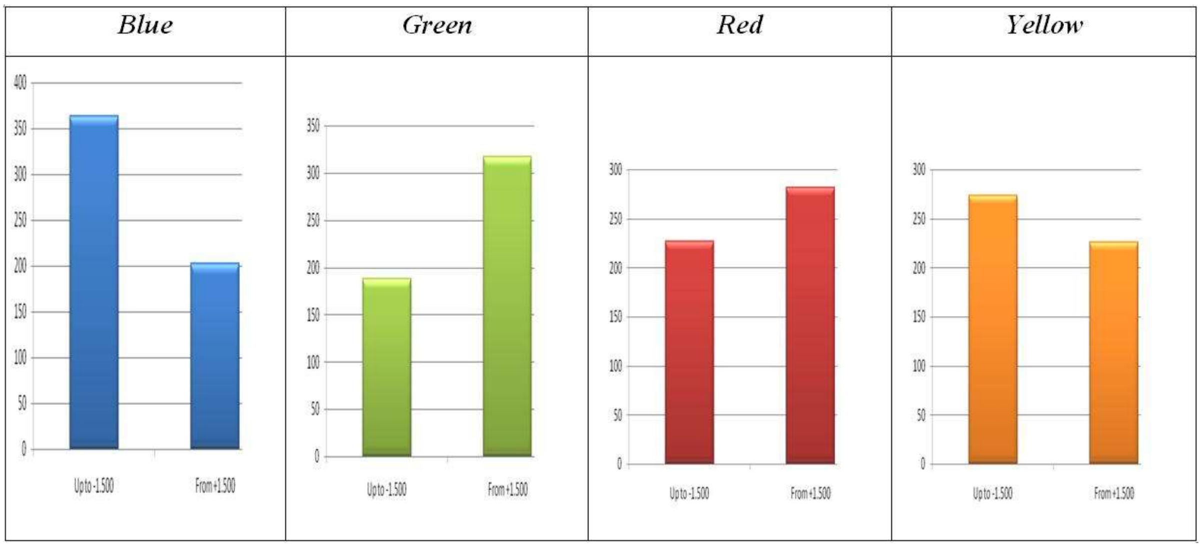
To study the retrocausal effect nonparametric statistical tests (Chi Square and the exact test of Fisher) were used. Individual tables were divided in 3 groups (first 33 trials, central 33 trials and last 33 trials), the cut off value remained 1.5, although it did not correspond any longer to the statistical significance value of 1% ($p<0.01$), since only 33 trials were considered. To calculate Chi Square values, expected frequencies were obtained "empirically" using targets non correlated with the color shown by the computer in phase 3.

Frequencies	*Differences of the mean values*			*Total*
	Up to -1.500	**-1.499 to +1.499**	**+1.500 and over**	
Observed	1053 (17.83%)	3680 (63.89%)	1027 (18.28%)	5760 (100%)
Expected	781 (13.56%)	4225 (73.35%)	754 (13.09%)	5760 (100%)

Observed and expected frequencies in HR distribution of mean differences, measured in phase 1 in association with the target

Differences up to -1.5 (on the left of the table) are associated with an observed frequency of 17.83%, whereas the expected frequency is 13.56%. On the right the observed frequency is 18.28%, whereas the expected frequency is 13.09%. The difference between observed and expected frequencies is equal to a Chi Square value of 263.86 which, compared to 13.81 for a statistical significance of $p<0.001$, results to be extremely significant. It was not possible to use the exact test of Fisher since this is not a 2x2 table. In the previous experiments it was impossible to assess the overall global retrocausal effect using Student's t and ANOVA

The tail values (up to -1.5 and from +1.5) denote retrocausality, which is visible on all the colors, as the following table shows.



Comparison of the retrocausal effect per color

For the red and yellow colors, the retrocausal effect is balanced between positive and negative increase of heart rate frequencies. Using the Student t and ANOVA tests these balanced opposite effects cancel each other and become invisible. Consequently, ANOVA and Student t are less powerful than Chi Square and non-parametric techniques, when used according to the methodology of concomitant variations.

- *Example 2: Resonance*

The concept of resonance is widely used in social sciences to describe emergent social phenomena.

The Vital Needs Theory posits that each individual needs to provide a finality and a meaning to life. When we lack finality, we lack the purpose in life, and we feel meaningless and depressed. Once we share finalities with others the process of resonance starts.

Following this hypothesis, we were asked to develop a questionnaire, aimed to measure resonance. This measurement was then used as a benchmark in the development of an app which analyzing voice, facial and gestural data recorded during the interaction of two persons would provide a measurement of resonance.

The Vital Needs Theory states that when we converge towards advantageous aims for life, we start experiencing positive emotions and feelings of wellbeing and warmth in the thorax area. Positive resonance is defined as the sharing of these positive feelings. When, instead, we diverge from advantageous aims for life, negative feelings and emotions are experienced. Negative resonance is defined as the sharing of these negative feelings in the interaction. Dissonance is defined as a mixed situation where one individual converges and the other diverges.

According to the Vital Needs Theory:

– *key variables* are relative to the perception of the future such as the items "*I feel confident in the future*" (for positive resonance)

and "*I feel with no future*" (for negative resonance);
– the *explicative variables* are items describing emotions and feelings.

A first questionnaire was devised to study which emotions and feelings were most concomitant with the key variables.

The questionnaire was made available through Google Docs and when a total of 160 valid questionnaires was reached data analysis was carried out. Respondents answered using values from 0 to 10. Objective variables were “Sex” and “Age”.

The aim of the analysis was to choose a subset of 20 items strongly correlated with the key variables.

Before starting the analysis plain frequency distributions of each item were used to decide the cut-off point for the transformation from the 0-10 values to the Yes/No values. The transformation was done using the median values which, in the absence of specific hypotheses, is the cut-off point which maximizes concomitances.

Plain frequency distributions were of the type:

Restless

	N	%
p. 0	56	35.00
p. 1	29	53.13
p. 2	18	64.38
p. 3	17	75.00
p. 4	9	80.63
p. 5	13	88.75
p. 6	5	91.88
p. 7	4	94.38
p. 8	7	98.75
p. 9	-	98.75
p. 10	2	100.00
Total	**160**	

The difference in color shows the division from low to high which was used to transform the variable in the dichotomous form.

The sample was of 71 males (44,4%) and 89 females (55,6%).

Sex		
	N	%
Males	71	44.38
Females	89	55.63
Total	160	

Males/females frequency distribution

The most consistent age class group was between 41 and 50 years of age:

Age		
	N	%
-30	16	10.00
31-40	36	22.50
41-50	44	27.50
51-60	35	21.88
61+	28	17.50
Missing Data	1	0.63
Total	160	

Age distribution

The following table shows the 10 items with the highest correlations with the key variable "*I feel confident in the future.*"

Labels have been translated from Italian into English, and unfortunately it is difficult to translate emotions and feelings. The result does not express exactly the original meaning.

"Confident in the future" is concomitant with:

Chi2	rPhi	% Yes % No	
160.00	1.000	(100.00%/ 0.00%)	Confident in the future
50.60	0.562	(77.50%/ 22.50%)	Delighted
32.81	0.453	(72.50%/ 27.50%)	Sure
29.70	0.431	(71.25%/ 28.75%)	Happy
25.80	0.402	(70.00%/ 30.00%)	Satisfied
25.70	0.401	(70.00%/ 30.00%)	Joyous
19.68	0.351	(67.50%/ 32.50%)	Determined
19.62	0.350	(67.50%/ 32.50%)	Enthusiastic
18.44	0.339	(66.88%/ 33.13%)	Joyful
18.21	0.337	(66.88%/ 33.13%)	Valued
18.21	0.337	(66.88%/ 33.13%)	Sociable
14.47	0.301	(65.00%/ 35.00%)	Intrigued
13.32	0.289	(64.38%/ 35.63%)	Stable
13.26	0.288	(64.38%/ 35.63%)	Wellbeing
13.21	0.287	(64.38%/ 35.63%)	Useful
12.13	0.275	(63.75%/ 36.25%)	Kind
12.09	0.275	(63.75%/ 36.25%)	Calm
12.08	0.275	(63.75%/ 36.25%)	Adaptable
10.10	0.251	(62.50%/ 37.50%)	Lively
8.09	0.225	(61.25%/ 38.75%)	Excited

Items mostly correlated to Confident in the future

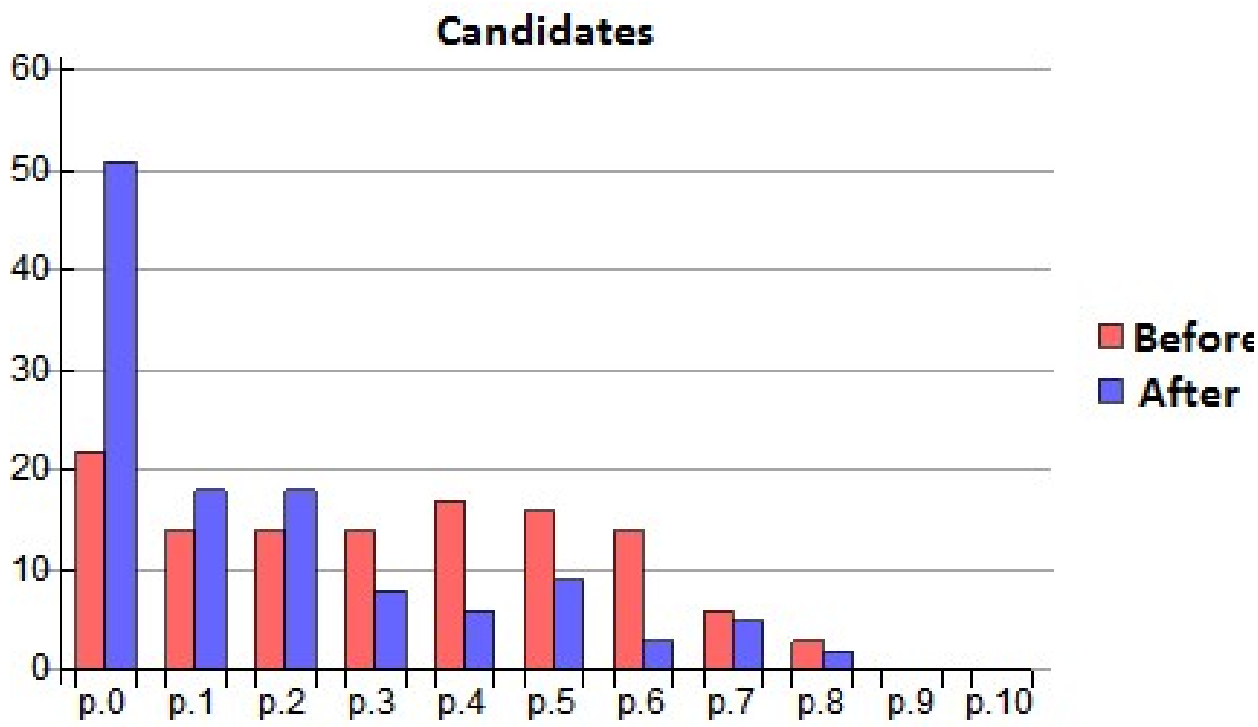
Once the items were selected:

– *Positive Resonance* was assessed as concomitant increase of values in the positive items and concomitant decrease of values in the negative items, among the two persons involved in the interaction.

- *Negative Resonance* was assessed as concomitant decrease of values in the positive items and concomitant increase of values in the negative items, among the two persons involved in the interaction.
- *Dissonance* was assessed as absence of concomitant increase or decrease of values between interviewer and candidate.

The short questionnaire of 20

items, for the assessment of resonance, was used during job interviews. The candidate and the interviewer were asked to fill the questionnaire before and after the interview. Results show a shift towards values which were generally concomitant between candidate and interviewer.



The aim of the project was to correlate this measurement of resonance with measurements provided by the analysis of vocal, facial, and gestural domains.

The voice domain consisted in 56,035 records, processed to provide indications of how the voice features changed between the first part of the interview and the last part. The same procedure was used for the 5,037,792 measurements of 28 features in the facial domain and the 6,786,111 measurements of the 20 gestural features.

Chi Square analysis showed several statistically significant correlations between the resonance value obtained using the questionnaire and features measured in the voice, facial and gestural domains.

The results of these analyses allowed to design an application that uses vocal, facial, and gestural information to measure resonance in the interaction between two persons.

5

SOFTWARE

The Sintropia-DS software was developed to make the methodology of concomitant variations available.

In this section only a limited number of options will be described. A complete description is available in the help sections of the software, or in the dedicated 2005 issue of the Syntropy Journal.

The first version of Sintropia-DS dates to 1982, it was distributed with the name DataStat, and extensively used in the Department of Statistics of the University of Rome.

Sintropia-DS merges database and statistical analyses (this is the reason of the extension DS: database and statistics).

To install Sintropia-DS in your computer: download the file from

www.sintropia.it/sintropia.ds.zip,

copy in the root disk "C:" the folder "Sintropia.DS", from the zip file, and find the Sintropia application in the folder Sintropia.DS.

This version of the software dates to 2005 and was intended for

Windows-XP. More recent version of the Widows operating system might require that you allow the use of the program.

Some characteristics of Sintropia-DS are:

- Online coding of data. Statistical analyses require data which has been translated in a numeric form. Online coding makes data-entry easy, more efficient, and allows to check constantly the quality of data, reducing in this way errors.
- Unity of structures. Commercial

databases are organized in sub-archives which are related together. This architecture conflicts with the statistical unit requirement. Sintropia-DS records are united in one archive, one structure, which allows to easily perform the analysis of concomitant variations.

– Easy editing of forms. It is possible to use forms of any level of complexity. Editing a Sintropia-DS form is easy. The same file used to print the form with a word processor can be used (with minor changes) to edit the structure of the Sintropia-DS database and data entry form. Extensive diagnostics guarantees that the final form is suitable for statistical analyses.

Other characteristics:

– Integration of database and statistical analyses optimizes data-entry for statistical analyses. The grid which translates data into the dichotomous form is produce automatically, reducing in this way errors and fatigue. Automatic checks during data-entry drastically increase the quality of data, and reduce data-entry time.

- Only few statistical techniques, coherent with the methodology of concomitant variations, are provided. Users with no background in statistics, can produce robust and correct statistical analyses.
- The integration of qualitative and quantitative data allows for the complexity of natural phenomena.
- Instantaneous analyses, independent from the dimension of the archive, allow

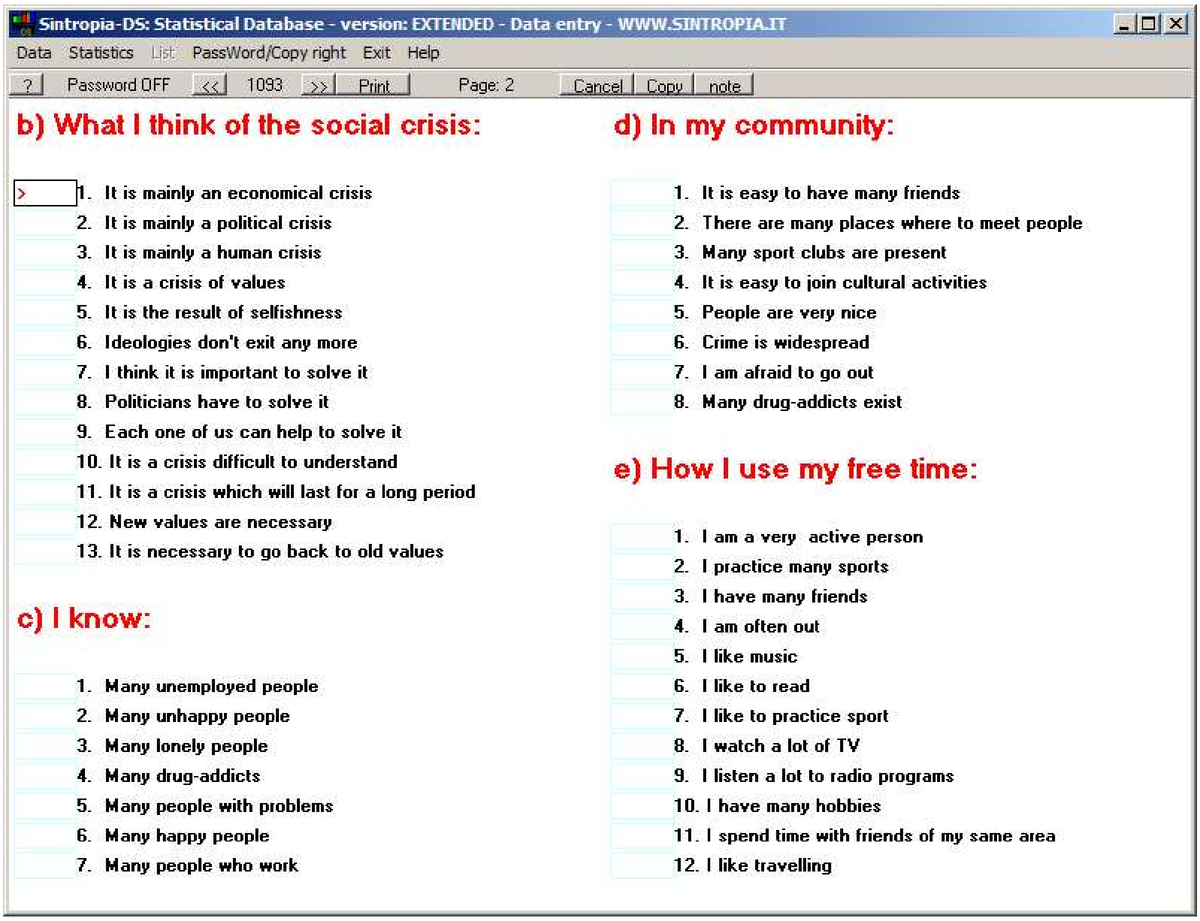
immediate visualization of the most complex results.

When you enter Sintropia-DS you will be asked for a password.

The password (SINTROPIA) is needed only when you want to input or modify data. Otherwise, you can enter pressing the button “Continue without password”. When you first enter Sintropia-DS you will be shown the first empty page of the record of the active database. In the example which comes with the software the first empty record is the number 1093 of a database relative to the dissatisfaction among teenagers; 1092 questionnaires are already present in the database.

