When Occam's Razor Cuts Too Deep

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Abstract

Occam's razor is frequently considered to be a cornerstone of the scientific method. Indeed, it was and remains a valuable tool for scientific and philosophical inquiry. However, we provided an overview of some historical instances in which it led science away from a reasonable and sound heuristic approach. Some words of caution are necessary to clarify how, contrary to common belief, a too strict adherence to such a principle did not guarantee scientific rigor but, rather, obstructed further progress.

1. Introduction

'Occam's razor' (or 'Ockham's razor') is a principle also known as the *'law of parsimony'* according to which *"pluralities [entities] should not be posited [multiplied] without necessity"* (*"pluralitas non est ponenda sine necessitate").* It was articulated by the English Franciscan friar William of Ockham (1287–1347), an academic philosopher and theologian.[1] Occam was concerned with the ontological parsimony in metaphysical inquiries but his principle is nowadays frequently applied in formulating modern scientific theoretical frameworks.

It is a heuristic strategy that looks after the most parsimonious ontology requiring the smallest number of pluralities and entities whilst maintaining sufficient explanatory power to account for all the known facts. It states that when confronted with two or more competing theories that are supposed to explain the phenomena, one should favor the simplest approach. Equivalently, it states that the simplest solution to a problem should be considered the most likely one. Occam's razor cuts out all the seemingly unnecessary assumptions, postulates, ad hoc hypotheses, and, eventually, empirically untestable statements that are considered to be redundant or unnecessary to explain what we observe. If different hypotheses make the same predictions or describe the same reality and facts, one should take that which is endowed with the fewest assumptions. Isaac Newton stated the rule as follows: *"We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances*" (Newton, 1729). In brief: Simpler theories and conjectures should be favored over more complicated ones.

This is reasonable, in some contexts, to some extent, and in particular conditions.

The problem, however, is that what should be considered 'simple', 'parsimonious', or 'unnecessary' can be a matter of subjective preference. We are going to argue that, as a matter of fact, the history of science has shown that deeper truths frequently are less parsimonious and much more complex than what we would like them to be, and that an intellectual, philosophical rigor assumes. It turned out to be a principle of methodological minimalism that has sometimes been misinterpreted and twisted into a modern form of philosophical minimalism, which cuts off not only unnecessary ontological categories but also everything that does not fit into the currently accepted paradigm.

Moreover, one should always keep in mind that the principle of simplicity is only one possible criterion of the adequacy of reasoning based on abductive inference[2], also called 'inference to the best explanation' (for a classic review, see (Lipton, 2004)). Even what must be considered the 'best' explanation, and to what extent we should rely on which specific inferential modality, remains a matter

[1] For historical correctness, we should point out that a similar criterium was enunciated long before Occam. For example, already Aristotle framed it by saying, *"…the demonstration which proceeds from fewer premises is superior to any other…"* (Aristotle, 1996).

[2] Other criteria are falsifiability, consistency, conservativeness, explanatory power, etc.

of debate. A theory that meets one criterion might not meet the requirements of another, and what we believe to be a ‘good’ conclusion might be colored by metaphysical background assumptions.

Here, we will first evaluate the strengths and weaknesses of Occam’s razor. Despite recognition that it remains an indicator of good scientific practice, we must, at least, be aware of its potential drawbacks and the several historic cases in which, contrary to common belief, it did not perform as expected.

A special focus is dedicated to evolutionary biology and theoretical physics. While, in evolutionary biology, though there is no reason to doubt the neo-Darwinian paradigm based on processes of natural selection and random mutations, the findings of the last two or three decades have shown that a too strict application of principles of parsimony has led to a much too simplistic understanding of biological processes, whose complexities are still far beyond our understanding. Then, we address the question of whether the extraordinary multiplication of (more or less complicated) theories that emerged in theoretical physics in the last decades is due to a lack of procedural parsimony.

A discussion will follow, making some conclusive remarks.

