ISSN 2282-7765 [online]
ISSN 2282-7757 [printed]

Volume 11, Number 1, June 2023

Science & Philosophy

Journal of Epistemology, Science and Philosophy

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SCIENCE & PHILOSOPHY - JOURNAL OF EPISTEMOLOGY, SCIENCE AND PHILOSOPHY

ISSN 2282-7757; eISSN 2282-7765.

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Publisher: **APAV** - Accademia Piceno-Aprutina dei Velati in Teramo
Tax Code 92036140678, **Vat Id. Number** 02184450688
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Science & Philosophy Volume 11(1), 2023

The concept of probability, crisis in statistics, and the unbearable lightness of Bayesing

Boris Čulina*

Abstract

Education in statistics, the application of statistics in scientific research, and statistics itself as a scientific discipline are in crisis. Within science, the main cause of the crisis is the insufficiently clarified concept of probability. This article aims to separate the concept of probability which is scientifically based from other concepts that do not have this characteristic. The scientifically based concept of probability is Kolmogorov's concept of probability models together with the conditions of their applicability. Bayesian statistics is based on the subjective concept of probability, and as such can only have a heuristic value in searching for the truth, but it cannot and must not replace the truth. The way out of the crisis should take Kolmogorov and Bayesian analysis as elements, each of which has a well-defined and limited use. Only together with qualitative analysis and other types of quantitative analysis, and combined with experiments, they can contribute to reaching correct conclusions.

Keywords: crisis in statistics; Kolmogorov's concept of probability; interpretations of probability; subjective probability; Bayesian statistics; Bayesianism [1]

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[1]Received on March 23th, 2023. Accepted on June 21th, 2023. Published on June 30th, 2023. doi: 10.23756/sp.v11i1.1161. ISSN 2282-7757; eISSN 2282-7765. ©The Authors. This paper is published under the CC-BY licence agreement.

Probability is the most important concept in modern science, especially as nobody has the slightest notion what it means.

Bertrand Russell, 1929 Lecture – cited in [Bell, 1945, p. 587]

In our days, serious arguments have been made from data. Beautiful, delicate theorems have been proved, although the connection with data analysis often remains to be established. And an enormous amount of fiction has been produced, masquerading as rigorous science.

David A. Freedman [Freedman, 1995, p. 35]

"... Bayesianism may survive for a while, along with mind-body dualism, many-worlds metaphysics, and other philosophical extravagances. Meanwhile let us hope that it will be gradually discontinued in the law, medicine, seismic engineering, policy-making, and other fields where lives are at stake.

Mario Bunge [Bunge, 2008, p. 173]

Published research findings are sometimes refuted by subsequent evidence, with ensuing confusion and disappointment. Refutation and controversy is seen across the range of research designs, from clinical trials and traditional epidemiological studies to the most modern molecular research. There is increasing concern that in modern research, false findings may be the majority or even the vast majority of published research claims.

John P. A. Ioannidis [Ioannidis, 2005, p. 0696]

It was most difficult to work when in the Republic of Croatia we had a "bus of the dead" every day, and in Split, one such bus would "arrive" every week. There was too much unnecessary dying, and such a situation throws you into depression and you keep repeating the same question to yourself:

> *Is it possible that people do not understand and would rather die than get vaccinated?*

And dying from corona is awful, painful. It's not death from a heart attack where it "cuts you off" and that's it, you're gone. Here people suffer and die in terrible agony.

Ivo Ivić (Slobodna Dalmacija newspaper, 25. 03. 2022.)