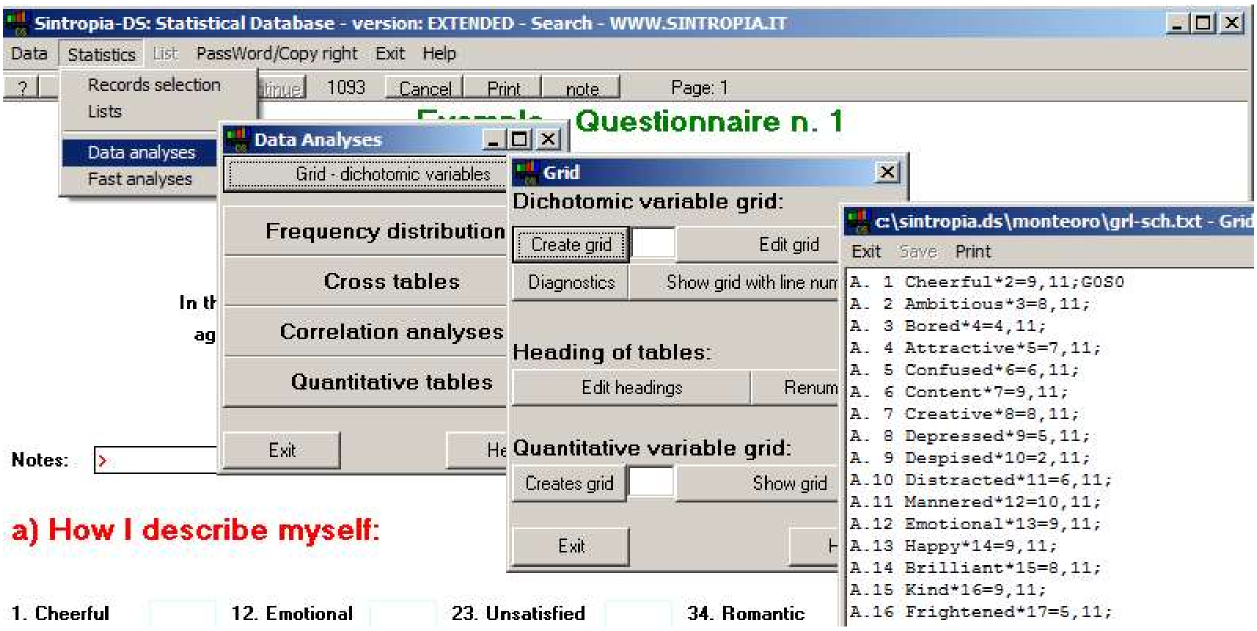
Sintropia-DS attributes a progressive number to each record of the database. A record can be a questionnaire or a data form. It is possible to go to a record entering the progressive number of the record, using the buttons << >> to go to the previous or next record and searching for those records which meet specific information.

A record can be divided in several pages. It is possible to change page using the keys *Page Up* and *Page Down*.



Sintropia-DS is divided into two sections: *Data* and *Statistics*. The Data menu allows to enter data, search, modify, import, etc. The Statistics menu allows to select records and to perform statistical data analyses.

In this example people were asked to answer using values from 0 to 10, where 0 meant total disagreement and 10 total agreements. But the methodology of concomitant variations uses dichotomous variables (0/1). Sintropia-DS translates data in the dichotomous form using a grid. The first option in the *Data analyses* window is therefore that of creating the "Grid" which allows to translate the information stored in the database into the dichotomous form.



In the example, the first dichotomous variable is defined in the following way:

A. 1 Cheerful*2=9,11;

- "A. 1 Cheerful" is the label.
- *2 is the field of the record in the database.
- =9,11 are the values that make

the dichotomous variable true, and that in this example go from 9 to 11.

Sintropia-DS treats the value 0 as the missing value. But, in this example people were asked to answer using values from 0 to 10. An option was used to automatically increase the information entered by 1. Consequently, in the database the information is stored from 1 to 11 and not from 0 to 10, where 1 indicates 0.

The translation of the variable "Cheerful" in the Yes/No dichotomous form used the median values and not the mid value of the 0-10 scale. When no specific hypothesis exists, the best results are obtained using the median value as the cut-off point, since this value maximizes the variability dividing the distribution into two equal parts. In order to choose the best cut-off, point plain distributions are usually analyzed. Since people use masks the median value of positive items is usually higher than 5, whereas the median value of negative items is usually lower than 5. To decide which value best separates the Yes and No sides of the dichotomous variable, it is necessary to analyses the cumulated frequency distribution.

Value	Records	%
0	9	0,92
1	5	1,44
2	12	2,67
3	4	3,08
4	14	4,52
5	59	10,57
6	99	20,74
7	175	38,71
8	239	63,24
9	81	71,56
10	277	100,00
Total	974	

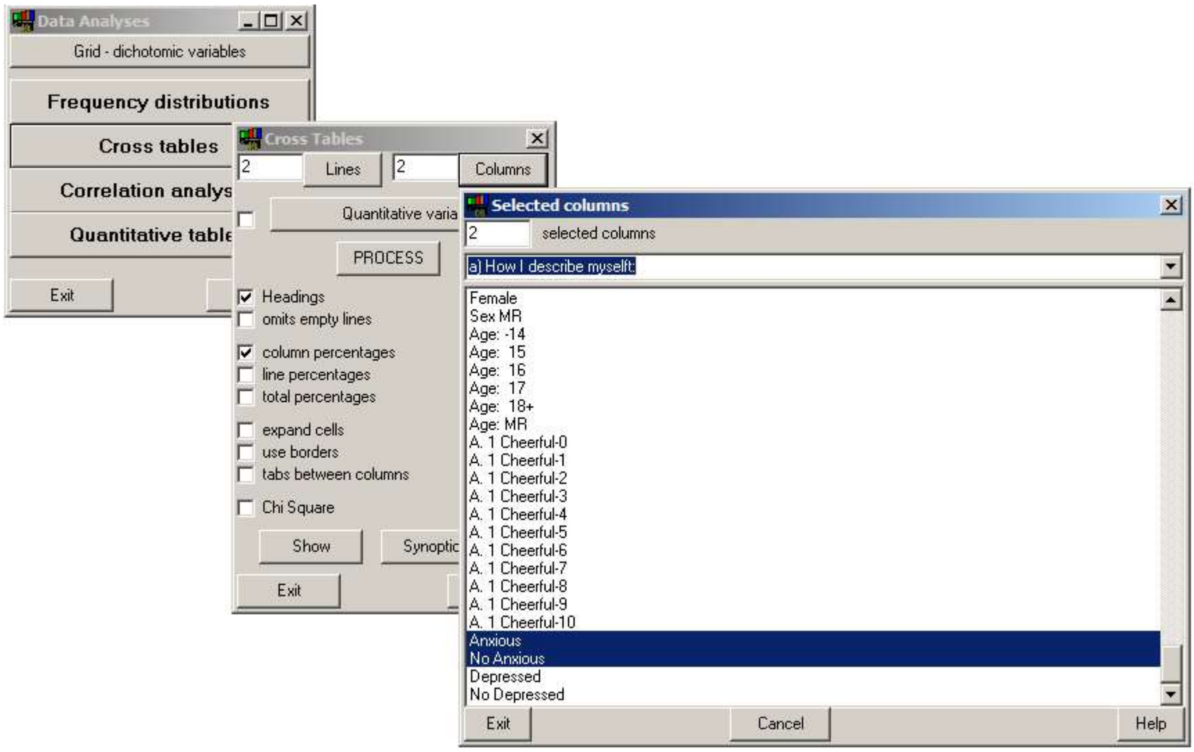
In this table we see that the median value is reached between the value 7 and 8. Consequently values from 0 to 7 are treated as

NO and values from 8 to 10 as YES.

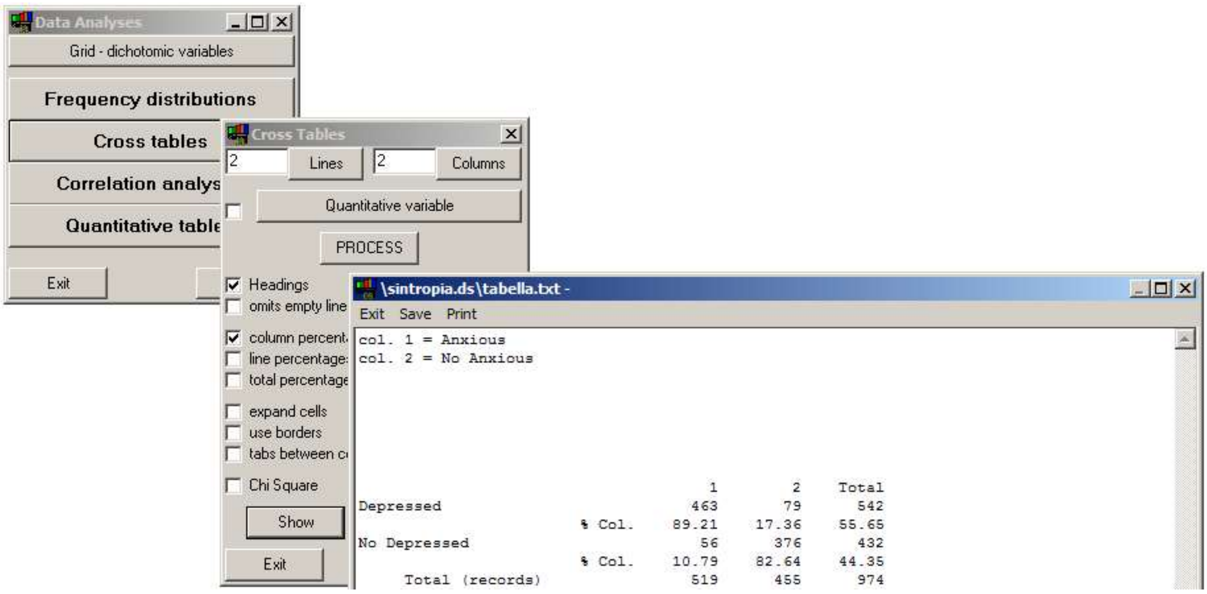
Out of a total of 1092 records, only 974 records have been used in the data analyses, since several questionnaires had too many missing answers or had data which was clearly invented, for example sequences such as: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0, 1, 2…. A field was added at the end of the record to mark if the questionnaire was valid or not.

In this application the grid is already present. We can therefore start immediately the data analyses.

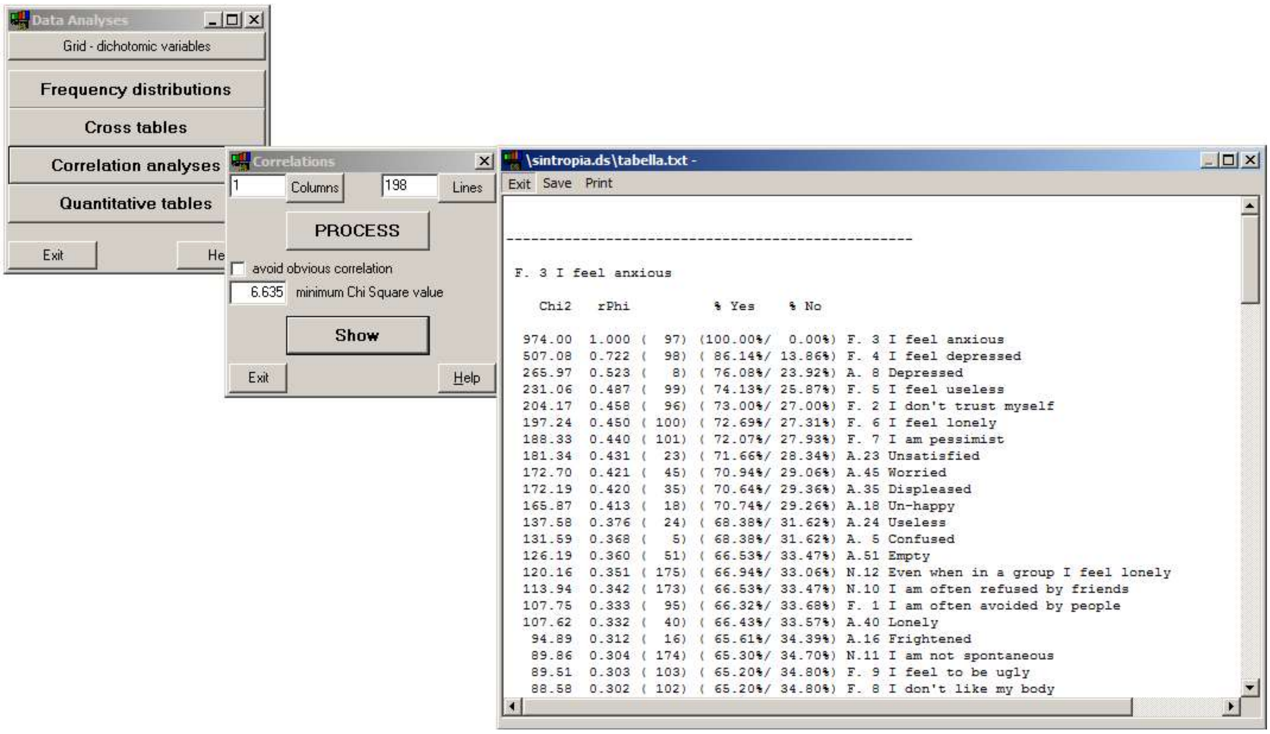
For example, choose the *Statistics* menu, the *Data analyses* option, *Cross tables* and then the button "*Columns*":



Select Anxious and No Anxious as column variables (at the end of the list). Then exit and choose the "Lines" button and select Depressed and No depressed as line variables. Exit again and press the button "PROCESS" and then the "Show" button:



You have produced your first cross table! Now, instead of "Cross tables" go back and choose "Correlation analyses". In the column window choose "F.3 I feel anxious". And in the lines window choose all the 198 items of the questionnaire (to the item "Q.8"). Press "PROCESS" and then "Show". The result is the rank of the 198 Chi Square values which "I feel anxious" obtains crossing the other 198 items of the questionnaire. *<u>This is a table of concomitances</u>*.

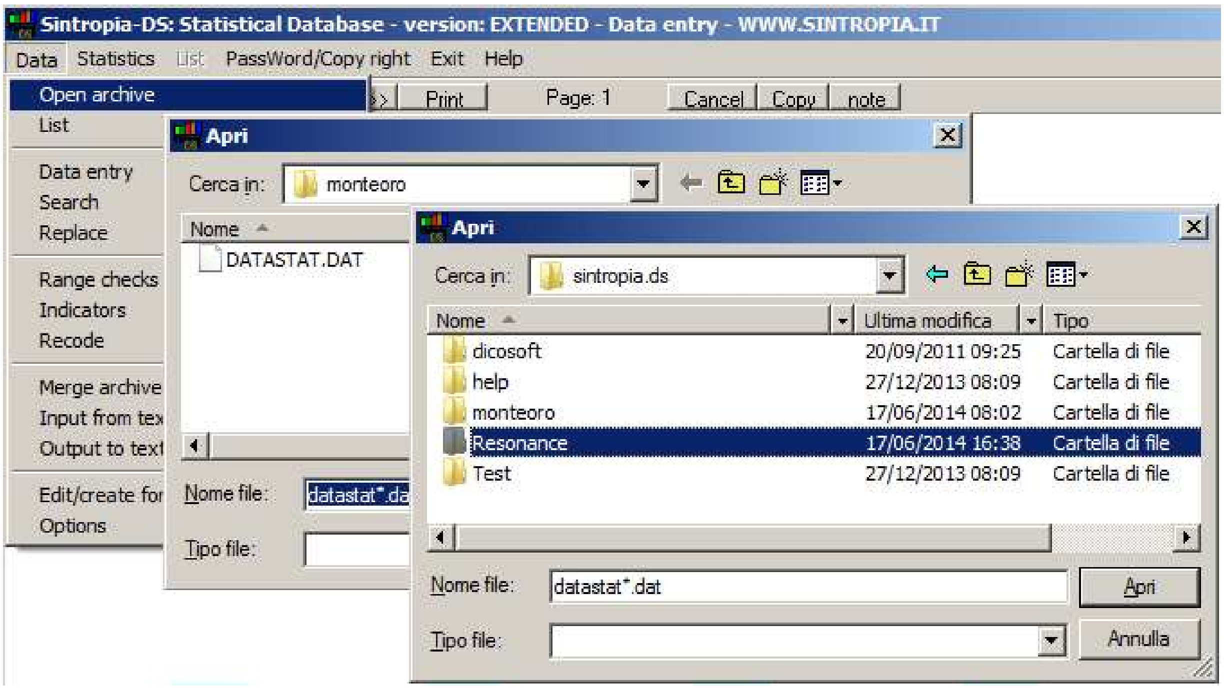


In this table of concomitances, we

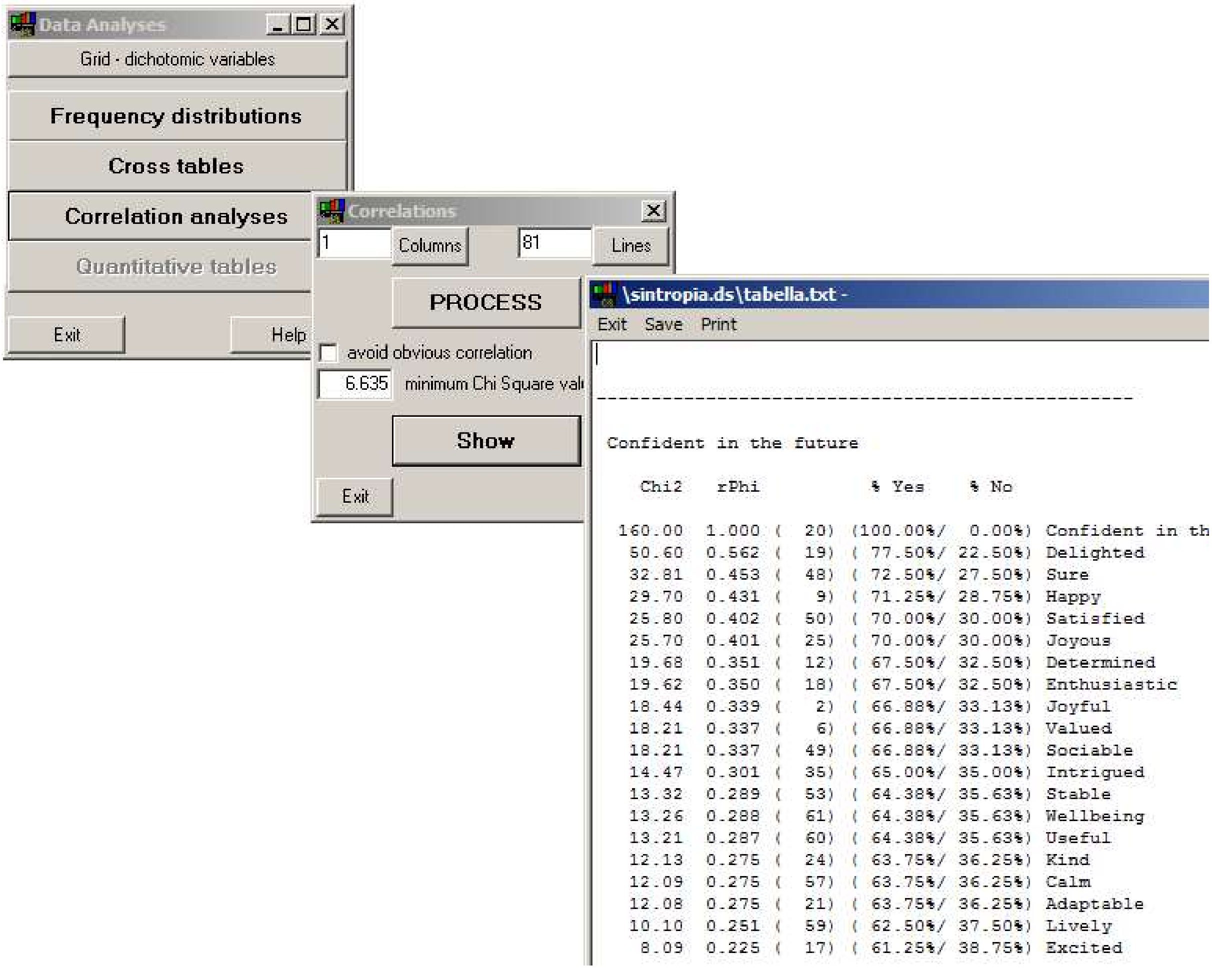
read that *I feel anxious* is strongly correlated (concomitant) with *I feel depressed*, *I feel useless*, *I don't trust myself*, *I feel lonely*, etc. Scientific hypotheses are nothing else than statements of correlations (concomitances).