2. Pros and Cons of Occam’s Razor

The Copernican revolution, which switched our worldview from a geocentric model to a heliocentric one, did not come about because the natural philosophers had any proof that the Earth orbits the Sun. The final proof that the heliocentric system accurately represents reality came about three centuries later (due to the observation, at the beginning of the 19th century, of the stellar parallax). Nevertheless, people began to accept Copernicus' suggestion because it is the simplest model that does not lead to 'pluralities' and 'multiplication of entities'. By contrast, the original geocentric model of Ptolemy, which insisted on maintaining the Earth as the central body and had each planet moving around an epicycle’s center and which travels around a larger circle (the deferent), had to be extended to a much more complicated system resorting to a plethora of other circles. Contrary to common belief, this approach could, nevertheless, trace, with a high degree of precision, all the orbital paths on the celestial sphere of all the known planets without having to posit the Sun at the center of the universe. One needs only to add a sufficient number of epicycles, one on top of the other, each with an appropriate size and moving with the right angular velocity. Then, one can approximate whatever kind of path for objects moving on the celestial sphere.[3] Thus, for the theory to work in accordance with the observations, one had to multiply by a considerable number of ‘entities’.

But the principle of ontological parsimony prevailed: Though at the time it was not entirely clear whether the heliocentric model was the true representation of the Solar System, it made much more sense to adopt this model because it was much simpler and it 'saved appearances' with only one circle (or ellipse): the planet's orbit around the Sun. This was, and remains, the most paradigmatic and successful example of the application of Occam's razor, favoring a conjecture over the other that was still in need of final proof.

However, a frequently overlooked aspect is that, historically, this was not the only reason — and probably not even the main reason — why people opted for the heliocentric model. Heliocentrism was not just a different interpretation of reality. Especially with the advent and application of Newton's theory of universal gravitation, the mathematization of the heliocentric model gave it enormous predictive power. By strictly mathematical proof, Newton could explain where Kepler's famous three laws of orbital motion come from. They arise as a natural consequence of the gravitational interaction between a massive central body (the Sun) and another, smaller one (the Earth). Moreover, gravity in a heliocentric system tells us when we must expect the next passage of a comet once we have measured its orbital parameters. Another example showing the superiority of heliocentrism was the application of Newton's law of gravity to the observed anomaly of the motion of the planet Uranus, which allowed, in 1846, the French astronomer and mathematician Urbain Le Verrier to predict the existence of another planet, Neptune, simply by making a calculation with pencil and paper, without even looking through a telescope. The existence of Neptune was confirmed shortly after by the observations based on Le Verrier's calculations. Such simplicity *and* predicting power of the theory of gravitation in the frame of the heliocentric system was something that adherents to the Ptolemaic geocentric model could only

[3] This is not surprising. It is mathematically equivalent to the weighted sum of harmonic oscillators — that is, to a Fourier series — and that can approximate whatever square-integrable function.

dream of. The epicycle theory could still correctly describe the observed astronomical motion of all the celestial bodies but it did not predict or explain so much.[4] This latter aspect made heliocentrism the much more appealing option, with its simplicity being a bonus.

This does not mean that principles of parsimony did not inspire the scientists of the time; rather, the historical efficacy of Occam's razor has been overemphasized. In fact, one could find opposite historical examples in which the razor was transformed into a chainsaw that cut too deep, causing an ontological reduction that went too far and led in the wrong direction or stopped some aspects of science from progressing.

Ironically, long before Occam, Ptolemy himself stated that *"we consider it a good principle to explain the phenomena by the simplest hypothesis possible"* (Franklin, 2001). Considering the Sun to be the central celestial body was an unnecessary hypothesis and was, therefore, denied for another 14 centuries. This anecdote alone makes it clear that what is considered 'simpler' or 'unnecessary' depends on what we know and, especially, on what we do not know, and is often colored by a subjective personal opinion.

Let us list more modern cases that exemplify the limits of Occam’s razor.