1 Introduction

The above quotes are quotes from people who know what they are talking about, from the famous philosophers Bertrand Russell and Mario Bunge, through the famous statisticians David A. Freedman and John P. A. Ioannidis, to Associate Professor Ph.D. Ivo Ivić, head of the Clinic for Infectiology of KBC Split and head of the COVID Hospital in Križine. Each of the quotes testifies to one aspect of the crisis in statistics. The first quote testifies to the insufficiently clarified concept of probability on which statistics is based. The second and third quotes testify that there is a crisis in statistics itself as a scientific branch. The main source of this crisis is the conflict (in Mayo [2018], the term "statistical wars" is even used) of two schools of statistics, classical (frequentist) and Bayesian statistics. The theoretical basis of this crisis is a different understanding of the concept of probability. The fourth quote testifies to a true inflation of bad application of statistics in scientific research: impossibility of replication and reproduction, incorrect implementation and interpretation of statistical procedures, but also misuse of statistical tests, problem of p-values, irresponsible Bayesianism, etc. (see e.g., Ioannidis [2005], Peng [2015], Greenland et al. [2016], Wasserstein and Lazar [2016]). In addition to various sociological reasons, which burden the scientific community, the reason for this is insufficient understanding of statistics itself, its methods and concepts, which are based on the concept of probability. The last quote testifies that a misunderstanding of science, above all the role of statistics in science, can have profoundly serious consequences. This quote, together with the preceding one, also refers to a crisis in education, especially in statistics education. Statistics education has a significant impact on the use of statistics both in scientific research and in making decisions in everyday life. Its most important task is to teach correct understanding of the concept of probability.

Thus, if we look at the internal reasons for the crisis (reasons that concern science itself), the main source of the crisis is in the insufficiently clarified concept of probability. The aim of this paper is to contribute to the separation of the concept of probability, which is scientifically based and verifiable, from other concepts that do not have these characteristics. The concept of probability that will be separated also gives answers to the question of when probability can help us describe and control reality and when it cannot. These answers allow us to identify the cause of the crisis in statistics: the wrong application of the concept of probability and, even worse, the application of the concept of probability where it is not applicable. These answers also give us guidelines for overcoming the crisis in statistics in all the aforementioned aspects.

In Section 2, the scientifically based concept of probability will be described. In essence, it is a mathematical probability model which, together with the conditions of its application, was established by Kolmogorov in 1933. The conditions

of its application determine how probability can and cannot help us. In Section 3 it will be described how this concept of probability affects the crisis in statistics. In Sections 4 and 5 it will be explained why some other concepts of probability are not scientifically based. Special attention will be paid to the Bayesian concept of probability, which, although not scientifically based, has a certain heuristic value, but also carries great danger.

Although this article covers a wide area, its main topic is the role of mathematical models and their application in the field of probability and statistics. I see the originality of the paper in 1) the explanation of Kolmogorov's concept of probability as a concept of probability based on a certain mathematical modelling of random phenomena, 2) the argumentation that Kolmogorov's concept of probability is fundamentally different from all other concepts of probability, including frequentism with which it is usually identified, 3) and the argumentation that Kolmogorov's concept of probability is the only scientifically based and verifiable concept of probability. However, the main message of the work is that Mark Twain's words "There are three kinds of lies: lies, damned lies, and statistics" returns to us today in a dramatic way: instead of significantly helping to overcome the crisis into which modern society has fallen, today statistics significantly contribute to the crisis. It is vitally important that statistics are developed and practised responsibly, and not that falsehoods are generated under the guise of science. A correct understanding of the concept of probability is crucial here.

2 Mathematical probability models and conditions of their application

It is usually stated that Kolmogorov formulated the axioms of probability theory in 1933 (Kolmogorov [1956]). The interpretation he gave to these axioms is rarely mentioned because it is viewed to only express von Mises' frequentism.[2] In the next section, I will argue that this view is wrong. In this section, Kolmogorov's formulation of the concept of a mathematical probability model and the conditions of its application will be briefly presented.

It is common to consider that determinism and randomness are mutually contradictory concepts. But is it so? We say that a process takes place *deterministically* if its future state is completely determined by the initial state. For example, the falling of an object from a certain height is determined by the initial conditions. If, under the same conditions, the process takes place in different ways, then we are talking about a *random phenomenon*. Example: rolling a die. However, when

[2] "Although Kolmogorov never abandoned his formulation of frequentism, his philosophy has not enjoyed the enduring popularity of his axioms." Shafer and Vovk [2006].

we release a body from a certain height (always the same initial condition), if we were to measure the time of its fall with sufficient precision, we would always get a slightly different result, because the fall depends on a multitude of factors that we cannot control (air resistance, movement of the air mass, shape of the body, etc.). Thus, the randomness is also present here, although determinism is dominant. On the other hand, if when rolling a die, we could accurately determine the initial conditions of the throw, according to the laws of classical physics, the motion of the die takes place deterministically. Determinism is also present here, although randomness dominates.