The methodology of concomitant variations allows to handle together unlimited numbers of variables, and to compare in this way different hypotheses, keeping trace at the same time of the context. Tables of concomitances analyze all the possibilities and provide as a result the list of those possibilities which are empirically supported by data.

Other archives are present in the folder sintropia.ds. In order to choose another archive, select the “Open Archive” option from the “Data” menu, select the folder and then the file “DataStat.Dat”:



In this example choose the archive “Resonance”.



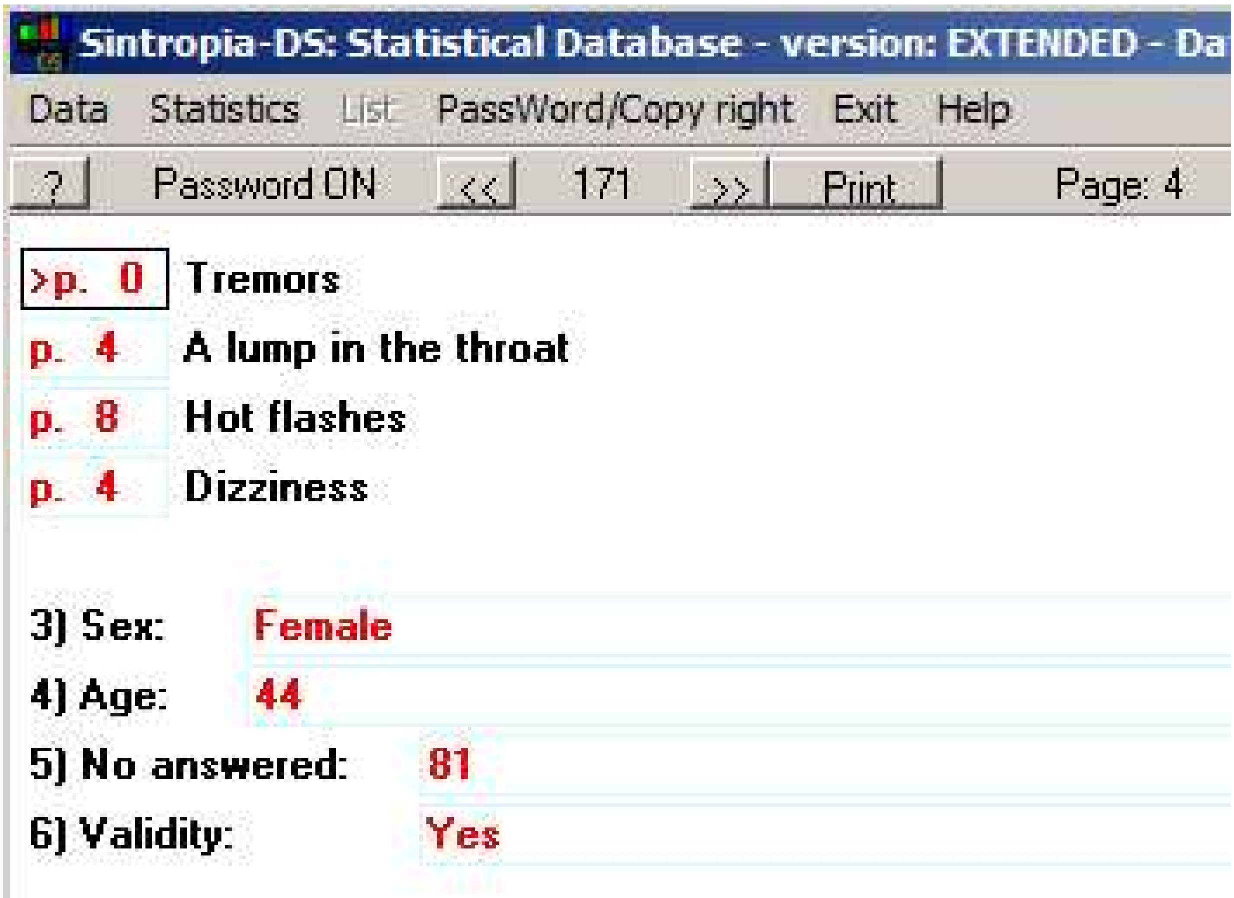
Go to the option "Data Analysis" from the menu Statistics and "Correlation analyses." Use the Columns button to choose "Confident in the future" and Lines to choose all the variables of the questionnaire. Press the button

“PROCESS” and then “Show”.

In the output window we see the concomitances among the key item “Confident in the future” and the other items of the questionnaire.

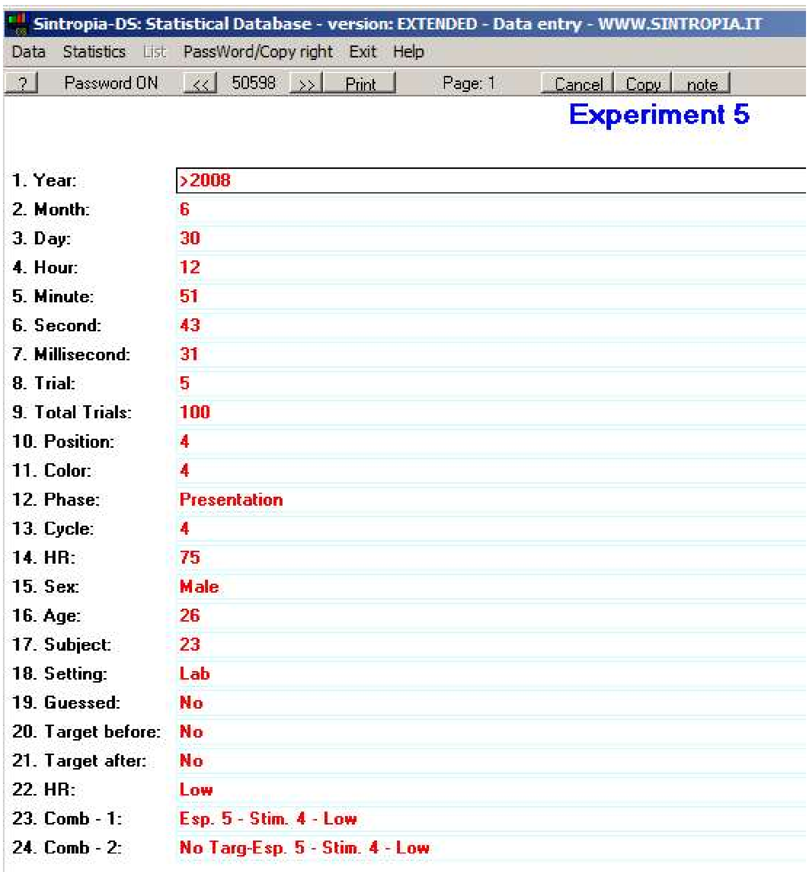
It is important to pay attention to the notion of “statistical unit” which in Sintropia-DS corresponds to the record.

The notion of statistical unit is fundamental in the analysis of concomitances, since it implies the “unity” of information, the record, which allows to study concomitances. Each Sintropia-DS database is a collection of records of statistical units. In the case of "resonance" the statistical unit is the respondent to the questionnaire.



The methodology of concomitant variations studies concomitances within statistical units. It is therefore always very important to correctly choose the statistical unit. Whereas when using the methodology of differences, the unit does not exist, but groups exist, and differences and variances are calculated among groups.

Now change database and move to the folder "Retrocausality."

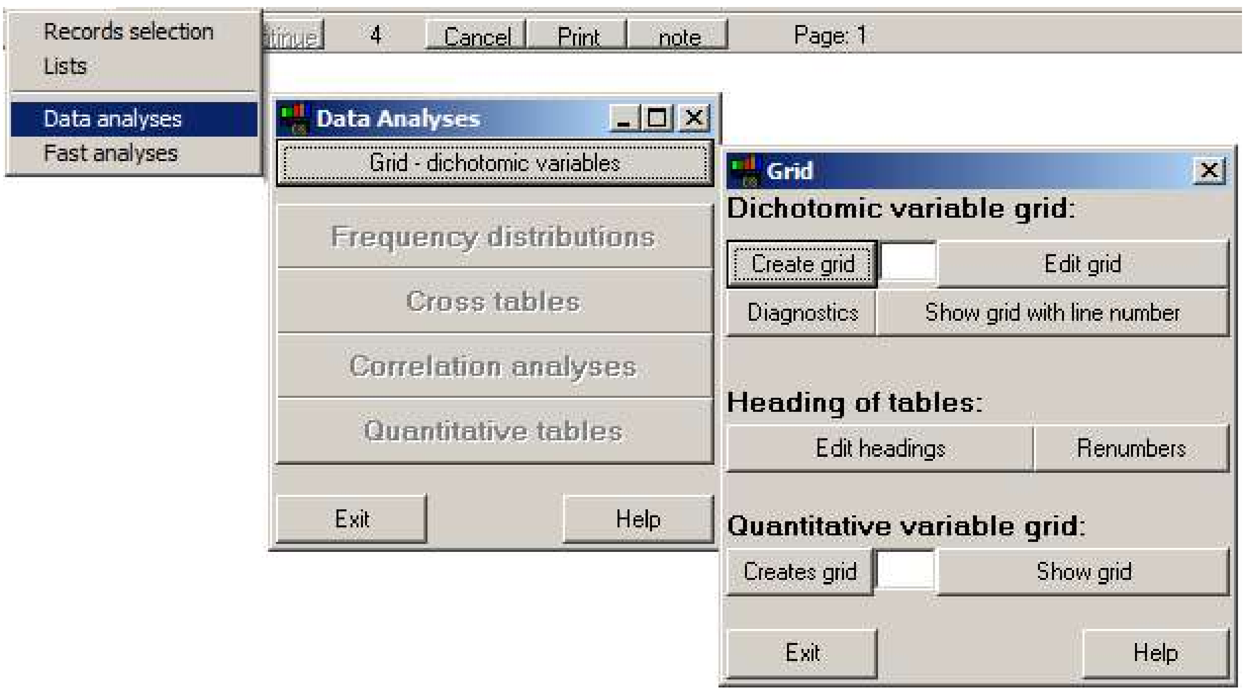


- Translation in the dichotomous form

Sintropia-DS processes data using a virtual record in which data has been translated into dichotomous variables. The grid instructs how to translate data into the dichotomous form. Dichotomous variables (0/1) are the simplest form of data. Any type of information, qualitative or quantitative, can be translated in one or more dichotomous variables. With dichotomous variables it is possible to handle together quantitative and qualitative, subjective, and objective information allowing complex analyses.

The logic is like what happens with computers, where starting from the bit of information (0/1) it is possible to produce the most complex applications.

When the grid which translates information in the dichotomous form is not present the data analyses options are not active. Choose the “Grid – dichotomous variables” option and press the button “Create grid.” Each line of the grid defines a dichotomous variable. A line has the label, the number of the field, the interval which sets the dichotomous variable true, and other information which tell if the variable is the first of a table (group), if it is part of a table with multiple answers, if it is the first variable of a synoptic table, if percentages must use a filter variable as totals.



The following example show the definition of 3 dichotomous variables which are all part of the same table.

1. Active*1=1,1;G0S0
1. Cancelled*=2,2;
1. MR*=0,0;

The first dichotomous variable "_1. Active_" refers to field number 1 (_*1_), and it is true if values go from 1 to 1 (=_1,1;_). It is the first variable of a table (_G_) it is not taken from a multiple answer item (_0_, otherwise the number of answers would appear), it is not part of a synoptic table (_S_, otherwise the small character s would be used), it does not refer to a filter variable (*0,* otherwise the line number of the dichotomous variable which has the totals is used).

The second variable "*2. Cancelled*" refers to the same table (for this reason the number of the field is omitted), the interval which sets the dichotomous variable true is (=*2,2;*), it is not the first variable of a table.

The third dichotomous variable "*1. MR*" is relative to the missing answer. With coded answers (which refer to lists) the missing answer is zero, whereas with quantitative variable the missing answer is minus 32,000 and with long quantitative variables -9,999,999.

The grid file is saved in the same folder of the archive in a text file named "*grl-sch.txt*". The headings, with titles of the tables, is saved in a file named "*tin-sch.txt*". When editing the grid, you might remove entire tables. When this happens, their heading must also be removed from the file "*tin-sch.txt*". Headings are organized in the following way:

001 ◄ progressive number of the table

Table 1 - Status of the record ◄

text (it can be long more than one line)
/// ◀ end

For example:

001

Table 1 Status of the record:
///
002

Date:
///
003

Sex:
///

After editing headings, it is

necessary to use the button “renumbers” which is present in the “Grid” window, to be sure that the numbers of the tables are progressive.

When grl-sch.txt file exceeds 32k (32,000 characters) it is necessary to use a text editor. Word processors often add special characters which interfere with Sintropia-DS, it is therefore recommended to use plain editors, such as the Block Notes editor available with Windows.

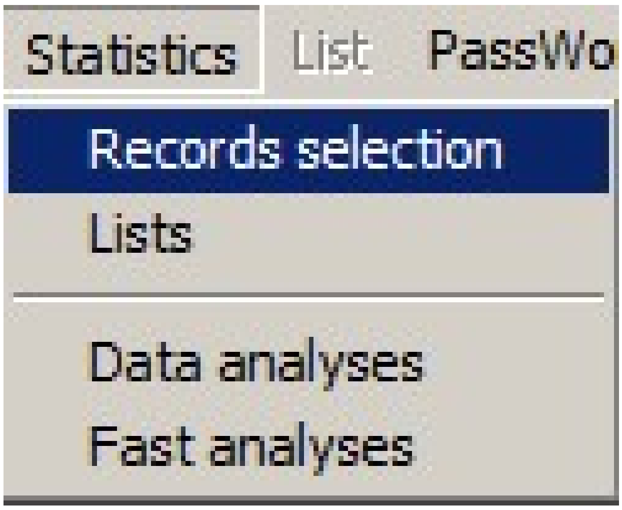
After editing the grl-sch.txt file, to check for mistakes, use the button diagnostics. It is a good habit to use this option before starting data analyses.

A separate grid is present for those variables which we want to treat as quantitative (sums, average value, and deviation). The grid is very simple, the first value is relative to the field in the database, the second to the label, the third to the status (synoptic table and beginning of a table). "S" marks the start of a synoptic table, s the continuation and G the beginning of a table. For example:

33*doctors *SG
34*nurses *s
35*volunteers*s

- Data analyses

The first option "Record selection" is used to select groups of records.



The selection of records remains active until a new selection is made. Record selection shows the data-entry form, and selection conditions are entered directly on the form. If no conditions are entered all the records will be selected, when conditions are entered only the records which match the conditions will be selected.

Commands:

– choose the field in which you want to enter a searching condition, press the “C” key to open the window which allows to enter conditions. If no window opens it means that the cursor is positioned on a text field.

- When a searching condition is present in a field the program shows the character "=" (equal). In order to select the records which differ from the searching condition press the key "#" or "=", and the character “#” will be displayed.
- If you want to activate frequency distributions, press the key "S", the program will show "St" in the selected field.
- If you want to use a quantitative variable as unit, select the field of the quantitative variable and press the key “Q”. To remind that the value of that field will be

used as a unit, the character Q is shown.

At the top of the page the following command line is displayed:

To select the records, press the button SEARCH and select in the Search window the button Start SEARCH.

The options of the command line are:

- “?”, opens the help page relative to this section.
- “Cancel”, opens the window “Cancel” that allows to cancel all the conditions entered and the statistical distributions. When records are divided in more pages, it is a good habit to cancel conditions, using this option, before starting a new search.
- “Search”, opens the search window. Usually only the option “Start SEARCH” is used. If you want to add a new search to an already existing selection use “Add SEARCH”, if you want to Open an already existing record

selection use the option "Open SEARCH", in this case the existing selection will be intersected (AND) with the opened selection.

– "Save", allows to save the selection and the selection conditions.
– "Open", allows to read previously saved selections and search conditions.