It was thought for a long time that atoms do not exist because they were considered a superfluous metaphysical assumption. Most notably, E. Mach contended that speculating about arbitrary unobservable entities is a metaphysical standpoint to accurately avoid. The atomistic hypothesis clashed with his general idea that facts must be reproduced *“so that each can be reached and mentally pictured with the least intellectual effort"* (Mach, 1919, p.421). Einstein considered this an example of a positivistic view that showed how *“philosophical prejudices hinder a correct interpretation of facts even by scientists with bold thinking and subtle intuition“* (Brush, 1968). At the time, neither could imagine how this ideal of a scientific descriptive economy would later have to deal with Nature’s immense multiplication of entities, in terms of not only atoms but also electrons, nuclei, quarks, and a plethora of short-lived elementary particles.

For years, Max Planck refrained from taking seriously his own idea about the discreteness of the energy quanta (which led to the inception of quantum theory) because he considered it a weird and unnecessary assumption that should be regarded only as a provisional working hypothesis (an assumption that the great Ludwig Boltzmann did not dare to embrace) and that he characterized as a “desperate act” to avoid the, until then, ineliminable ‘ultraviolet catastrophe’ (Tipler & Llewellyn, 2003).

The contingent character of what is considered to be a ‘good explanation’ is evidenced also by the quantized aspect of light. Before the quantum revolution, it was considered an established fact that light is a wave, as it always behaves like a wave in every experiment involving interference phenomena. The good old ‘duck test’[5], which is (more or less implicitly) assumed in abductive reasoning, forced us to the conclusion that there is no need to believe otherwise. But Nature gave us a nice lesson on how tremendously subtle it can be and, once quantum physics became an established science, we had to update our knowledge and conceptions of the world, also accepting the corpuscular aspect of light, notoriously embodied by the photon.

If you did not know anything about quantum physics and relativity, these would appear to be superfluous and much too complicated theories, and Occam's razor would opt for classical physics as the preferred theory. In fact, classical physics once seemed able to describe the entire universe by positing only particles and the classical laws of mechanics and electromagnetism. Nowadays, we know that the theory of relativity — and, especially, quantum mechanics — turned this worldview upside down.

The existence of nuclear forces is an entirely unnecessary hypothesis from the perspective of classical physics as well.

To speculate whether the Sun also might not be the center of the Universe because it is orbiting around the center of another cluster of stars–what we term nowadays a galaxy–would have been

[4] It could, however, still be used effectively to predict solar eclipses.

[5] If it looks like a duck, swims like a duck, and quacks like a duck, then it is a duck.

legitimately rejected as an unnecessary and too contrived hypothesis because we had no observational evidence that would have supported such an idea.[6]

Extending Euclidian to non-Euclidian differential geometry by relaxing Euclid's postulate of parallel lines in an N-dimensional space could be considered a non-parsimonious hypothesis without any practical applications. After all, we perceive that space is three-dimensional and structured according to the Euclidian axioms, and there was no reason to believe that reality could follow different geometrical principles other than by a mathematical abstract extension obtained by 'unnecessarily multiplying' mathematical objects, such as metric tensors.

But science was forced to relax minimalist methodological criteria, because of anomalies.

Quantum physics was born out of the 'ultraviolet catastrophe'–that is, the classical prediction that a black body would emit infinite radiation. The observation by H. Becquerel and M. Curie of materials glowing in the dark emitting X-rays could be explained only later with the progress of atomic and nuclear physics, which led to the discovery of nuclear forces. The fathers of differential geometry were wondering about the unprovability of Euclid's fifth postulate. As is well known, Einstein applied differential geometry to formalize his theory of general relativity, itself one of the most impressive intellectual realizations of the 20th century. He had to deal with the non-invariance of Maxwell's equation first (special relativity) and later accounted for the anomaly of the precession of the perihelia of Mercury (general relativity). Something astronomers would have never been able to explain by sticking to the more 'parsimonious' and 'simpler' celestial mechanics of classical physics or the above-mentioned best explanation inference that led to the discovery of Neptune.

On the one hand, this latter historical parallel highlights Occam's razor's heuristic usefulness (it made sense to conjecture the existence of a new planet based on an abductive reasoning that considered it the best explanation for Uranus' orbital deviation) but, on the other hand, it limits the working hypothesis resulting from it: If the putative 'best explanation' remains empirically sterile and the observational anomaly persists, it might be a good practice to relax the conceptual boundaries and permit far less parsimonious theoretical frameworks.