Determinism and randomness are always present, the only question is which one dominates. Thus, they are more complementary than conflicting concepts. Moreover, in science, the question of determinism and randomness arises not so much as a question of what nature is like, but more as a question of how we will describe a particular phenomenon, in a deterministic or stochastic way. That is why we will talk bellow about deterministic and stochastic (probabilistic) models of description of nature. In specific situations, a model of a certain type (or a combination of models of different types) should be selected to provide a satisfactory description of the situation. Even the basic physical theories about the world, classical physics and quantum physics, are big models of this type. One is based on determinism, the other one on randomness. According to classical physics, the world is deterministic, and randomness is the result of our inability to control all parameters of a process. According to quantum physics, in its standard interpretation, randomness is a necessary part of the description of the world: we can only determine the probabilities that something will happen.

Deterministic models are, mathematically speaking, sets of functions that determine some quantities using other quantities. That is why the mathematics of deterministic models is in the essence the mathematics of functions. Mathematics can offer various models, and the person who applies them must determine which models are good enough for his problem. How to use mathematical models is no longer a matter of mathematics but a part of science that deals with a certain phenomenon. For example, in the case of a fall in vacuum on the Earth's surface, mathematics can offer various models of how the distance travelled *s* depends on the time of fall *t*:

$$s = kt, s = kt^2, s = kt^3, s = \frac{k}{t^2}, s = k\ln(at), \ldots$$

Physics has chosen the model that corresponds to reality: $s = \frac{1}{2}gt^2$, where $g = 9.81ms^{-2}$. However, this model is an approximation because g depends on the location on the Earth's surface, and we can determine g most precisely experimentally. If we analyse the real situation, the fall of a body somewhere on the Earth's surface, then we have to take air resistance into account. The previous

formula is now only approximately good for heavier bodies and lower speeds. If the speeds are higher, then air resistance is more prominent, and we need a more complicated model that gives us more accurate results. However, this still remains an approximate solution. A model that would provide a more accurate solution should include airflow, temperature, humidity, pressure, vibrations, the shape of a falling body, etc. Increasingly accurate models would be increasingly complicated. But no matter how complicated they are, they could not describe the most ordinary fall of leaves in autumn under a gust of wind. The deterministic models lose their power of description because now we encounter a random phenomenon: under the same initial conditions that we can control, the leaves will fall in different ways. Thus, to get an even more precise model, we would have to include a corresponding probability model.

This example illustrates the general situation. The goal of any modelling is to find the simplest possible model that gives accurate enough results for our needs. When we create a model, we try to test it by comparing the values it predicts with the values we determine experimentally. If this match is good enough, that is, if from the point of view of the problem we want to solve, the obtained deviations are negligible, then we accept that model. If not, then we look for a better model, which is often more complicated. The same applies to probability models.

To describe random phenomena, mathematics offers probability models. For a simple illustration I will use the roll of an irregular traditional die. We specify a random phenomenon by specifying the conditions under which it takes place (for the die, we must precisely define the conditions under which the die is rolled). To the specified random phenomenon, we associate the outcomes space (sample space), a set whose elements we call outcomes. The only condition for the outcomes space is that exactly one outcome is associated with each realization of the random phenomenon. We can associate various outcomes spaces to the same random phenomenon depending on what we are interested in. For the die, it is usually the set $\{1, 2, 3, 4, 5, 6\}$, but it can also be the set $\{even, odd\}$, if we use the die to make a binary choice. We describe events with words that set conditions on outcomes (e.g., that a number divisible by 3 will be rolled), and "officially" define events as sets of outcomes that satisfy a given condition (divisibility by 3 gives the set $\{3, 6\}$). We cannot predict what will happen in a single roll of the die. However, a regularity emerges in the sequences of rolls. In each sequence of rolls, we can associate a relative frequency $\frac{n_D}{n}$ to the event D, where n_D is the number of rolls in which D occurred, and n is the total number of rolls in the given sequence. It is an experimental fact that for each such sequence of rolls the relative frequencies are approximately the same. The higher the number of rolls, the better the grouping of the frequencies. The number around which the relative frequencies are grouped is called the probability of the event D and denoted by