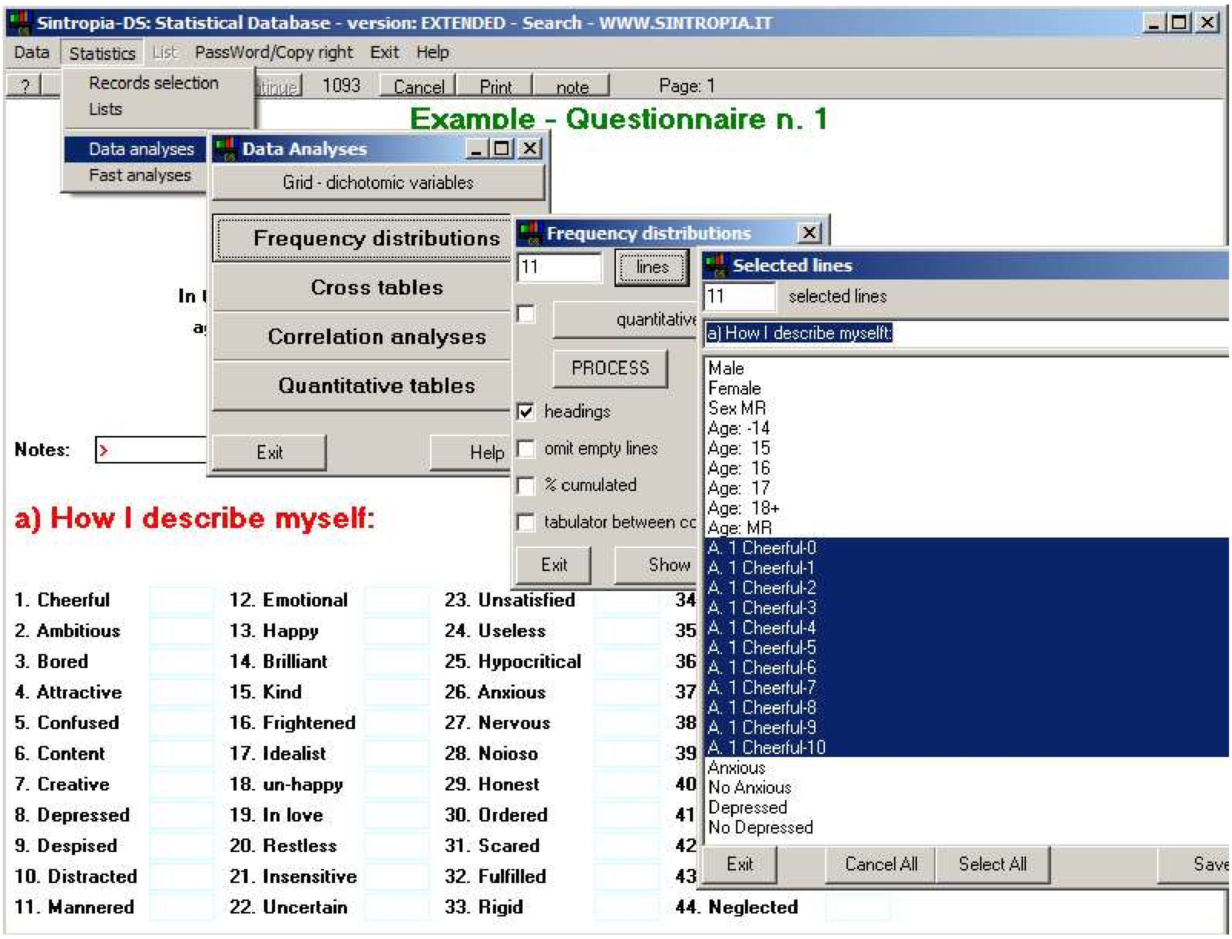
The simplest level of data analysis are frequency distributions. Variables are treated separately, and concomitant variations are not calculated.

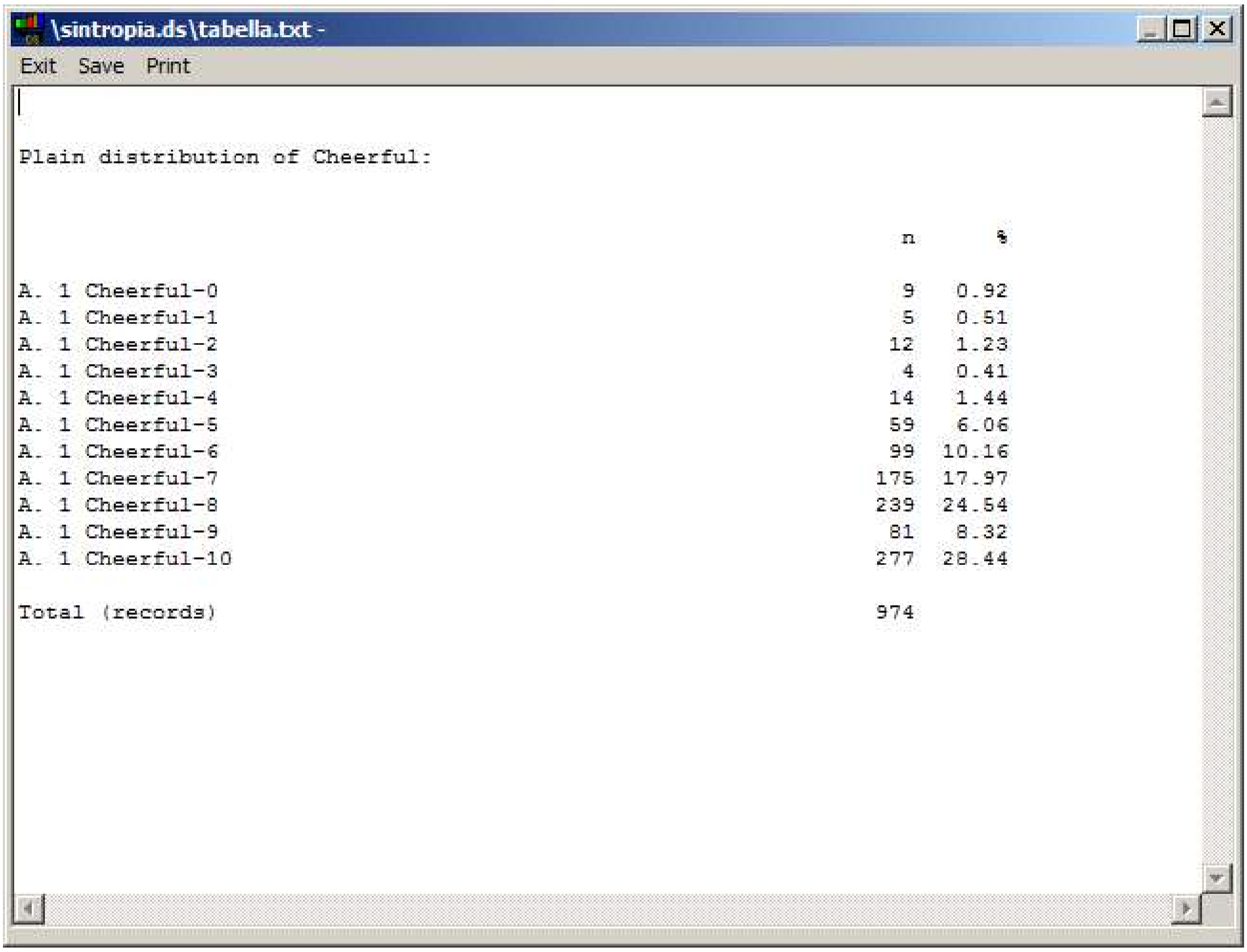
Go back to the “MonteOro” database. If you are in a different folder, go to the “Data” menu and then “Open archive” and select MonteOro, which is relative to the questionnaires on the dissatisfaction among teenagers.

Choose from the “Statistics” menu the option “Data analyses”, then “Frequency distributions” and then the button “lines”. If lines are already selected press “Cancel All”. Go at the end of the list and select the A. 1 group:

You should have 11 lines selected. Exit this window, press the button

"PROCESS" and the button "Show". The following table of frequency distributions should appear.





Plain distribution of Cheerful:

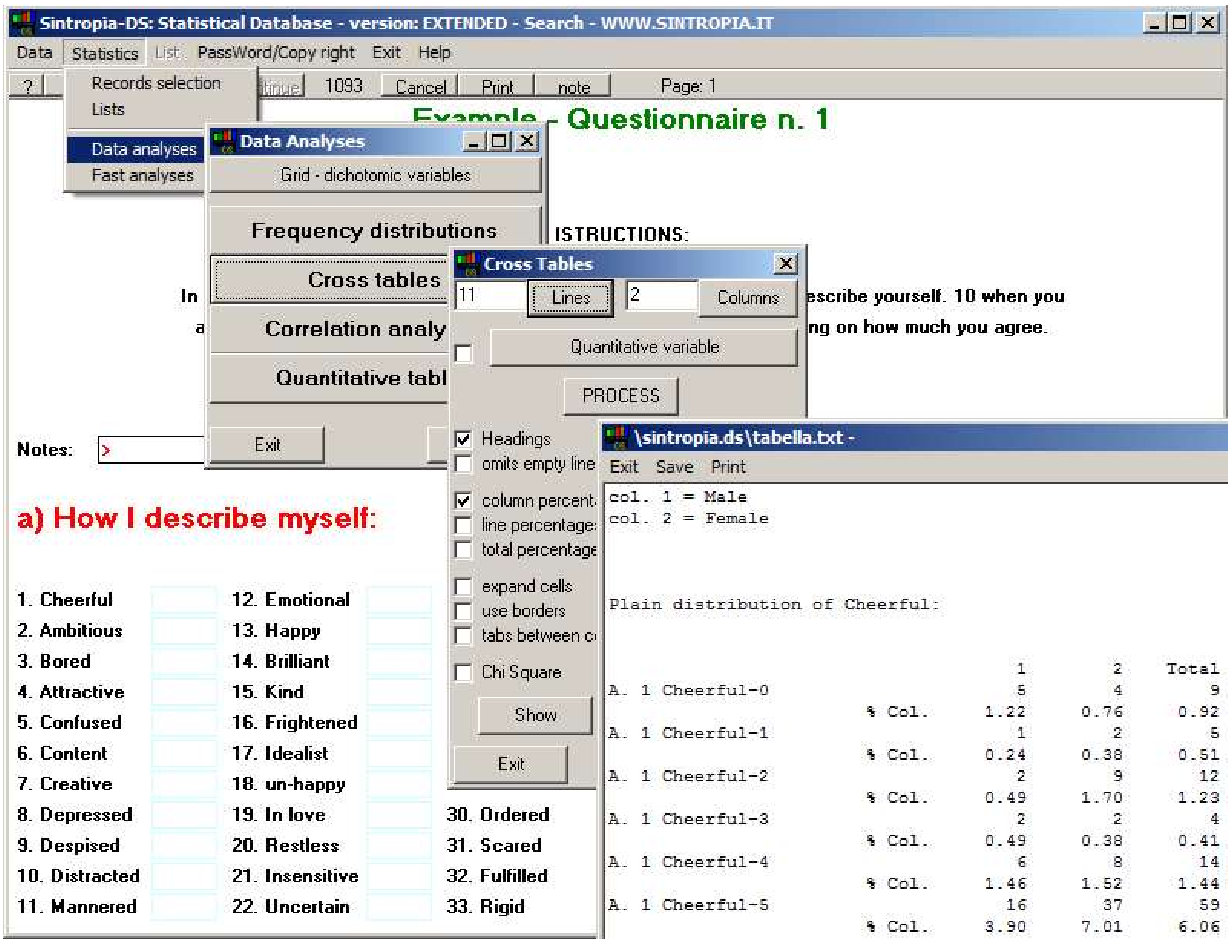
	n	%
A. 1 Cheerful-0	9	0.92
A. 1 Cheerful-1	5	0.51
A. 1 Cheerful-2	12	1.23
A. 1 Cheerful-3	4	0.41
A. 1 Cheerful-4	14	1.44
A. 1 Cheerful-5	59	6.06
A. 1 Cheerful-6	99	10.16
A. 1 Cheerful-7	175	17.97
A. 1 Cheerful-8	239	24.54
A. 1 Cheerful-9	81	8.32
A. 1 Cheerful-10	277	28.44
Total (records)	974	

In this frequency distribution table, we read that on a total of 974 subjects, 9 have answered “0” to Cheerful, 5 have answered 1, 12 have answered 2, etc… Each of these 11 lines is a dichotomous variable, but they are all grouped in the table “Plain distribution of

Cheerful:”

Cross tables are required for studying the concomitances among two variables. To produce cross tables, choose the option Data analysis of the menu Statistics and then Cross Tables. Choose the lines (the 11 lines of the previous example should still be active) and the columns, for example Male and Female.

Press the button “PROCESS” and then “Show”.

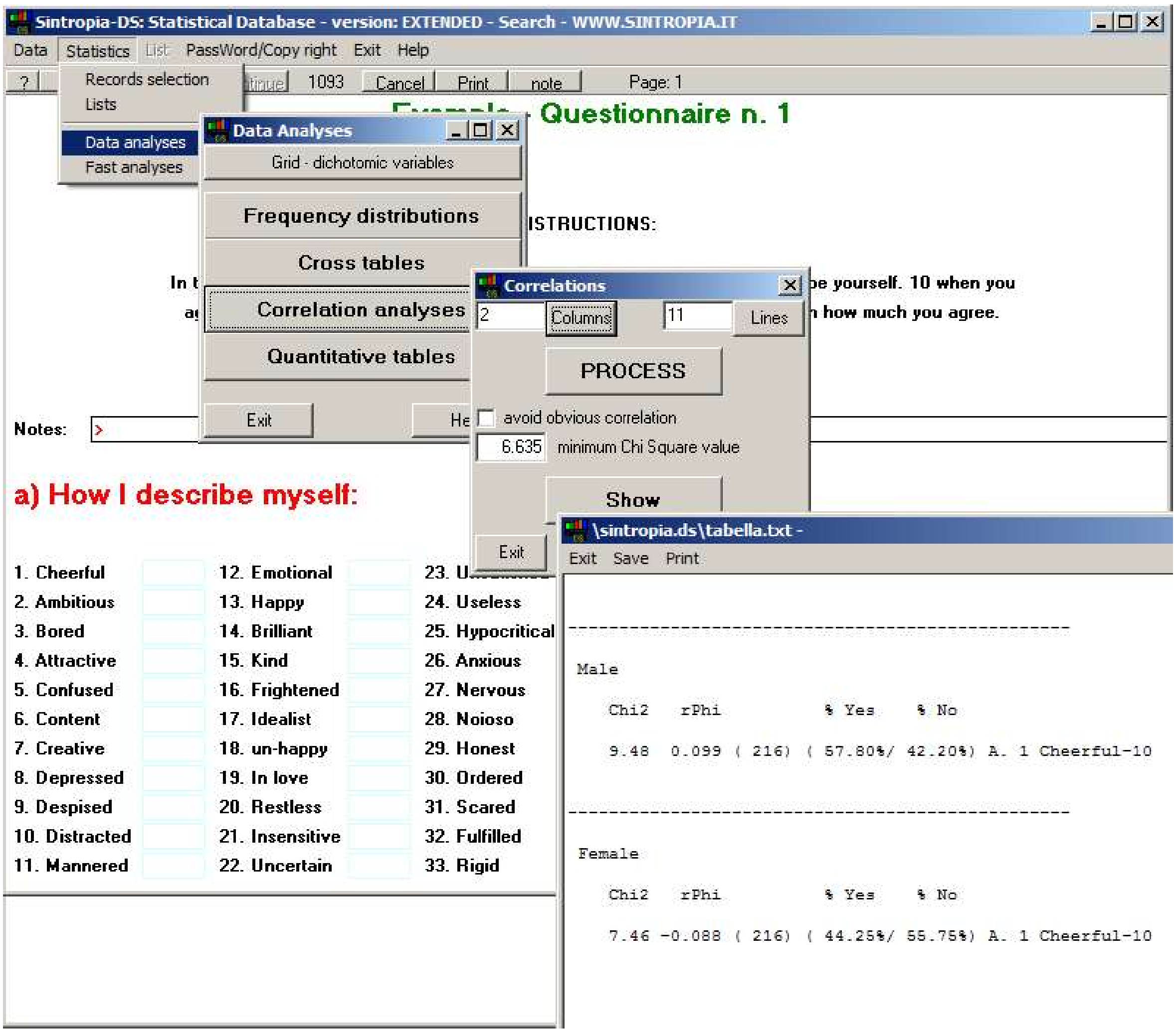


The first column of the table is relative to “Males” and the second column to “Females”. We see that the first line with 9 respondents is divided in 5 males and 4 females. Concomitances are detected when percentage values are different from the percentage value of the

Total column. For example, 3.9% males answered 5 to Cheerful and 7% female, against an expected value of 6.06%.

The problem with cross tables is that a concomitance might occur in only one cell, and we can handle up to 4,000 cross tables for each variable, with a total of 16milion possible tables. This is just impossible to read!!! Concomitance tables solve this problem.

For example, if we use the same lines and columns selection (11 lines of Cheerful" and Males and Females in the columns) we get:

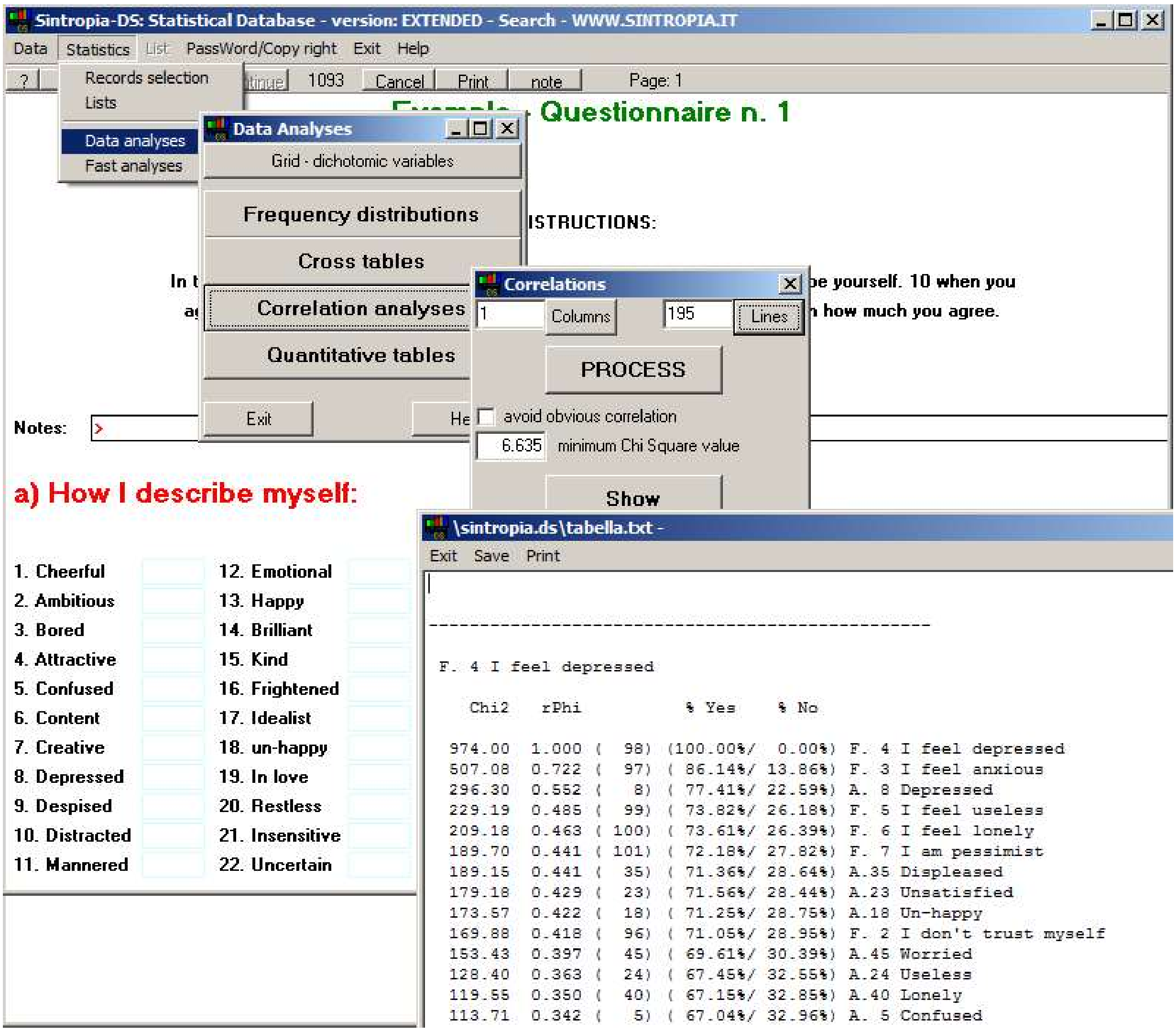


The only significant concomitance is observed with the value 10 57.8% males have answered 10 compared to 42.2% for females.