Moreover, in biology, proteins, rather than DNA, were once thought to be the carriers of genetic information because they are made of 20 different amino acids, while DNA has only four nucleotides, apparently making it less suitable for containing large amounts of information. Paradoxically, the simplest hypothesis appeared to be to opt for the most complicated information carrier. For this reason, while DNA has been known about since 1869, it received relatively little attention until the mid-1940s (Dahm, 2005).

In geology, continental drift was long considered an unnecessary and too contrived conjecture to explain the dispersal of species (for an in-depth analysis of Occam's razor misapplications in biogeography, see (Baker, 2007)).

In psychology and medicine[7], a too diligent application of Occam's principle had detrimental effects as well. A straightforward application in modern medical education, where clinicians must discriminate between 'relevant' and 'irrelevant' data based on the simplest explanation, could be a quite dangerous medical practice (Whyte, 2018). And, in psychology, as Koleva and Haidt put it: *"Unfortunately, many psychologists place such a high value on parsimony that they will cut away everything that can possibly be cut away, even if the resulting theory fits the data less well. They turn Occam's razor into Occam's chainsaw, clear-cutting the forest until just one tree is left standing. The most famous and disastrous application of Occam's chainsaw was the insistence by radical behaviorists that psychology can get by without mental constructs"* (Koleva & Haidt, 2012).

In summary, trying to cram Nature, let alone human psychology, into the straitjacket of a theoretical framework that sticks to principles of parsimony is a double-edged sword. Discrimination, awareness of our limited knowledge, and willingness to relax our desire to avoid more complicated ontologies are mandatory.

[6] E. Kant, however, famously advanced the conjecture of 'island universes'.

[7] I cite the cases from psychology and medicine almost as sidenotes only because these are not my fields of expertise. There might be much more to say about the misuse of Occam's razor in these fields as well.

3. The Case of Evolutionary Biology

One field on which we would like to briefly focus is evolutionary biology.

It turns out that we repeatedly underestimate our ability to grasp how tremendously complex the biology of life is. For example, the more we study the structure and function of living organisms, even of a single cell, the more we remain surprised by the until-then unimagined level of complexity. In hindsight we realize — sometimes much later — that we have in mind a much too superficial model of reality. Uncritically applying principles of simplicity to a natural context that we already know will almost certainly turn out to be much more complex than our present models display could backfire as a self-defeating strategy.

A more recent example of this can be seen in the idea that genetic variation and natural selection alone account for all the evolutionary changes in a passive living organism. This is an idea motivated by a desire for parsimony and simplicity but it is now widely accepted that this was a quite inaccurate oversimplification.

It turned out that organisms themselves can facilitate their own evolution, also beyond the mere accident. Cells can rearrange and restructure their DNA with mobile genetic elements. For example, retroviruses infecting cells can insert their genetic material, copying and spreading it throughout the genome. These mobile pieces of DNA allow organisms to evolve beyond a process based merely on natural selection (Poletti & Mavilio, 2017).

Epigenetic changes can determine how an organism reads its DNA, forming different tissues out of the same genome. Evolutionary changes can be caused by ecological ones, leading to the creation of new phenotypes without necessarily implying a genotype change. Which DNA regions are active and expressed are determined by an epigenetic regulation that alters the way the DNA is read and that can change in time. The same region of DNA can be read in different ways — that is, it can encode structurally different proteins. These variations are not directed only by a blind selective or random process, as was once believed, but by the organisms themselves, presumably when under environmental stress (Bale, 2014).

Other processes, such as symbiogenesis — that is, cell fusion — contribute to the evolutionary walk independently of selective and genomic aspects as well. The paradigmatic example has become the origin of mitochondria, and plausibly other cellular organelles, resulting from an endosymbiotic association of bacteria with an archaea cell (Gontier, 2016). Symbiogenetic processes were proposed already in 1905 by Russian biologist Konstantin Mereschkowsky (Kowallik & Martin, 2021) but were ignored at the time. In the 1960s, Lynn Margulis, who was unaware of Mereschkowsky's work, proposed a symbiogenetic theory of the origin of eukaryotic cells but still met with skepticism (Sagan/Margulis, 1967).