$P(D)$. *That number is not uniquely determined by the grouping, but we postulate it*. The meaning of this number is that it approximates (estimates) the relative frequency of the event *D* in a sequence of rolls:

$$P(D) \simeq \frac{n_D}{n}$$

It follows from this meaning that the probability function *P*, which associates a probability with each event, cannot be an arbitrary function. Given that it approximates relative frequencies, it must have properties of relative frequencies for a given sequence of rolls. Such are the following properties, which we call probability axioms, because other properties can be derived from them:[3]

1. $0 \leq P(D) \leq 1$
2. $P(\emptyset) = 0$, $P(\Omega) = 1$
3. $A \subseteq B \longrightarrow P(A) \leq P(B)$
4. For mutually exclusive events A and B, $P(A \cup B) = P(A) + P(B)$

where Ω is the outcomes space.

By modelling the random phenomenon of rolling an irregular die, we arrived at the (almost) general concept of Kolmogorov's probability model of a random phenomenon. A *finite probability model* consists of:

- a non-empty finite set Ω which we call the *outcomes space*, its elements *outcomes*, and its subsets *events*,
- and the function *P*, which we call *probability*, which assigns a number to each event, whereby the above axioms of probability must be fulfilled.

Here we limited ourselves to finite models because infinite models (e.g., random selection of a point from a geometric figure) have somewhat more complicated mathematics, while the basic ideas are the same as for finite models.

As with deterministic models, mathematics offers various probability models too. By choosing a non-empty set and a function that assigns a real number to each subset, where the function satisfies the stated axioms, we obtained a probability model. The main problem is to choose a model for a given random phenomenon that describes the phenomenon well. The basic criterion for the correct choice of a probability model, set by Kolmogorov in 1933 ([Kolmogorov, 1956, p. 5-6]), is that the probability $P(D)$ of an event D must match well enough the relative frequencies of the event in a sequence of repetitions of the random phenomenon:

[3]These axioms are not independent: the third property and one of the properties under 2. can be derived from the other properties.

$$P(D) \simeq \frac{n_D}{n} \qquad (1)$$

What is "well enough"? The answer is the same as with deterministic models: from the point of view of the problem we want to solve, the deviations must be negligible. This approximate equality is the basic connection between a probability model and reality, the basic criterion for the usability of the model in the description of a given random phenomenon. Thanks to this connection, the use of probability models is as firmly scientifically based as the use of deterministic models. On the one hand, if we know from some theory or experiment the probability of an event, then by this connection we can estimate the relative frequency of its occurrence in a series of repetitions of a given random phenomenon. On the other hand, if we determine the relative frequencies of events through experimentation, then by this connection we can estimate their probabilities. If we analyse how probability is used in classical statistics, we will see that it is precisely this concept of probability.

Let us not forget that the basic assumption of this modelling is that a random phenomenon can be replicated an arbitrary number of times. Thus, Kolmogorov's overall conception sets two criteria for the usability of probability models:

- the basic condition for applicability of probability models: *probability models can be applied to random phenomena that can be replicated an arbitrary number of times*.
- the basic condition for the correct choice of a probability model for a given random phenomenon: *the probability of an event must match well enough with the relative frequencies of the event in a sequence of repetitions of the random phenomenon.*

When the stated conditions are met, probability models successfully describe what will happen in a sequence of repetitions of a random phenomenon. This is confirmed by the exceptional success of these models in statistical mechanics and quantum physics, but also in industry, including the "industry" of insurance companies and games of chance. By taking a random sample from a population, the success of these models is extended to biology, medicine, and social sciences. By ensuring that each individual has the same probability of being selected into the sample, the population parameters become the parameters of the probability model of random selection of an individual from the population. Then the basic connection (1) relates the relative frequencies in the entire population to the relative frequencies in the sample. However, the problem of obtaining a random sample arises here. The deviation of the actual sample from a random sample can drastically devalue the obtained results.