With a Chi Square value of 3.841 the risk of stating a concomitance which does not exist is 5%; with a

Chi Square value of 6.635 the risk is 1% and with a Chi Square value of 10.827 the risk is 1/1000. When the risk is 1% or lower the concomitance is usually considered to be statistically significant.

Correlation tables can summarize many tables in only one page. For example, choose as the only column the dichotomous variable “F.4 I feel depressed” and all the other 195 variables of the questionnaire (until Q.8) as lines, then press PROCESS and Show.



What you get is the list of what is concomitant with depressed. First, we find "*I feel anxious*", then "*I feel useless*", "*I feel lonely*", "*I am pessimist*", etc…

A more analytical description of this technique is available in the

2005 issue of the open access Syntropy Journal.[53]

- *Factor Analysis*

In the development of a scientific theory six criteria are fundamental:[54]

1) Simplicity: a theory should embody as few "entities" as possible (this criterion is known as "Ockham's Razor").
2) Few or preferably no adjustable parameters.

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[53] http://www.sintropia.it/journal/index.htm

[54] Hotson D.L. (2002), Dirac's Equation and the Sea of Negative Energy, Infinite Energy, 43: 2002.

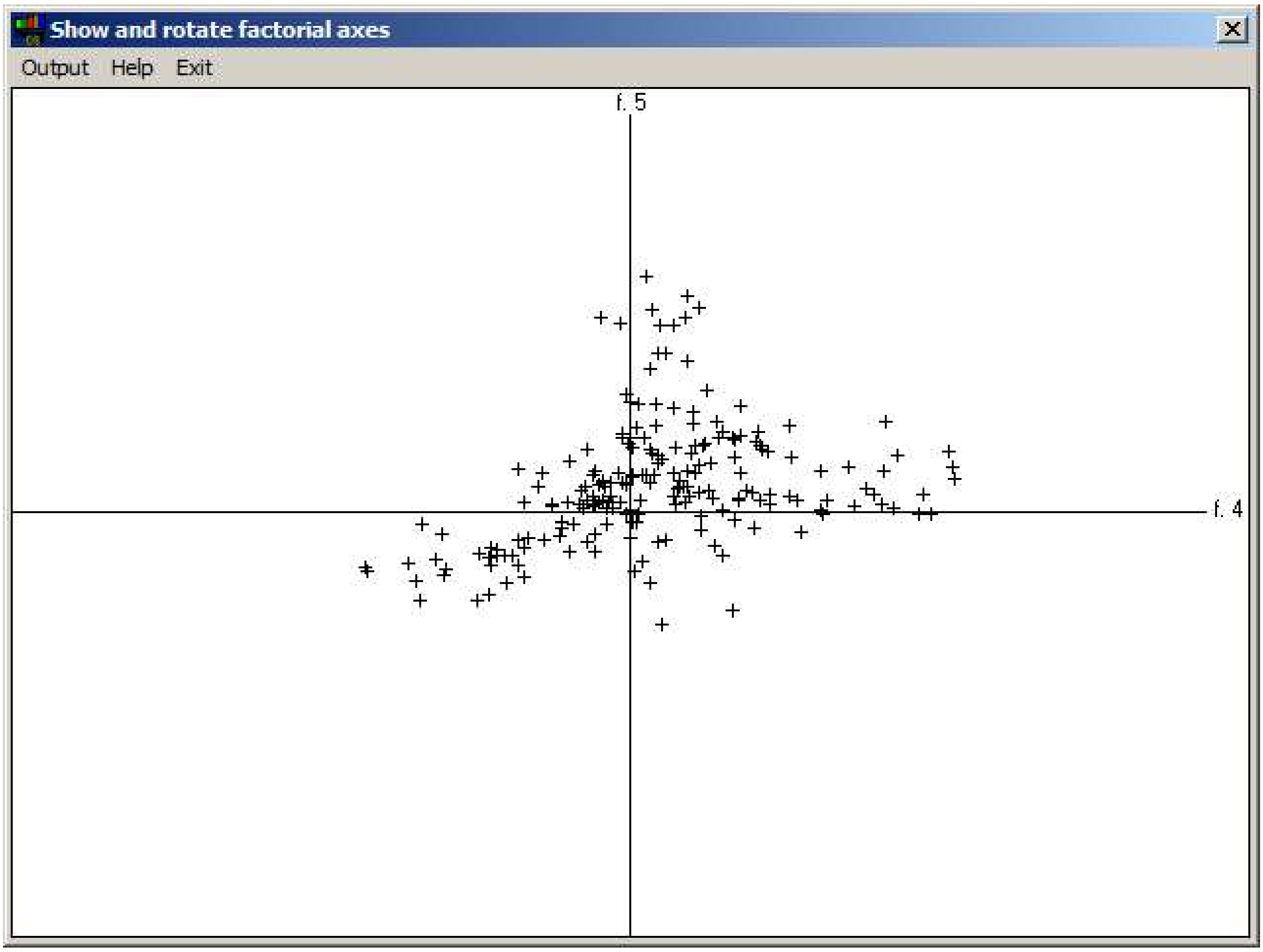
3) It should be mathematically consistent.
4) It should satisfy all the known data, including unexplained or anomalous data, or data dismissed as a "coincidence" according to previous theories.
5) It should obey causality: every effect should have a cause (forward or backward-in-time causality).
6) It should be falsifiable, making testable predictions.

The first criterion known as Ockham's Razor was stated by Guglielmo of Ockham (1295-1349) and affirms (in Latin) that "*Entia* *non sunt multiplicanda praeter necessitatem*": Elements are not multiplied if it is not necessary to do so. This criterion means that the trend of universal laws is that of economy and simplicity: the lowest possible number of entities are used. Science should therefore evolve from more complex models to simpler ones, and in any demonstration, it should always be necessary to use the lowest number of entities.

Ockham's criterion is because the universe always shows economy of means. For example, DNA, which is at the basis of life, and which is now considered the most complex entity, codes information using 4 elements, the 4 azotize bases. Complexity theory shows that 3 elements would not have been sufficient, whereas 5 would have been redundant; DNA could have used an unlimited number of elements, but only 4 were necessary and only 4 have been used. Similarly, to produce stable matter, only 3 particles were necessary: electrons, protons, and neutrons, and again only 3 particles are used. Information science shows that it is possible to generate any sort of complexity simply starting from two elements: yes/no, false/true, 0/1, +/-.

Factor analysis can reveal patterns and structures which can help in the formulation of theories.

It represents the original dichotomous variable in a multidimensional Cartesian space that has as many dimensions as there are factorial axes. The correlation between the dichotomous variables and the factorial axes are used as factorial coordinates. In this way, by intersecting any two factorial axes, it is possible to represent every variable on a plane, where space proximity of two variables should indicate correlation.



In the example relative to the dissatisfaction among teenagers, which is available with the Sintropia-DS software, the first factor shows together:

----- Factor: 1

–I feel anxious
–I feel depressed
–I feel useless
–I feel lonely

This factor suggests the strong correlation between depression, anxiety, loneliness and feeling of being useless.
Whereas the second factor shows together:

----- Factor: 2

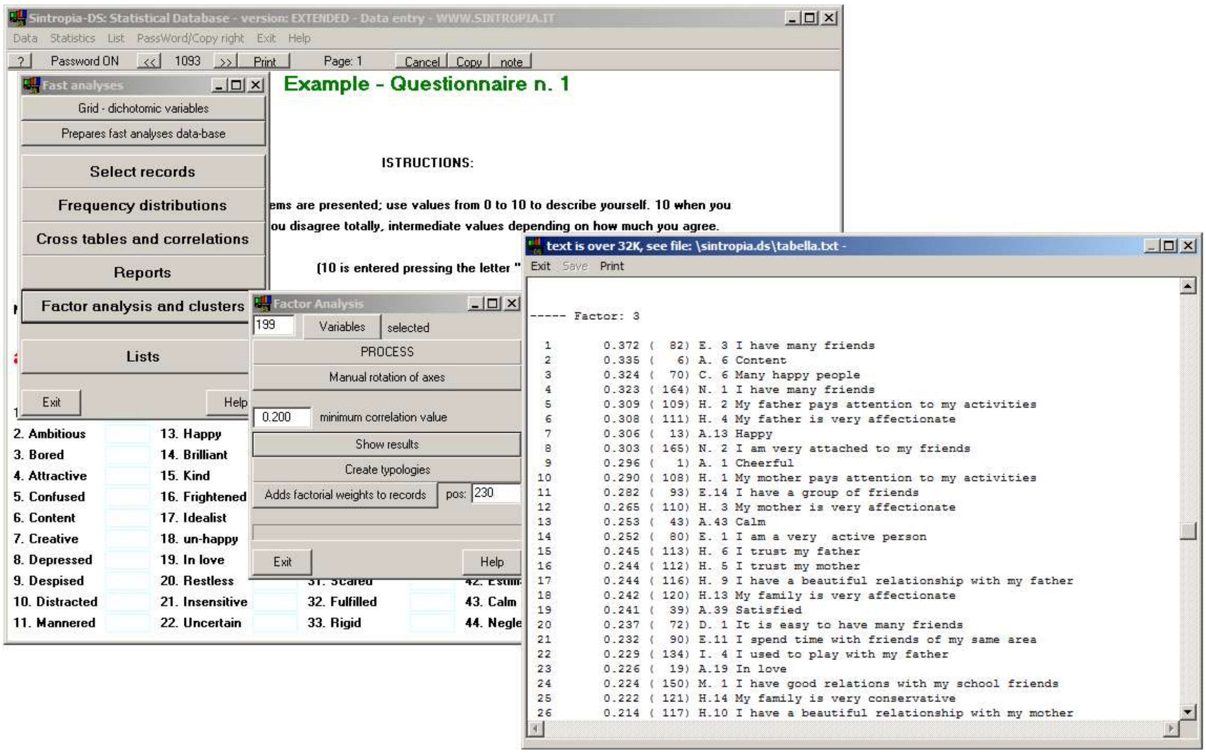
–I am motivated to study
–School is an important step for my future

- I like school subjects
- Relatives often come to see us at home
- I am well considered by the teachers
- We often visit our relatives
- I live in a rich family
- Ambitious

Which suggests the link between social class, family cohesion and school motivation.

To enter the factor section, choose the menu Statistics, then Fast analyses and Factor analysis and cluster.

In the following example we have just pressed the button Show results, which shows the results of the latest factor analysis.

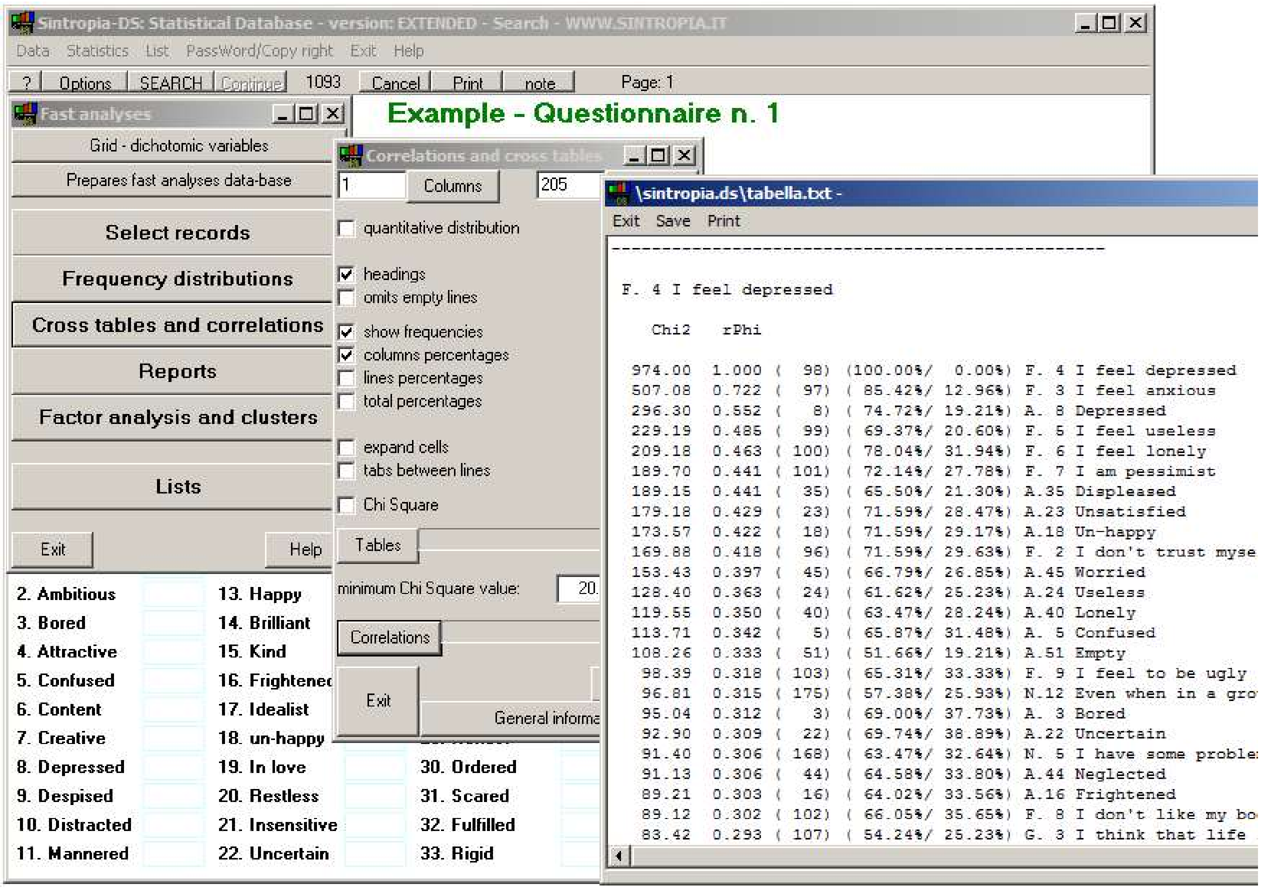


Sintropia-DS implements the factor analysis method described by Raymond B. Cattell in the book "*The Scientific Use of Factory Analysis in Behavioral and Life Sciences.*"[55]

[55] Cattell R.B. (1956), The scientific use of factor analysis, www.amazon.it/dp/1468422642

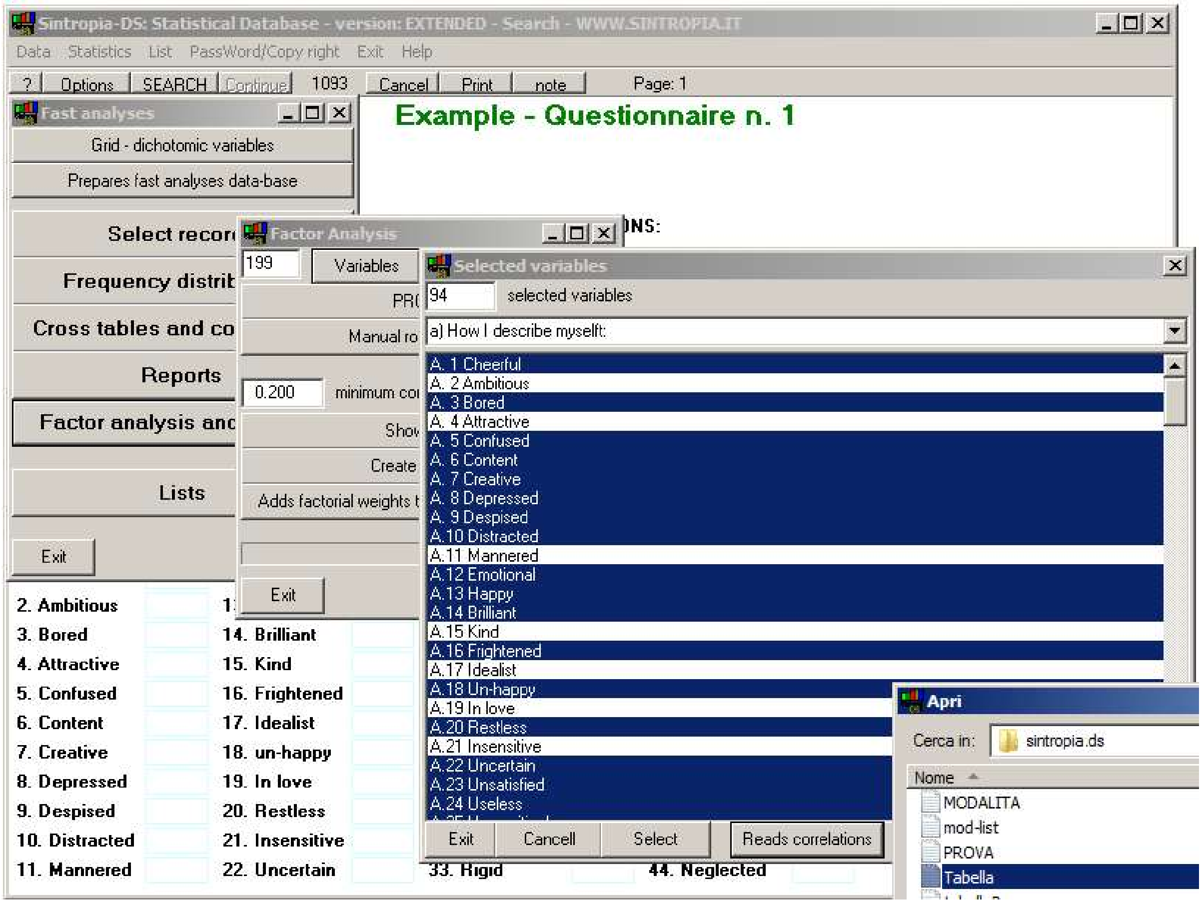
Let us try an example. The aim is to study depression.