Meanwhile, the gene-centric model that considered DNA as something that can 'selfishly' act alone by a fixed top-down control, like a computer with a ROM memory, turned out to be grossly misleading. DNA is more of a database, a sort of RAM memory, in which the CPU and the program must reside elsewhere. It is mostly a passive tool that cells can use to change themselves (Shapiro, 2013).

Moreover, it is now clear that single-celled organisms have a degree of sensing and information processing of their surroundings that can hardly be explained inside the orthodox paradigm. A form of 'basal cognition' in cells and plants exists that previously was thought to be possible only in organisms with a brain, or at least a nervous system. This 'basal cognitive' behavior in response to environmental stimuli shapes the evolutionary trajectory that, again, cannot be explained by random mutations and natural selection alone (for a modern review of the elusive concept of 'basal cognition', see (Lyon & al., 2021)). Cellular basal cognition was observed already in 1906 by the American zoologist Herbert Spencer Jennings but taken seriously only about a century later (Dexter et al., 2019).

These new findings have now been accepted by mainstream molecular and evolutionary biology. Nevertheless, what remains a matter of controversy is where to lay the emphasis. The orthodoxy defends the so-called 'modern synthesis' by maintaining genetic variation and natural selection as the primary evolutionary driving forces. It accepts, and also incorporates, the above-mentioned factors, such as epigenetics, symbiogenesis, cell basal cognition, etc., but regards these as secondary engines of evolution. On the opposite front stands another academic movement incarnated in the so-called 'extended evolutionary synthesis' (Laland & et, 2015) or 'The Third Way' (Website, 2021), which considers the gene-centric model of the modern synthesis as outdated and tends to highlight these non-genetic mechanisms as having weight equal to, if not more than, genetic factors in determining the evolutionary change (Shapiro & Noble, 2021). The debate is far from being settled, and biology might well be on the verge of a major paradigm shift.

Whatever the case, the almost exclusively gene-centric view of life turned out to be based on unwarranted assumptions that were questioned only rarely. The undeclared but de facto (more or less unaware) parsimonious assumption was that evolution could be explained by natural selection and genetic drifts alone. But it appears that life is an extremely complex phenomenon that does not at all follow rules of simplicity with no intention of refraining from multiplying entities. We are nowhere near ‘explaining’ life because genes ‘explain’ life no more and no less than the words in a dictionary ‘explain’ literature. Presupposing this much too simple and parsimonious evolutionary worldview as an a priori working hypothesis prevented us from seeing further despite the evidence to the contrary.

It is also worth noting how the modern synthesis’ narrow view of evolution played in the hands of the controversial theory of Intelligent Design (ID). While the supporters of ID accept evolution, they reject the self-sufficiency of natural selection and random mutations, thereby advocating for a ‘Designer’ filling the gaps. They often argue with Occam’s razor, too. An example of this line of reasoning is W.A. Dembsky’s ‘Design Inference’ method, in which competing explanations are selected with an "explanatory filter" for the best explanation, making evolution without design highly improbable (Dembski, 1998). He argued from parsimony principles as a criterion to quantify the likelihood of regularity, chance, or design in evolution. This received a prompt critical rebuttal by several authors. For example, Fitelson et al. proposed alternative simplest explanations based on more parsimonious orderings leading to the antipodal conclusion (Fitelson et al., 1999). This is another case making it clear that it is our metaphysical and ideological background, with all our personal qualitative and subjective assumptions and premises, that determines whether a hypothesis is parsimonious, simple, or unlikely. Arguing for or against metaphysical worldviews with likelihood arguments based on principles of simplicity or parsimony is a dubious epistemological move.

