

# **The Manufacturing of Facts**

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## **1. Introduction**

My little talk is about facts, facts, as we know these from science and technology in our everyday life. Our scientific understanding is based on tough facts. All the exact theories in natural sciences are founded on experimental data. Of course, we ourselves do not know these facts neither their reliability, but we know that there are some experts for every scientific specialization who know all about these things. And as our modern world view is mainly based on science, it is also based on the scientific facts. Theories may be incorrect or false, but facts remain facts.

## **2. What are Facts?**

The term „Fact“ comes from Latin „facere“, what means nothing else than „do“. Consequently, „factum“ in Latin means the result of an action, something which is done by man. This is something surprising for us: The facts, which we are realizing as the highest form of proofed knowledge, are manmade things! The scientists claim that scientific facts are things with a large stability and constancy, independent from the wishes and prejudices of the individual scientist - and it turns out, that the facts are manufactured by the scientists themselves!

Of course I know that scientific facts are something completely different! They are the result of accurate observations and repeatedly carried out experiments. There are a lot of research principles, which will rule out any subjective element of the obtained scientific knowledge.

In this sense, a scientific fact is statement about empirical data and their interconnection.

I will present to you two scientific facts, one recent and one from the 18. Century:

*Metals are the compound of a dull metal-lime and the bright phlogiston, the fire-substance.*

*If the metal burns, the phlogiston escapes from the metal in the form of a flame.*

*Water is boiling at 100 degrees Celsius (273.15 K) under the pressure of one atmosphere.*

Indeed, everybody knows now that the phlogiston theory is wrong, that metals are pure elements and the metal oxides are compounds of the metal and oxygen. Thus, the above stated „fact“ consists in reality of a true observation (the burning of the bright metals and the formation of lime-like reaction products) and a „false“ theory (phlogiston) classifying and interpreting the observations. An observation without any interpretation is useless for us.

Therefore, the above statement should be replaced by conditional sentence:*If the phlogiston theory is correct, then the phlogiston escapes from the burning metal and a lime remains.*

Now this is a true if-statement but its fact-like character has vanished into thin air!

But what is the matter with the statement about the boiling point of water? First of all, one should ask, what we mean by „water“ and by „boiling“? „Boiling“ means that in the bulk of the heated water occur small bubbles of water steam, which then are increasing and rising to the water surface, and „water“ means chemically pure water (distilled water). But every chemist knows, that, even under the normal pressure of one atmosphere, pure water in very clean vessels do not boil at 100 degrees Celsius! One had to increase the temperature to 103 or 105 or more degrees to induce the boiling process. But after that, the boiling begins explosion-like

(the so called boiling delay effect). The reason is, that the creation of a bubble needs some energy (surface energy), which must be supplied by the system itself. Therefore, if the water is dirty, if it contains dust particles or little porous stones, the real boiling point will be closer to 100 degrees - but is this still pure water? On the one hand, in the water must be enough particles with a big surface area to induce the boiling at 100 degrees at the interface solid/liquid, but on the other hand, the structure of water must not be modified even at this interface!

It turns out that, characterizing the whole situation, also the fact-like statement about the boiling point becomes a if-statement: *If the water contains enough immersed solid particles and if these particles do not affect the structure and properties of the water (with exclusion of the boiling delay effect, of course), then the water under normal pressure is boiling at 100 degrees.*

So, even the simple and seeming clear fact of the boiling point bases on a risky interpretation and the term „boiling point“ itself appears to be a fuzzy linguistic variable! And the difference of the two statements, the one about the phlogiston and the other about the boiling point, vanishes to be of fundamental character.

### **3. Mechanisms of Perception and the Evolution of Categories**

Simplistically speaking, one can say that our perception works through the forming of conscious and preconscious concepts. That means that the human perception is a multiple cascade of signal processing mechanisms aiming on the reduction of complexity. This begins with the optical signal processing in the retina of the eye leading to an increase of contrasty, and is

continued by several unconscious pattern recognition processes, which, by the way, also create new pattern (a common example are the constellations at the night sky). This is followed by the conscious abstraction processes, by the forming of concepts, of concepts derived from concepts and so on. All these processes work through abstraction: all irrelevant data will be removed and only a few essential data and pattern will be left. This conception forming process is a very powerful instrument, but every advantage has its own disadvantages.

The crucial disadvantage here is: How the retina in our eyes, how our brain knows, which of the received data are essential and which are inessential? Clearly, this is a question of valuation, i.e. of interpretation according to a system of values. Therefore, even our perception bases on several „theories“, which were formed during the biological evolution of living beings, and, after that, during the cultural evolution of men. But the validity of these theories is only proofed by the actual needs in the struggle of survival. In a new context, in another situation, a former „true“ theory can become „false“.

In this sense, each (scientific) concept is, despite of its seeming constancy, a intersection of a stream of unordered data with an interpretation system. They form a dynamic system, because each new received data demands an new act of interpretation and categorization. One of the most important achievements of this dynamic system is the maintenance of relatively stable concepts in a continuous changing environment. In the language of mathematics we would say that a concept is a stable state of the dynamic system. But behind the quiet surface of the concepts is a very lively dynamic.

If the environment changes slowly in one direction, then the dynamic system of interpretation can maintain the stability of a certain concept only by a slow changes in the meaning of the concept. This slow drift of the concept meanings is a well known fact in linguistics. But from the theory of dynamical systems we know, that during the drift of one control parameter a

stable state of the system can become unstable. This point is called a bifurcation: usually at this point appear one or two new stable states with qualitatively new properties. Accordingly, the concept loses its stability and one or two new concepts appear instead. At this point the system is very sensitive to small disturbances from the environment.

So, at this bifurcation point in the evolution of our concepts our understanding reaches a qualitatively new level. But the price is high: Due to the high sensitivity in this point, formerly small and inessential errors in our perceptions and concepts can amplify to essential faults. Generally speaking, at the bifurcation point the distinction of inessential and essential data becomes senseless. But even this distinction is the basis of all abstraction processes.