We select the menu Statistics, then the option *Fast Analyses, Cross tables and correlations* and in the *Columns*, we select "*F.4 I feel depressed*" whereas in the Lines we select all the dichotomous variables. We also set the minimum Chi Square value to 50, then press *Correlations* and obtain the correlations that the variable Depressed has with the other variables of the questionnaire (with values starting from Chi Square 50).



We then go to Factor analysis (in the menu Statistics and the option Fast Analyses).

We chose the first button Variables and then we choose Read correlations. An Open File window will show, and we select the file Tabella.Txt (which has the list of the correlations that we have just seen) from the Sintropia.ds folder.

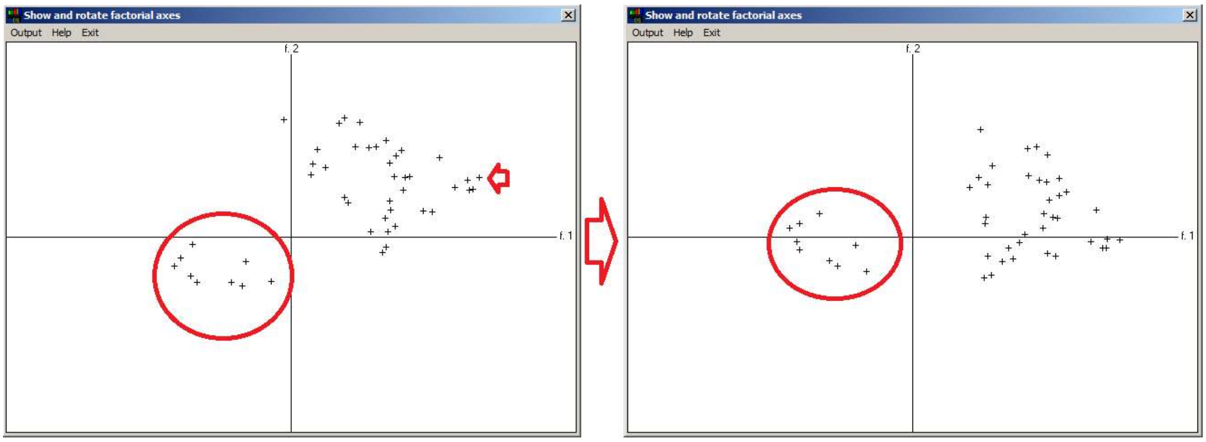


The program activates in this way only those dichotomous variables which have at least a 50 Chi Square correlation value with depression.

We exist the window “*Selected*

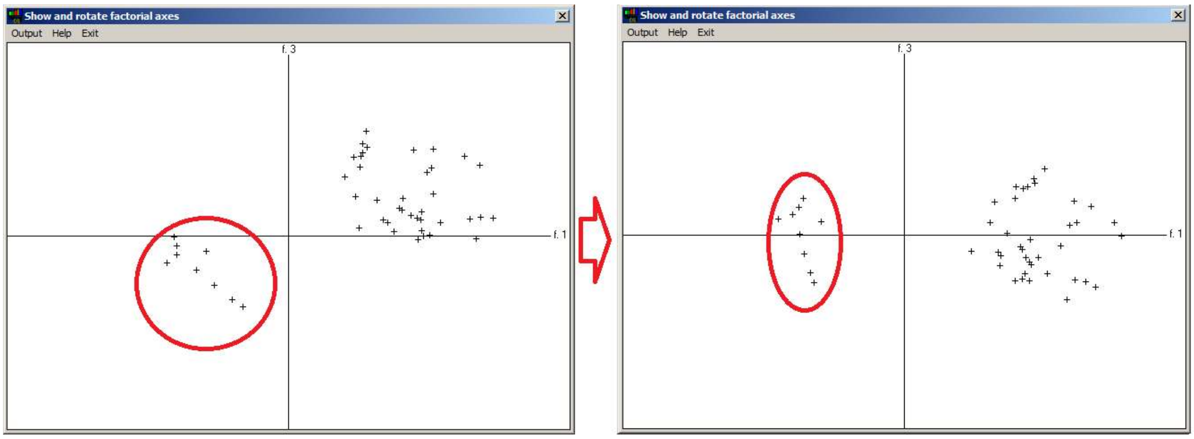
Variables" and press the button *PROCESS*, which we find in the Factor Analysis window. The program calculates the factor analysis axis, but before reading the results we need to rotate them. The reason is that factorial axes should coincide with factorial structures, otherwise variables which are not correlated may be interpreted as related. When factorial axes are rotated results become stable.

To rotate factor axes we press the button *Manual rotation of axes* and enter in the intersection of axis 1 and 2 (the following procedure is named MaxPlane).



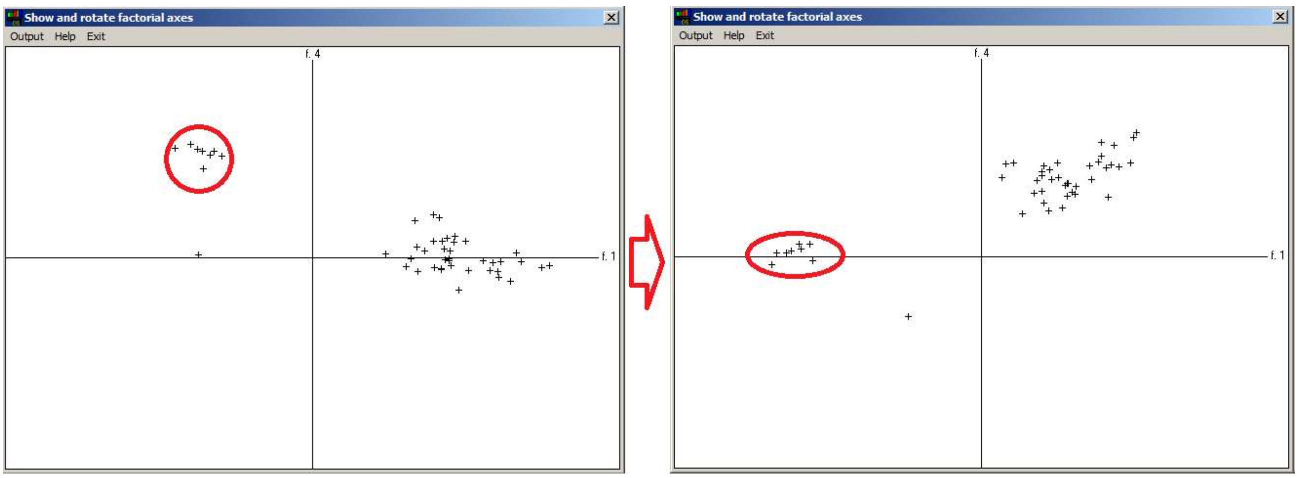
We see that the left structure is not on the f.1 axis. To rotate the plane and have this structure on the f.1 axis we select with the mouse the area indicated by the red arrow (on the positive quadrant). We get the new configuration on the right.

This procedure needs to be repeated for all the combinations of the factorial axes. To go to the next plane f.1, f.3. we click on the text f.2. We get the following representation.



We rotate the plane so that both structures tend to be on the axis.

We then proceed to f1, f.4. The following axis shows.



It is not convenient to rotate this plane, since moving the left structure on the axis will displace the right structure, which accounts for more variables. When we end rotating axis 1 with all the other axes, we start with axis 2, and so on. When we finish this process. we can read the results:

----- Factor: 1

```
1 0.774 F. 4 I feel depressed
 2 0.749 F. 3 I feel anxious
 3 0.683 A. 8 Depressed
 4 0.663 F. 5 I feel useless
 5 0.651 A.35 Displeased
 6 0.616 F. 7 I am pessimist
 7 0.612 A.18 Un-happy
 8 0.606 F. 6 I feel lonely
```

----- Factor: 2

```
1 0.471 I. 9 I was very lonely
2 0.448 F. 1 I am often avoided by people
3 0.390 N.12 Even when in a group I feel lonely
4 0.387 N.10 I am often refused by friends
5 0.333 F. 6 I feel lonely
6 0.306 A.44 Neglected
7 0.304 N.11 I am not spontaneous
```

The factor model used in Sintropia-DS (CFA – Common Factor Analysis) differs from the component model (PCA - Principal Component Analysis), which is normally found in statistical software. The PCA model uses all the variance of the variables in the factor representations, whereas the CFA model uses only what is common among the variables. In other words the PCA model assumes that the system is closed and we know all the variables, whereas the CFA model assumes that the system is open and we are dealing with only a limited number of variables. The PCA model works well when applied to mechanical systems (for example the study of the trajectories of planets), whereas it produces instable results when applied to life sciences. The CFA model, instead, produces robust results when applied to life sciences.

Raymond Cattell describes this

situation in the following way:

"Most researchers have long since come to recognize that what happens in most scientific fields is better represented by the factor model than the component model. Even in a large set of variables, we do not gather all the sources of influence that will account for the variance of every one of them. The analysis cannot be treated, as the component model seeks to do, as a complete, self-explaining system. Each variable is likely to be affected by some influences not covered by its companion variables in the matrix. … programmers include in software packages elements neat to the mathematicians and numerous users of factor analysis, who trust the

computer technicians, end with a crop of misleading results uncritically quoted in scientific journals … mathematical neatness, which can easily become pedantry ... A warning should be issued that researchers hand over to computer programs only when they clearly know what is in them. … We reject the component analysis approach as not having any necessary relation to the model of stable, identifiable, replicable influences of determiners across the natural world."

Unfortunately, the component model (PCA) is widely used in economics, finance, biology, psychology and sociology and the factor model is instead difficult to find in statistical software. Results have become misleading and of little or no scientific value.

- *Database structure options*

Not all the information can be used for statistical analyses. For example, names and addresses usually are not analyzed.

Commercial database	Statistical database
Name: ..(text)…… Address: ..(text)…… Town: ..(text)……	Name: ..(text)…… Address: ..(text)…… Town: *code of the official list of towns for cartographic representation of data*
Marital Status: ..(text)……	Marital status: 1. *un-married* 2. *married* 3. *separated* 4. *widow*
Instruction: ..(text)……	Instruction: 1. *Illiterate* 2. *Elementary diploma* 3. *High school diploma* 4. *University degree*

Translating labels into codes provides several advantages:

- *Dimensions*: while a number (from 0 to 255) requires one byte of memory, a text requires as many bytes as the characters which have been reserved, for example MARR (Married) requires 4 bytes.
- *Errors reduction*: the risk of committing errors is reduced, the program accepts only labels which are in the list, it is not possible to enter a different label or a code outside the range of codes present in the check list.

- *Fast and easy data-entry*: labels can be completed by the program, and one digit can be entered with the pressure of only one key. Searching becomes easy, thanks to the lists of labels which summarize the information which is present in the database.
- *Immediate data analyses*: when a group of records is selected, frequency distributions can be automatically produced on all coded fields. For example, if we select only the married population, with a university degree, we automatically see all the frequency distributions on all

the other fields.

- *Scientific research*: beside producing frequency distributions, statistical archives allow to study relations between variables using cross tables, correlations, and factor analyses. Opening the way to scientific data analyses.

Consequently, when choosing the items of a form, attention should be paid to how the information will be coded.

The structure of a Sintropia-DS database is like how the form has been written. If our form is:

Subject progressive no.:
Blood pressure before:
Was the drug received? Yes/No
Blood pressure after:

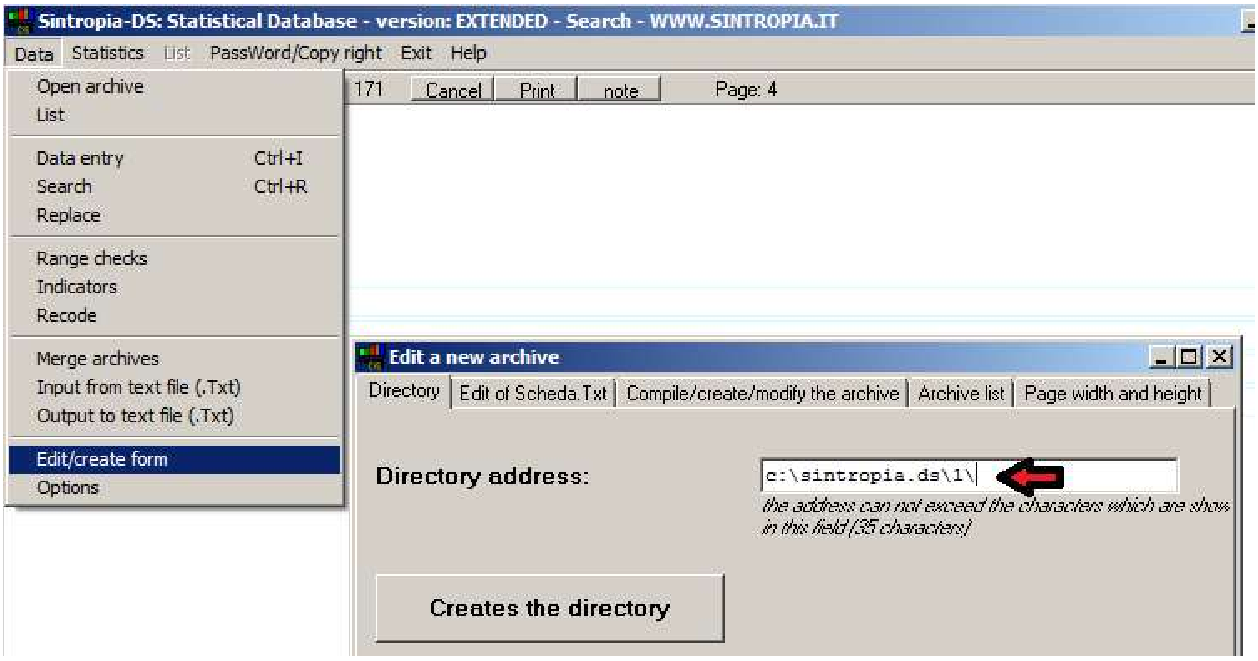
The structure of the Sintropia-DS database is the following:

**T*
Subject progressive no.:
**CQ X200*
**T*
Blood pressure before:
**CQ*
**T*
Was the drug received?
**CC*
Yes
No
**T*
Blood pressure after:
**CQ*

In the first line we enter a title, which reminds us of the project on which we were working on. *T is followed by a text, *C by a field. Fields can be of different types, such a quantitative field *CQ or list of modalities *CC.

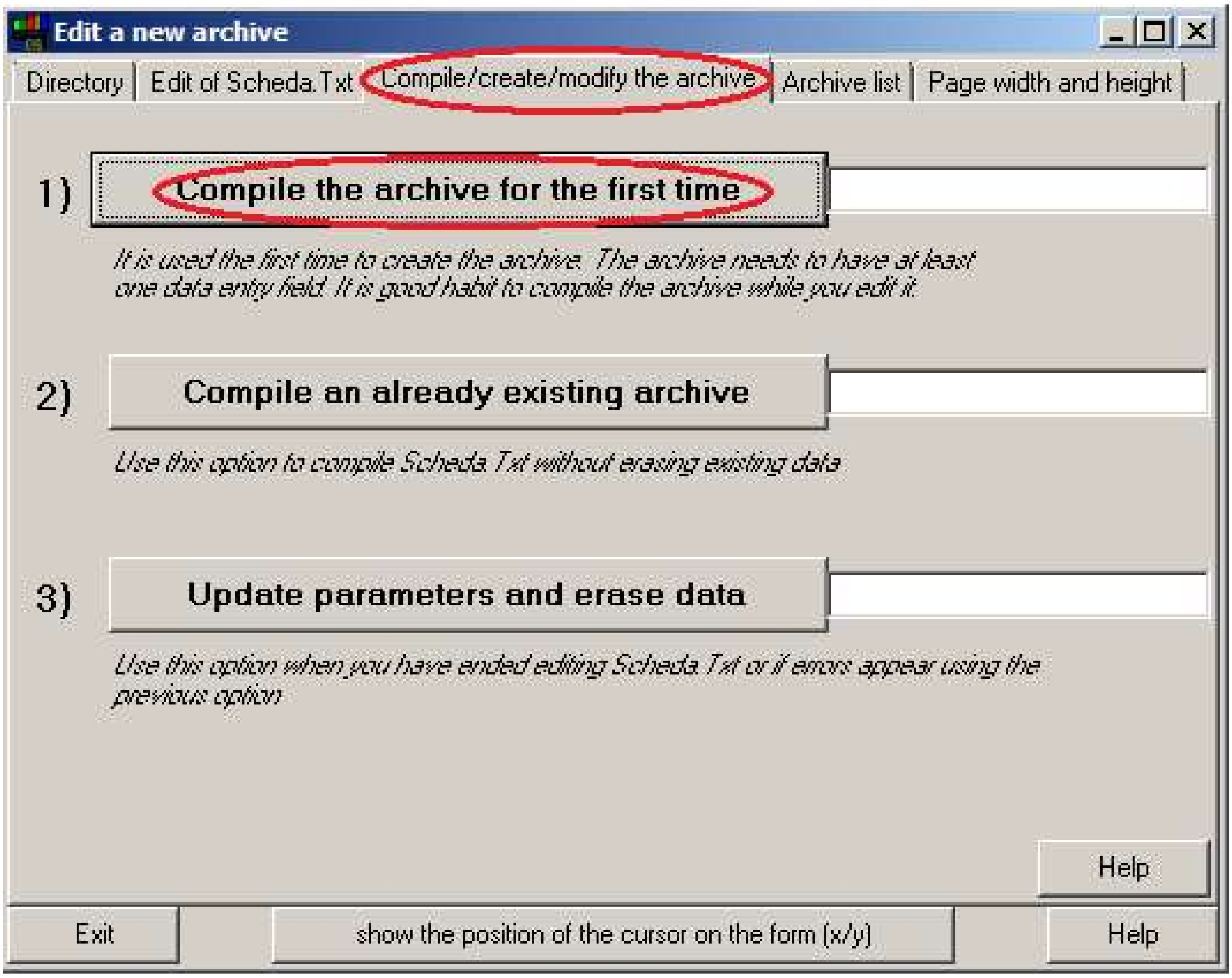
The structure of the database must be written using an ASCII editor, such as Windows' block notes, and saved with the name scheda.txt (the extension .txt is usually given automatically) in a folder dedicated to the database. For this example, we have created the folder "1" in sintropia.ds.