4. The Case of Theoretical Physics

After the success of the standard model of particle physics in the 1960-70s, a theory of quantum gravity — that is, a theoretical framework that unites Einstein's general relativity with quantum mechanics in a unique model — seemed to be at hand. However, five decades later, no model is in sight that unifies gravitational forces with electromagnetic and nuclear forces into a coherent and self-consistent picture, let alone any experimental evidence suggesting a way to accomplish such unification. Moreover, a quantum reality suggesting weird ontologies where particles can be in a superposition or entangled states, where local realism no longer holds, where random processes reflect a theory without hidden variables, and where Einstein's infamous ‘spooky action at a distance’ is commonplace added further uncertainty to the conceptual foundations of theoretical physics.

This resulted in a lack of substantial progress in the field, which, however, is paradoxically characterized by an explosion of theoretical models, at times compounded by quite mathematically complex and conceptually contrived notions, each presenting itself as a candidate for a theory supposedly leading to a paradigm shift. A plethora of theories of quantum gravity (e.g., string theory, canonical quantum gravity, and many more) and interpretations of quantum mechanics (e.g., the de Broglie-Bohm pilot wave theory, the Many Worlds Interpretations (MWI), and many more) were developed throughout the decades. This resulted in an endless series of speculations, conjectures, and, not rarely, unfalsifiable hypotheses, such as the existence of the multiverse or of our universe branching into many ‘Worlds’.

This doesn’t look as an intellectual practice minimizing entities. In fact, among other things, this also has contributed to an increased dissatisfaction that led to an appeal to a more rigorous and radical application of razors, blades, and knives.

Curiously, however, the proponents and supporters of each of these alternative theoretical frameworks or ontologies claim that their model is the most parsimonious. For example, the MWI can be considered the most parsimonious and simplest one because it does not introduce a new entity at all but, rather, multiplies the present one (our universe). Moreover, Hugh Everett, the father of the MWI, explicitly posits the superiority of his interpretation on the grounds of what (to him) appears to be a criterion of conceptual simplicity that should increase the confidence in a theory without many ad hoc constants, restrictions, and independent hypotheses and be free from arbitrariness (Everett, 1956).

After the enormous predictive power of the standard model became clear, string theory was developed as the leading candidate to extend it. One could argue that string theory is the most parsimonious (and beautiful) theory ever because it posits only one type of fundamental entity building up the entire universe, namely, the string. On the other hand, quite apart from the fact that string theory failed to make experimentally detectable predictions, it requires the addition of many odd components, such as extra dimensions or supersymmetric particles, and is vitiated by several degrees of freedom that led to the multiverse landscape conjecture.

These lines of argument, however, were never a guiding principle for the fathers of the much more successful theory incarnated in the standard model of particle physics. The standard model is anything but a simple or parsimonious theory, let alone a mathematical structure based on few assumptions. It is a cumbersome and contrived theory that hardly reminds one of Occam's precepts. And yet it turned out to be one of the most successful theories of modern science.

The bottom line is that the normative adherence to a principle of simplicity or parsimony has its subjective dimension. Occam does not have only one razor but possesses an entire set of cartridge razors. The delimiting criterion identifying an explanatory construct as 'parsimonious', 'simple', having the 'fewest assumptions' and 'necessary' or 'unnecessary entities' is in the eye of the beholder, not an objective definable requirement, no more and no less than criteria of 'beauty' or 'elegance'. The disordered proliferation of (more or less fancy) speculations in the modern landscape of theoretical physics is not associated with a lack of obedience to an abstract normative principle. The reasons for this phenomenon are much more articulated and complex, remaining a matter of debate but, in our view, the stagnation of modern theoretical physics has much deeper reasons rooted, on the one hand, in the factual lack of experimental data and, on the other hand, in a systemic educational and academic structure unfit to cope with such a state of affairs.

5. Discussion

These were only a few examples from a long list that should make it clear that Occam's razor is no more than a heuristic principle, a rule of thumb, whose effectiveness has been largely overemphasized. It can be a valuable point of departure for a scientific investigation and a useful approach to forward sober hypotheses. In some sense, it could justify initial 'epistemic inertia' that can lead us in the right direction.

