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## EDITORIAL

### Science, pseudoscience, evidence-based practice and post truth



### Ciencia, pseudociencia, práctica basada en la evidencia y posverdad

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We live a time when it is easier to question the value of statins to fight cholesterol or the efficacy of vaccination and replace these treatments with homeopathic substances that lack any demonstrated therapeutic effect, promoting *BILIEF* to the category of *PSEUDO-SCIENCE*, than rely on evidence-based facts supported by the *SCIENTIFIC METHOD*. These are challenging times for clinicians and we need to be aware of the “siren songs”, question easy *TRUTH* even when it looks *EVIDENT* and the recent so-called *POST TRUTH* where beliefs seem to be stronger than *FACTS*, and find the path for safe *EVIDENCE-BASED PRACTICE*. This brief paragraph contains several terms and constructs that we often use, hear or read but the definitions of which require more careful reflection, the goal of this editorial.

Paradoxically these are both great and hard times for science. On the one hand, we are witnessing the highest research activity we have ever known in optometry and vision science and in every discipline in general. Unfortunately, this is also proving a perfect culture medium for clinical practice that is far from being supported by good research. Such practice has always existed, yet it has been presumed that increased research activity would either provide proof for it or abolish it completely. Instead, in some cases, neither of these two options takes place and this practice has found an ecosystem in which to thrive and is even covered with a veneer of credibility by being published here and there.

We should not confuse “evident” thoughts with facts supported by “evidence”. Evident is sometimes used

synonymously for “obvious”, *something that can be seen*. However, a better definition would be that the word “evident” refers to something “clearly understood”. However, personal thoughts can be evident simply because they make sense according to some biased facts or because they coincide with general beliefs. Evidence, however, is defined as “the available body of facts or information indicating whether a belief or proposition is true or valid”. Therefore, we should not confuse beliefs with evidence and should always seek confirmatory observations (facts), properly collected and analysed. Ultimately, evidence can confirm our beliefs but not the reverse.

The prominent role of facts mentioned above takes us to another relevant concept – “post truth”. The term is increasingly present in the media and in 2016 was declared the word of the year by the Oxford Dictionary.<sup>1</sup> It is an adjective used to describe “circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion and personal beliefs” or according to the Cambridge Dictionary “a situation in which people are more likely to accept an argument based on their emotions and beliefs, rather than one based on facts”. Interestingly, by the end of this year – 2017 – its translation to Spanish “posverdad” will be indexed in the Official Dictionary of the Language by the Royal Academy of Language (Real Academia de la Lengua). In some way, defining “truth” itself will help us understand the concept of post-truth. “Truth”, a noun, is defined as *the quality of being true*, while “true” is an adjective that means “in accordance with fact or reality”. Another definition is “being accurate or exact”. Both definitions are very important from the scientific point of view as they imply that before we attribute this quality to something

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we need to ensure that is accurate and factual, therefore it must be *verifiable* using the appropriate methods. From the philosophical perspective and according to the Neo-classical Correspondence Theory *a belief is true if there exists an appropriate entity – a fact – to which it corresponds* as described in the Stanford Encyclopaedia.<sup>2</sup>

Altogether, these definitions tell us that truth should not be based on personal beliefs, but should be confirmed with facts. However, in the scientific field, facts are not easily accepted without question and multiple verifications. One way to achieve such confirmation is through the Scientific Method “*consisting in systematic observation, measurement, and experiment, and formulation, testing and modification of hypotheses*”. When the scientific method goes beyond observation and is complemented with accurate measurements, preferably with something other than our eyes, indissociably linked to previous “*experiences*” of our brain, it allows us to make judgements. In fact, as the astrophysicist Neil deGrasse Tyson writes in his recent book, such experience “*is more often than not a satchel or preconceived ideas, post-conceived notions, and outright bias*”.<sup>3</sup>

The abovementioned confusion between beliefs and facts leads us to another concept highlighted in this editorial, *pseudoscience*. To better understand the full concept of “*pseudoscience*”, instead of making a direct semantic interpretation as “*false science*”, it is a good idea to first define science itself. Science is the “*understanding of the mechanisms that govern our world, from the fundamental laws of the universe to the biological processes of the simplest living organisms to the complexity of the human body*”. Science is ultimately a way (maybe the best way) to acquire knowledge. It may be the best way because it does not work with pre-conceived beliefs seeking confirmation. Instead, science works with hypotheses to explain facts and the more hypotheses science rejects, the closer the scientist gets to a scientific explanation. Another important consequence deriving from the above is that we should not confuse “*causality*” with “*casualty*”. An association between two parameters does not necessarily mean that one is the cause of the other. We should first consider the possibility of a casual combination and make any effort to reject such relationship with other potential bias and exclude any other justification for our findings before we accept the explanation and attribute the causality of a given event. Only when we have no additional justification for the findings should we accept the causal relationship.

There are, however, many other sources of knowledge including traditional beliefs and expert opinion that we should not ignore. This is where we should reintroduce the definition of pseudoscience according to the Oxford Dictionary as “*a collection of beliefs or practices mistakenly regarded as being based on scientific method*”.<sup>2</sup> Therefore, pseudoscience arises when those sources of knowledge assume the role of science itself. The reader might find it helpful to recognise pseudoscience by some of its characteristics according to some authors: *used to be contradictory, makes exaggerated or unprovable claims, relies on confirmation bias rather than rigorous attempts at refutation, lack of openness to evaluation by other experts, and*

*absence of systematic practices when developing theories*. Social media and means of dissemination of all kinds including blogs, forums, discussion groups etc. also provide fuel for these approaches to gain exaggerated attention, promoting such forms of knowledge to the rank of science and furthering the emergence of pseudoscience.

These considerations lead me to conclusions that might be relevant for everyone who is involved in research, clinical practice or both. *First*, not all the treatment approaches we follow today are based on scientific principles. In fact, there are several examples of treatments that have proved to be beneficial but whose scientific bases are not yet fully understood. *Second*, even when we have no science-based approach to fully understand their mode of action, we might feel compelled to use them not because obscure interests motivate us, but because we have been able to confirm their results in successive systematic observations in well-designed, research experiments that are not biased by our beliefs or preconceptions. *Third*, the requirement of evidence-based practice should make us seek robust proof of systematic behaviours. This is generally provided by clinical trials that minimise the risk of bias by picking statistically significant sample sizes, using control groups, randomising the treatment and control subjects and whenever possible, eliminating the potential placebo effect by masking subjects and/or investigators. *Fourth*, we should use the most objective and repeatable measurement methods we can in order to minimise the impact of our beliefs and observation bias on the final outcome that we are testing. *Fifth*, we should never accept as truth, science-based or evidence-based practice that which in fact might be personal opinions, isolated case reports, non-systematic case series, or severely biased “*scientific*” reports. Ultimately this does not mean that those forms of knowledge are not relevant to the advancement of clinical practice and science itself, but they should not be overvalued or taken as givens without any further questioning and validation by testing (back to *Third*).

As health care professionals, we should be ready to accept that our beliefs are not more important than facts. Moreover, the wider our experience, the more powerful our beliefs might be. And whether we are more clinically oriented or research oriented, we need to bear in mind that science makes no effort to confirm beliefs or hypothesis. Instead, it attempts to reject any potential explanation until there is one that cannot be rejected and therefore might be linked to the observation we have made. This must confirm the power of science in serving clinical practice.

## References

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