When we enter Sintropia.DS the last database we were working on is shown. Choose the menu "Data" and the option "Edit/create form" and enter the folder address (in this example "c:\sintropia.ds\1\") where file scheda.txt with the structure of the database was saved.

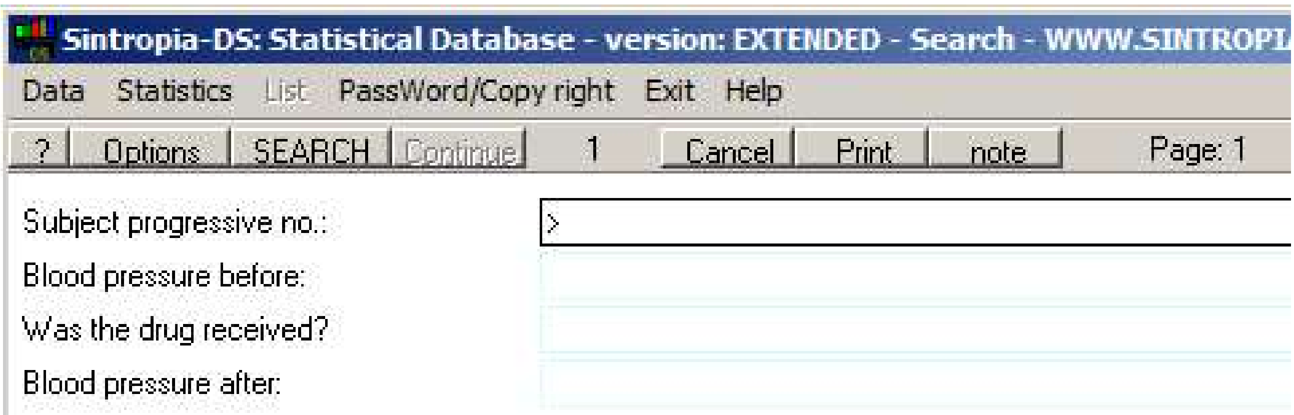


Choose compile/create/modify

archive and press "Compile the archive for the first time."



If no errors are encountered the database is ready for work:



To start entering data you need to select the data entry option (menu Data). Whenever you enter Sintropia-DS the program is in "Data Entry" mode, on the first empty form at the end of the archive.

When in Data Entry, just under the menu, a command line is shown:

- The first button "?" provides access to the help section.
- Between the first and the second button the status of the password is shown. Data entered will be saved or modified only when the password is ON. If the password is OFF, you have to exit the program and enter again with the correct password. When you first install the program, the password is "SINTROPIA" (written in capital letters). It is possible to change the password using the option "Password" of

the menu.

– The second button “<<” allows to go to the previous record. Records are numbered progressively from no. 1 onwards. The number attributed to records becomes a permanent number. Empty records cannot be saved.

– Between the second and the third button the progressive number of the record is shown. Clicking on this number opens a window which allows to choose a record number or go to the fist empty record at the end of the archive.

- The third button “>>” allows to go to the next form. Since Sintropia-DS does not allow to save empty records, if the record is empty and you are at the end of the database, it is impossible to move to the next record. Data is saved automatically when moving between records.
- The fourth button “Print” opens a window which allows to output data. When the need is to output only few fields of the record, it is necessary to edit an output form.
- After the fourth button the page number of the form is shown.

Records are organized in pages. It is possible to change page using Page Down and Page Up keys.

- The Cancel button opens the window “Cancel” which allows to: cancel the data of the field selected by the cursor, all the data of the record, all the fields selected in the window “Options”.
- The copy button allows to copy the content of another record. If the content of the selected record has been accidentally modified, it is possible to recover it choosing the option

"opening the present form."

- The last button "note" opens a note page which can be maximum 32k (32,000 characters). When a note is associated to the record the command bar shows in capital letters the text "NOTE".

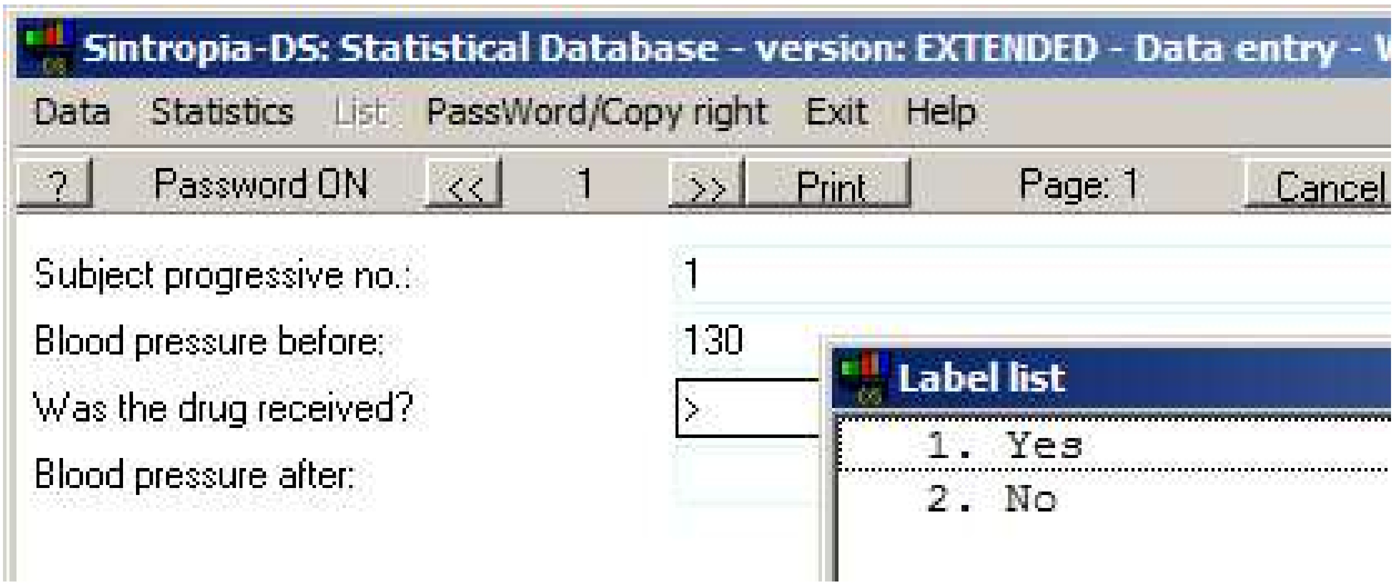
Active keys are:

- PgDn (Page Down) goes to next page.
- PgUp (Page Up) goes to the previous page.
- End goes to the end of the record.

– Home goes to the beginning of the record.
– Arrows keys go to the next or previous field.
– F1 << goes to previous record.
– F2 >> goes to next record.
– F8 cancel data in the selected field.
– F3 shows the list of labels associated to the selected field.
– F4 copies the content of the field.

Now, let us enter the data of the first record: subject n. 1, blood pressure before 130, was the drug received Yes, blood pressure after

We move the cursor to the first field and write “1” followed by the Enter key. The cursor automatically moves to the following field where we write 130, followed by the Enter key. In the third field we can write Yes (or just Y), or we can use the number 1, since Yes is the first modality in the list, or we can ask for the list pressing the key F3 and choose from the list:

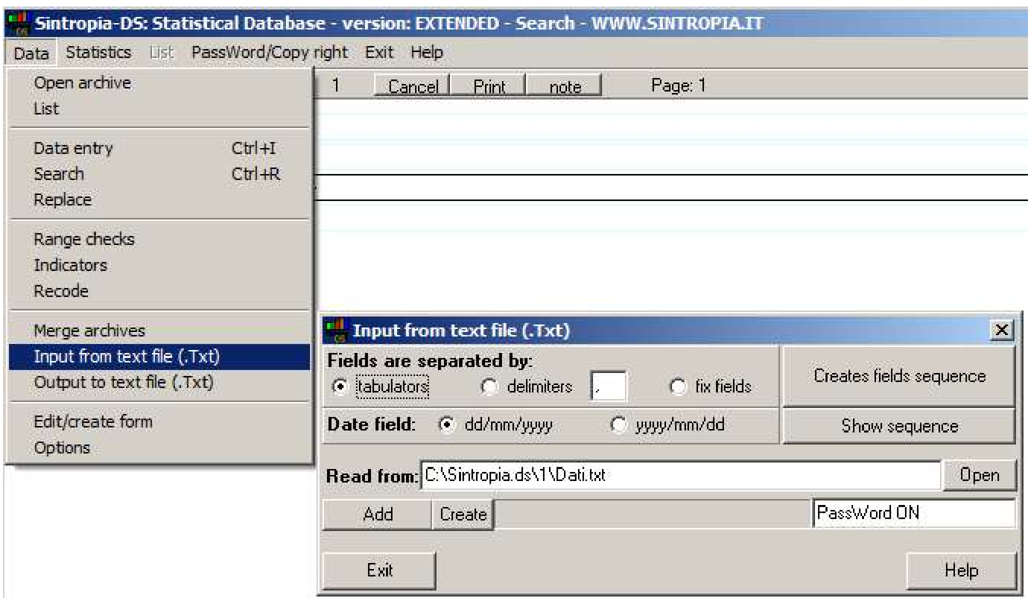


Once we have entered this information, we write 130 for blood pressure. We save and go to the next record by pressing the key “F2” or the button “>>”. When changing record, the data is automatically saved.

When data is available in Excel files, or in some other format, it is possible to import it in Sintropia-DS:

	A	B	C	D	E
1	1	130	Yes	120	
2	2	140	Yes	125	
3	3	135	No	130	
4	4	120	Yes	120	
5	5	125	No	120	
6	6	130	Yes	130	

We first need to save this data in a text format such as the .CSV format (comma separated values). We then choose the option "Input from text file" from the Data menu.



Create field sequence creates the sequence of the fields which need to be imported. This sequence can be edited using the option "Show sequence". The delimiter in CSV files is usually the semi-column ";". The "Open" button selects the file where data is saved. At this point we are ready to Create (Import) the file by pressing the button "Create". The file is read into the Sintropia-DS database. If there are problems a diagnostic page tells which problem was encountered, and in which line it was detected. Sintropia-DS can handle databases up to 500,000 records and 4,000 fields per record.

- *More detailed information about developing a Sintropia-DS form*

File Scheda.Txt contains:

- a first line, usually with the name of the project.
- text command lines, which start with *T and are followed by lines with the text which will be shown on the form (for example questions and instructions).
- field command lines, which start with *C and are followed by the

definition of the data in the field.

- page command lines, which start with *P and divide the form in pages.

A command line starts with the character *. Commands are written in capital letters. All what is written in small letters is omitted and considered as a note, except for the words: elvetico, courier, arial, modern, roman which define the font type. In a form it is possible to specify at the most 9 combinations of colors, fonts, and character dimensions. When this number of combinations is exceeded, information will be shown using the first combination of characters. If the color, justification, dimension are not specified, the program uses the definitions of the last field. When no indication is given the color black is used, text will start from the left of the form at pixel n. 5 and will be justified to the left. If you want to start the text at a different pixel position the character X is used, followed by the number of the horizontal pixel. Similarly the character Y is used, followed by the number of the vertical pixel (starting from the top). If character Y is followed by an equal sign (Y=) text will be written at the same vertical position used by the last definition.

Text (*T) command lines are followed by one or more lines of text which will be shown on the page. Commands in the text command line (*T) can be:

C Centered text
< Left justified text
> Right justified text
_ Underlined text (_)
I Italics
M Bold
S Normal text
G Big character
P Small character

N Black
R Red
B Blue
V Green

By default, fields start at X position 100 (100 pixel from the left). If you want to start the field at a different pixel position use character X followed by the number of the horizontal pixel, or character Y followed by the number of the vertical pixel (starting from the top). If character Y is followed by an equal sign (Y=), the field will be shown at the same vertical position used by the last definition. Letter Z followed by the horizontal position tells where the field will end; when not used the right margin of the form will be used. The following commands are also possible in the *C line: I Italics, M Bold, S Normal text, G Big character, P Small character, N Black, R Red, B Blue and V Green.

Field command characters *C are followed by lines that define the data type.

– *CA: Text (alphabetic field), followed by the number reserved for the text. For example *CA40 indicates a text line which can have at the most 40 character.

– *CC: Coded field. Coded fields are all those which use a list of labels. *CC is followed by the list of the labels. When a label list is present in more fields we can give it a number, for example *CC #1. When *CC #1 will be encountered again the program will use the label list found at the first occurrence of *CC #1. Labels cannot start with numbers, as numbers are always interpreted as codes. When a coded field command is followed by a number it tells how many fields to reserve for data-entry. For example, *CC3 tells to reserve 3 fields for data-entry. If the number of fields is followed by a comma and a number, it tells to divide the fields in more lines. For example, *CC21,3 will reserve 7 lines with 3 fields each, totaling 21 fields.

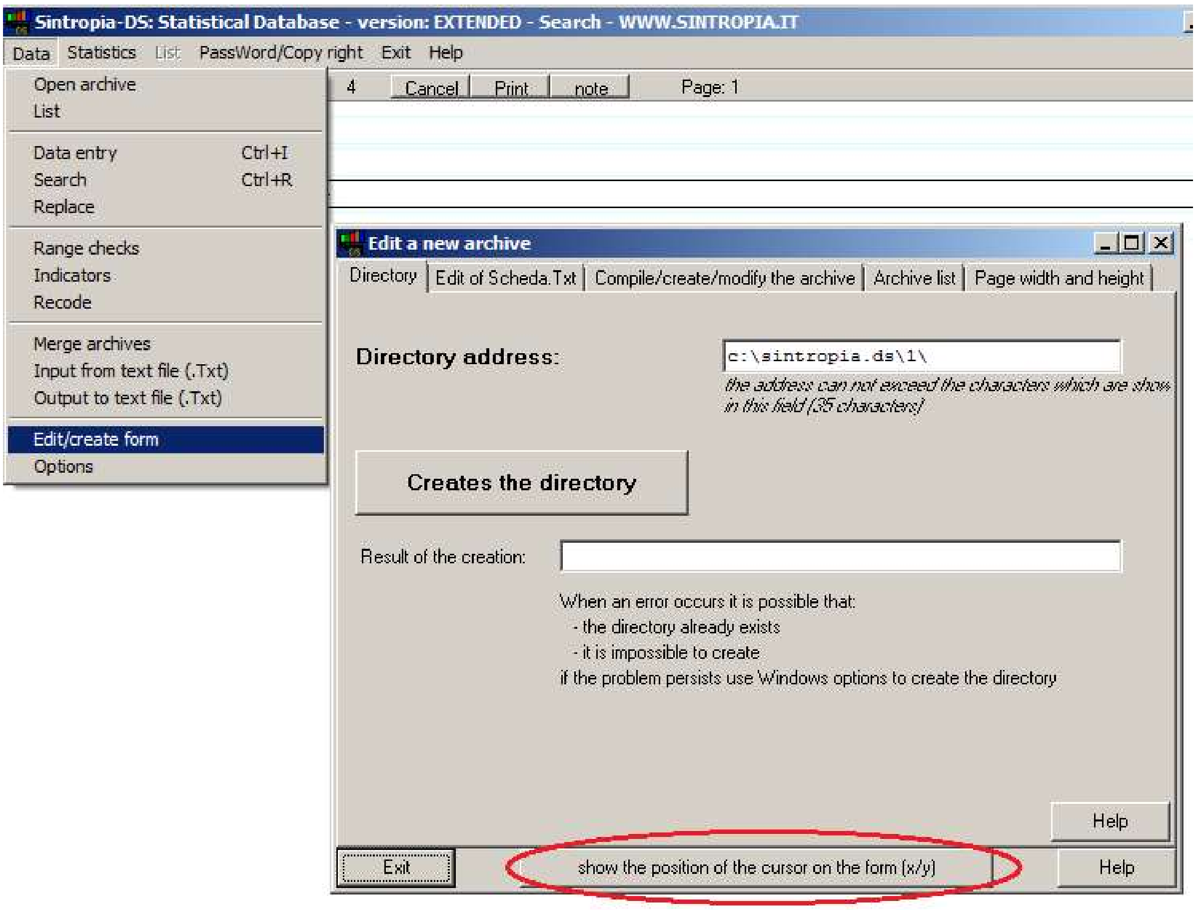
– *CQ Quantitative field from -32,000 to +32,000
– *CL Long quantitative field from -999,999,999 to +999,999,999
– *CT Territorial field (uses official census lists of towns)

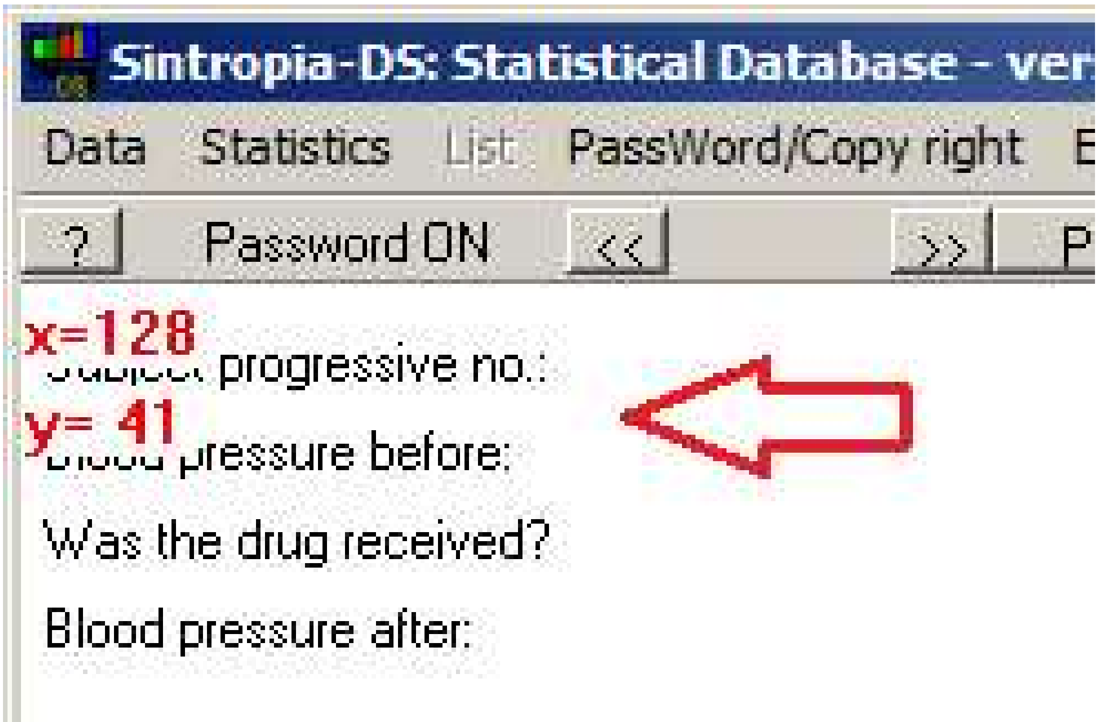
– *CO Time field
– *CD Date field
– *CP Percentage field

*P (Page) command line is used to change page.