Recently, I. Mazin appealed to all scientists for a more thorough application of Occam's razor, complaining about an 'inverse Occam's razor' plaguing the scientific community, which manifests in the *"worrying trend to favor complex interpretations"* because *"they are perceived as more impactful"* (Mazin, 2022). Scientists prefer to frame exciting interpretations because these more easily get through the editorial and peer-review process and into high-profile journals. It is not a rarity to see exotic explanations mesmerizing scientists for years based on experimental data that later turned out to be flawed. We agree with Mazin's conclusion: It should be admissible to present new experimental data with no attempt to search for contrived speculative models that supposedly explain it in the first place, or that one should first adopt simpler models that could explain the experimental data before jumping to complicated theories.

But precisely for this reason, we must find a delicate balance between an excessively hypothetical theoretical practice and a conscious awareness of the limitations of a too strict adherence to a principle that cuts out potentially powerful intuitions. If, as time passes, no tangible results emerge from its application, that could be because it has become a chainsaw that cuts too deep, eliminating parsimonious but correct hypotheses. The fact that a theory does (or does not) pass Occam's razor test is not proof that it is (or is not) the correct explanation. Too much depends on whether we have a complete understanding of the complexity of the phenomenon we want to describe. If one misses that complexity and does not know all the underlying laws, processes, and variables that determine a phenomenon, something we never know for sure, invoking, uncritically, Occam's razor will almost certainly lead to an oversimplification, wrong conclusions, and, therefore, a lack of progress. Sometimes deeper truths require a move away from simplicity and parsimony. Occam's razor should not be elevated to a scientific criterion, let alone a proof for or against a conjecture. A quotation credited to Einstein says: *"Everything should be made as simple as possible, but not simpler."*

In fact, a dogmatic application of the principle of parsimony may result in something too simple — that is, something simply incorrect. It can morph a theory of knowledge into a destabilizing intellectual force that acts like an ideological guardian preventing further progress rather than a rational intellectual practice. We can't take it as an undeclared law that should be followed automatically.

There are also psychological factors, such as social reinforcement that strongly pressures, for example, philosophers of mind — perhaps, even more, the dualists, idealists, or non-materialists — to resort to Occam's razor. Material monists invoke Occam as a rational and scientific criterion for dismissing any metaphysical assumption.[8] The dualists, or idealists, eager to show that they are just as analytic, rational, and scientific as their physicalist colleagues, jump on the same bandwagon and invoke the same principle, obviously to defend the opposite thesis. However, this equally questionable attachment to principles of parsimony and simplicity is not rooted in a genuine conviction of a sober and well-thought methodology. Rather, it is prompted by the desire to please and appease (in most cases without success) their counterpart. They feel compelled to repeat words like 'parsimony', 'simplicity', and 'unnecessary' only because they believe that this makes them look more rigorous, analytic, and scientific and distance themselves from too-mystical positions. But this has never been successful or convincing, nor has it been in any way productive.

At any rate, to the best of my knowledge, I cannot think of a single historical case in which this minimalist approach settled a debate. I have never seen someone changing his/her mind because of a theory or hypothesis based on its supposed minimalism. Occam's razor can be invoked to both defend and attack the very same theory, hypothesis, or conjecture. Notwithstanding, there remains a pervading tendency to claim that it is one's own theory, not the rival one, that conforms best and is in line with a principle of parsimony. In too many instances, it has been used to defend a 'Weltanschauung' rather than leading to a consensus on the best solution to a decidable problem.

In the end, it is an approach through which people can justify everything and the contrary of everything. Like it or not, ultimately, we choose a worldview because of our personal preferences, our belief systems, and our unconscious (necessary or unnecessary) assumptions. In science, we cannot dismiss or blindly accept something only on the grounds of an abstract and limited principle. A too straightforward application of such a principle not only has frequently led to wrong conclusions but has also made us blind to new phenomena and prevented science from progressing. In science, principles of parsimony or simplicity can't be put on par with the role played by logic, mathematics, and the predictive power of a theory confirmed by experimental evidence. Because, as the history of science shows, Nature couldn't care less about our anthropomorphic principles of ontological parsimony and simplicity.

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[8] One can't fail to notice how, in popular discussions, it is common among skeptics and atheists to invoke Occam's principle to support a physicalist worldview — an application that a friar could hardly have had in mind.

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