When editing a Sintropia-DS for the first-time strings might be overwritten by data entry field. This problem is solved entering the X position from which the data entry field starts.

To find positions, use the button “show the position of the cursor on the form (x/y)” (in Edit/create form). You will enter a special mode which allows to know the x/y positions of the point you are selecting with the mouse.





The X value can be added in the *C command line. For example, *CX128 tells to start the field at the X pixel position 128. To come out from this special mode you just select the Data entry option or any other option.

It is possible to add an image or a logo to the form. Save it in the file “logo.bmp”, in the same folder of the database. The image will be shown on each page of the form starting from the left-upper angle. If you want to move the logo on the form, move the logo on the .bmp file down or right the number of pixels you want it to be moved.

When compiling the scheda.txt file, diagnostics will tell if errors have been encountered.

Diagnostic is of the type:

11, field type not defined *C
12, List after a pointer to a list (#)
-> very good

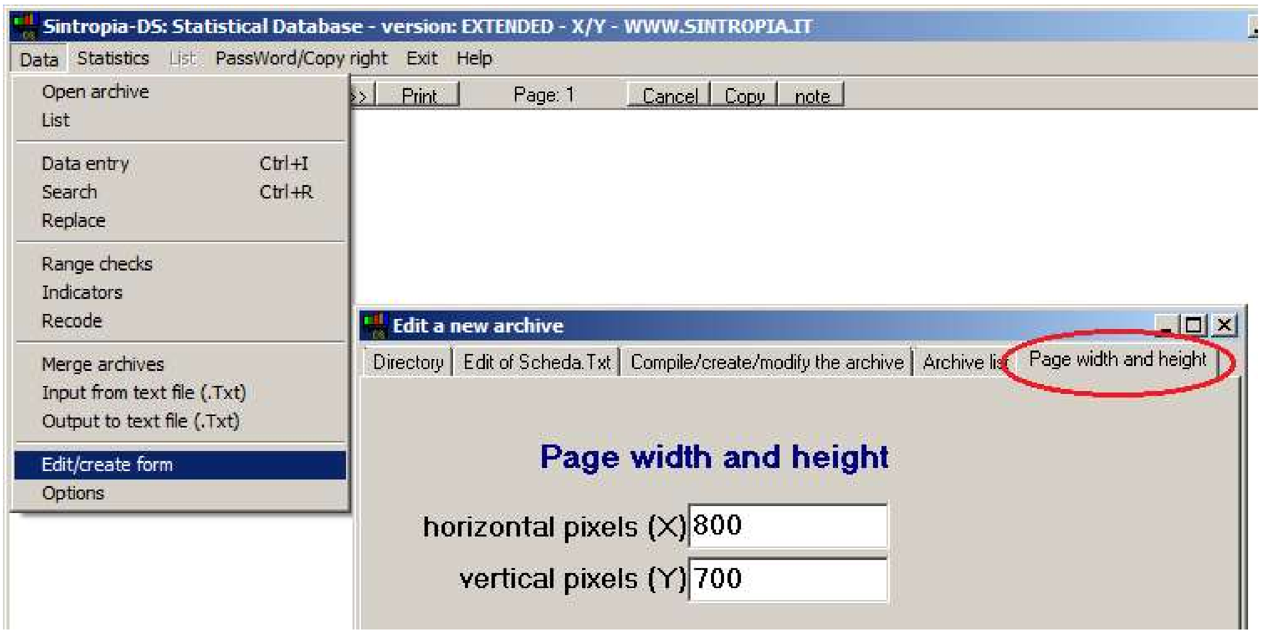
13, List after a pointer to a list (#) -> good

14, List after a pointer to a list (#) -> fair

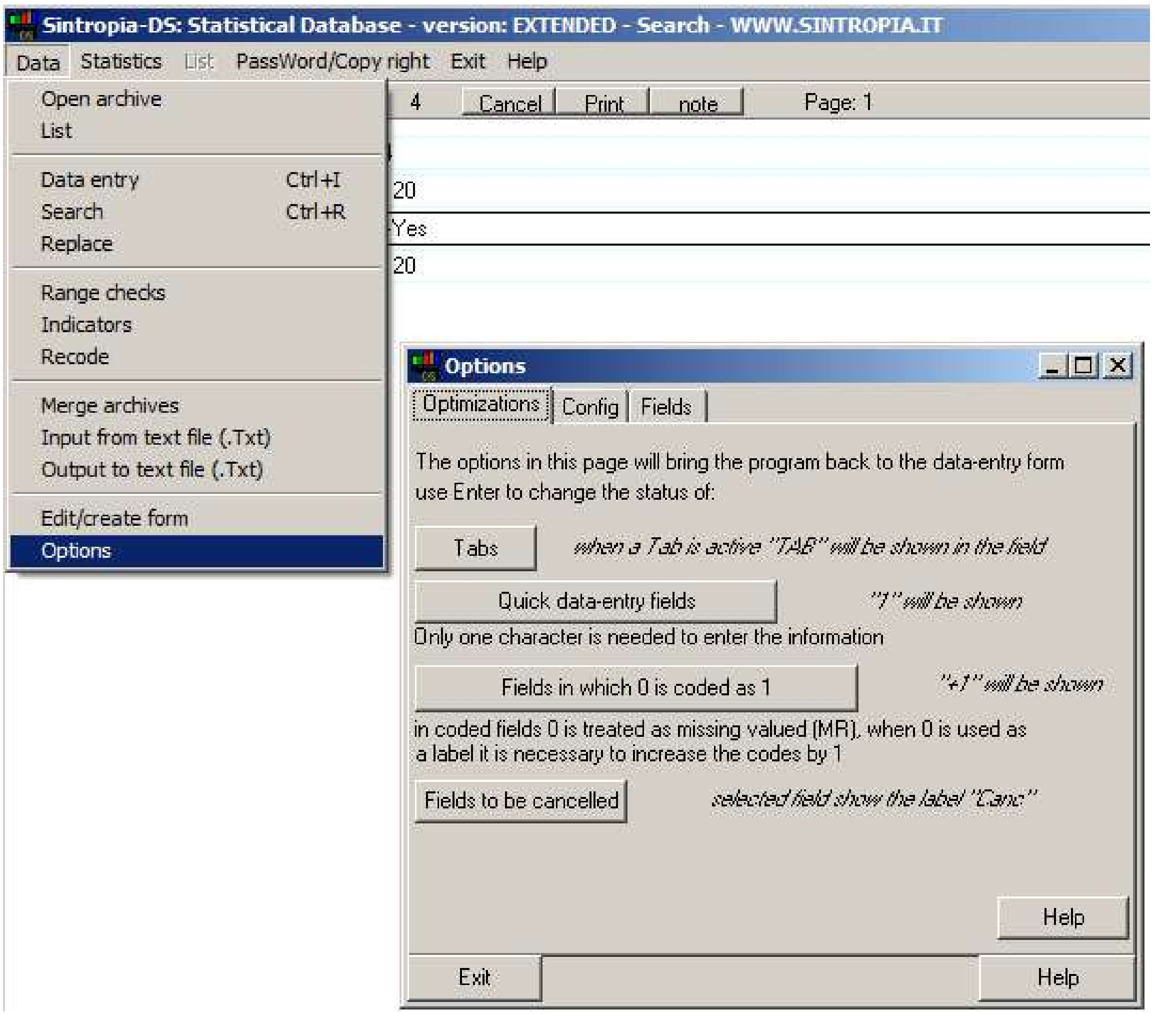
15, List after a pointer to a list (#) -> bad

The number at the beginning corresponds to the line in the Scheda.txt file which originated the error. The program shows the text which has produced the error. You go back to scheda.txt correct the error (in this example change *C in *CC) and compile again. When no diagnostic messages appear, the form is ready for data-entry.

It is possible to define the dimensions of the window by using the Page width and height options in the Edit/create form window.



When the editing is over it might be useful to optimize some data-entry functions, choosing “Options” at the end of the menu “Data”.



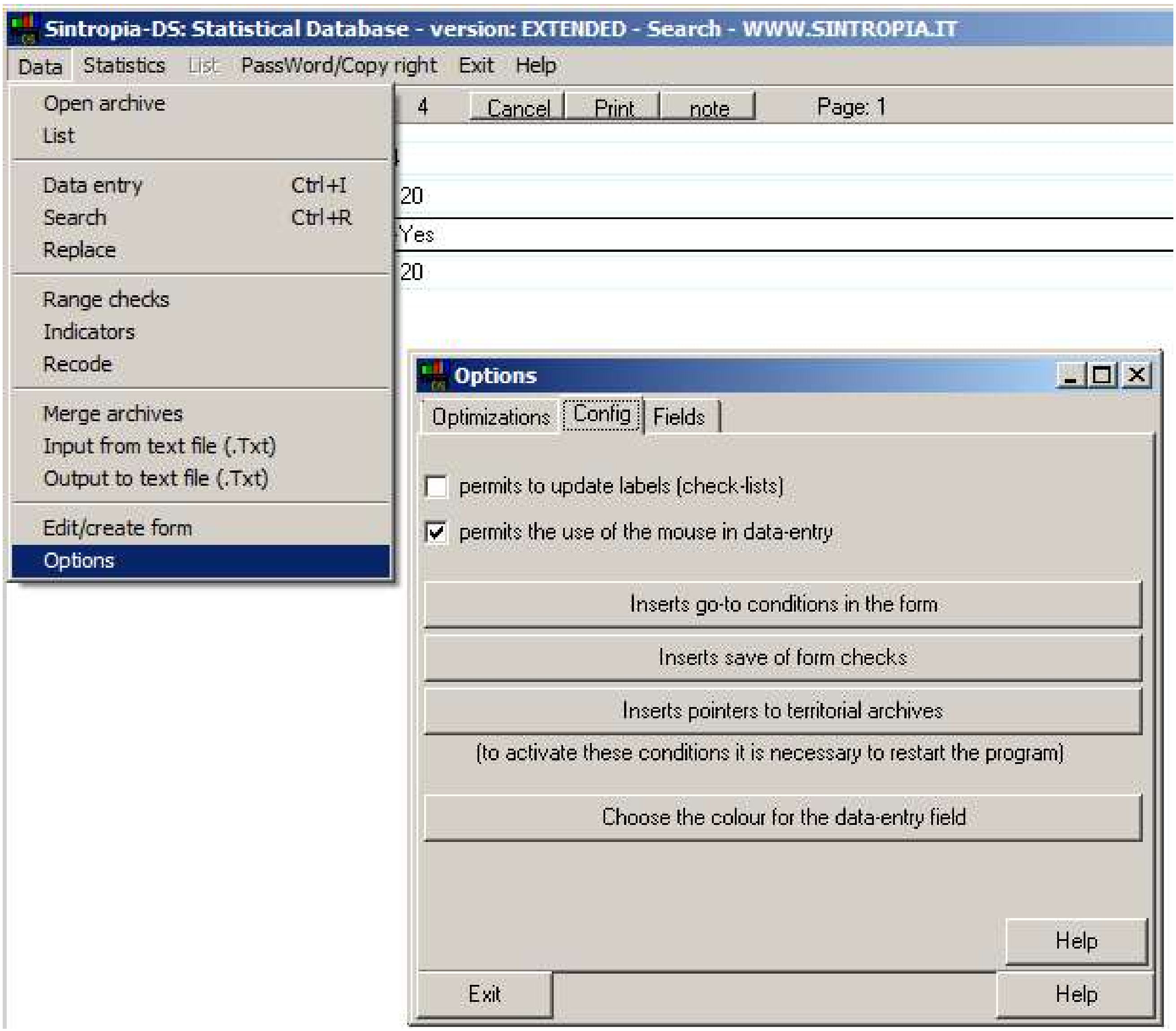
Options are:

- Tabs which allow, during data-entry, to jump quickly to the next group of items just pressing the Tab keyboard key.
- Quick data-entry fields allow to

enter labels and values by only pressing one key "0" to "9" for codes "0" to "9" and "a" to "z" for codes from 10 to 35.

– Since 0 is treated as the missing answer, when questionnaires use scores from 0 to 10 it needs to be treated as a data. This is done automatically, increasing the code value by one (and consequently all the other codes).

It is also possible to enter conditions, such as go to, etc.:



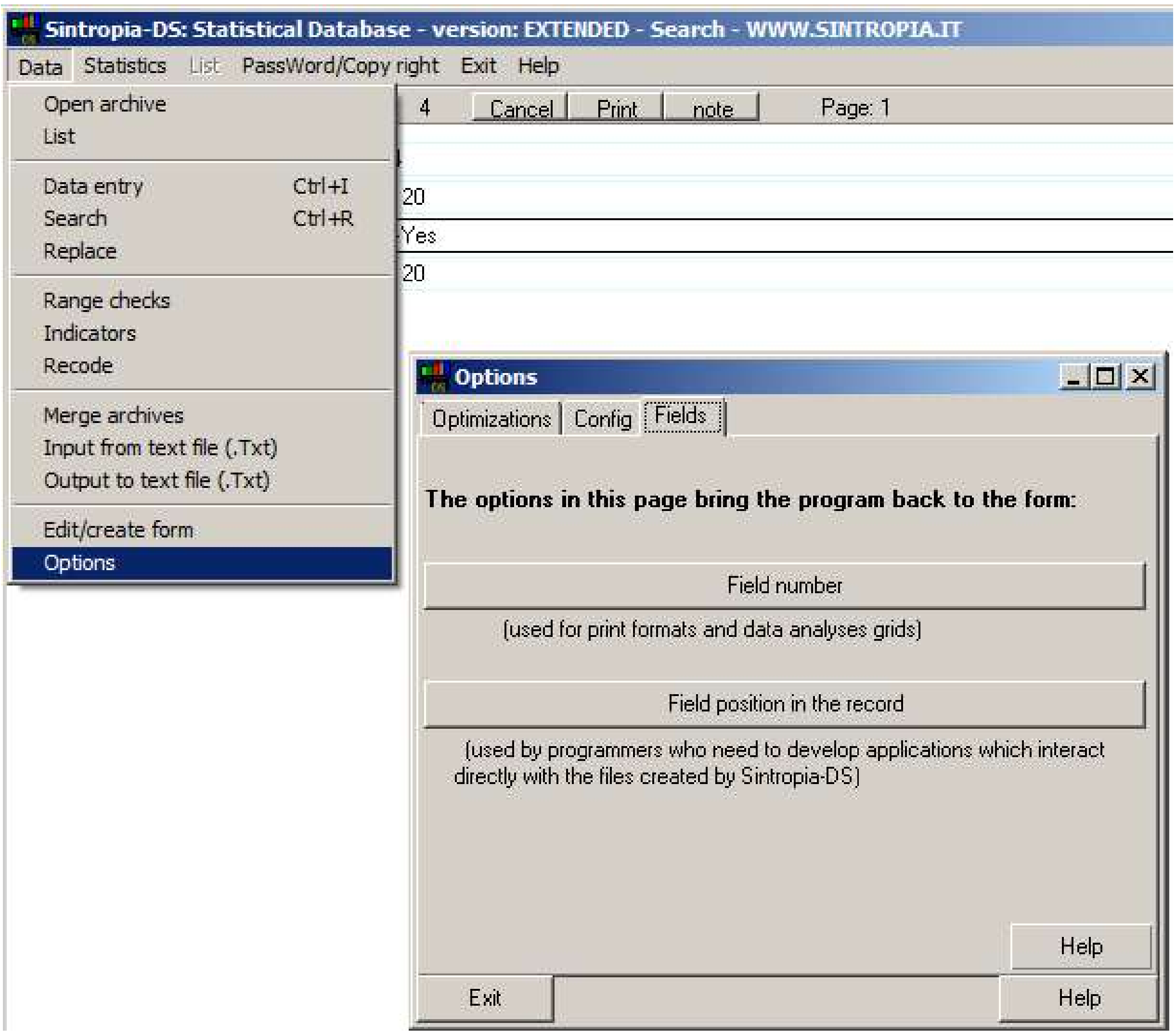
– GO-TO CONDITIONS. Depending on the information which has been entered, it might be convenient to jump automatically to a different section of the form. For example: 5=3,7>30 tells that when the field 5 has a value between 3 and 7 then jump to field 30. It is possible to enter more conditions, following the requirement that one line is one go-to condition. For example: 5=3,7>30; 5=8,8>35. If field 5 has a value between 3 and 6 then go-to field 30. If field 5 is equal to 8 then go-to field 35. If the jump is relative to information present in a different field, then the syntax is the following: 7=5=3,7>30 When on field 7 if field 5 has a value between 3 and 7 then jump to field 30.

– SAVE OF FORM CHECKS. It is possible to perform checks before saving information. For example: 1,Operator . If no information is present in one or more of the listed fields the program will show a window informing that data is missing and asking what to do before saving.
– COLOR. It is possible to highlight the data-entry fields using a special color.
– UPDATE LABELS. When a new label is entered the program shows the list of known labels and asks if the new label has to

be added to the list. This function allows to create lists while data is entered and is often used on items which were difficult to code. When data entry is done using more than one computer, this option can create problems; it is therefore possible to disable it from the option window.

– MOUSE. When data-entry has been optimized, it can be convenient to disable the use of the mouse, to avoid accidental jumps from one field to the other.

Field numbers are used to set several options of the program, such as go-to options and save of form checks.



– FIELD NUMBER. When choosing this option the program goes back to the Data Entry option, showing for each field the corresponding field number.

– FIELD POSITION IN THE RECORD. It is used by programmers who need to develop applications which interact directly with Sintropia-DS files. Data is stored in two different files. The alphabetical file alf-sch.dat and the numeric file num-sch.dat. When the position option is chosen the program goes back to the Data Entry option and shows, for each field, the position.

– To know the length of each record use the option “List” of the menu “Data”.