The basic connection (1) between a probability model and reality also tells us when probability cannot help us in describing, predicting, and controlling reality. A typical such situation is a single realization of a random phenomenon (e.g., which number will fall in one roll of a die). In a particular case, an event will happen or not happen. *Except in some extreme situations, probability cannot tell us whether an event will happen or not*. It is the so-called *problem of the single case*. Extreme situations are when the probability of an event is close to 0 or 1 to a few hundredths or smaller. If the model is good, in the first case we can *practically be sure* (Kolmogorov's term) that the event will not happen, while in the second case we can practically be sure that it will happen. Likewise, if the probabilities of the event are close to those extreme values, and we must make a decision, then it is more reasonable to make the decision that the event will not happen (if the probability is close to 0) or that it will happen (if the probability is close to 1), although we do not have absolute certainty.

Take, for example, the problem of vaccination, which dominated the Covid-19 pandemic. Roughly speaking, the data show that the probability that someone will die from vaccination is at most in the order of millionths, and that they will die from Covid-19 (unvaccinated, because the vaccinated are practically certainly protected) during a pandemic is in the order of thousandths. According to this rough but basically correct model, in a larger population, such as a population of 4 million people, roughly the size of Croatia, if everyone chooses not to vaccinate, about 4000 will die, and if everyone chooses to vaccinate, about 4 will die. Thus, at the level of the whole society (population), it is correct to recommend vaccination. This will save thousands of lives. But what about the individual? A choice that is good for the whole society is not necessarily good for an individual. Although both probabilities are exceedingly small, the probability that an individual will die from vaccination is a thousand times smaller than they will die from Covid-19, and it is reasonable, if we have no other knowledge, to choose vaccination. Although probabilities cannot deprive us of uncertainty in single cases, they are still an important indicator that tells us which decision is more reasonable to make.

The above probability model of the Covid-19 pandemic has another significant drawback related to the probability it assigns to the occurrence of an event in a particular case. This is the so-called *problem of the referent random phenomenon*: *the probability of an event depends not only on that event, but also on the random phenomenon in relation to which we observe it.* The model assigned the probability of death from Covid-19 to an individual in relation to the entire population. If we narrow the population to which that person belongs by setting additional conditions (age, specific health problems, ...) then this probability changes and increasingly suits that person. For example, the following graph (Figure 1) shows

what percentage of people in each age group in Croatia died from Covid-19.[4]

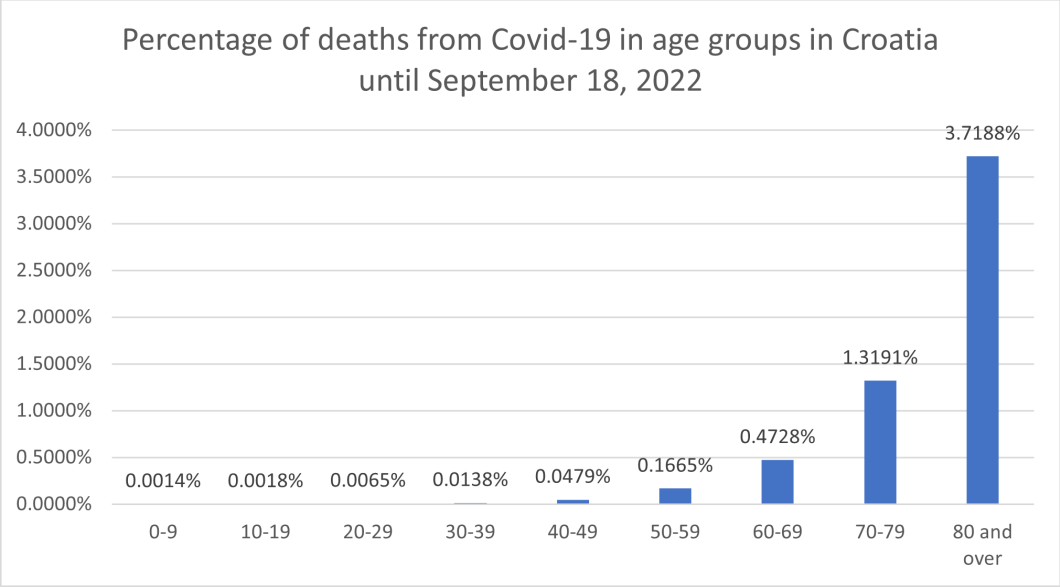

Figure1: Mortality by age group

These percentages estimate the probabilities that someone in each age group will die from Covid-19. In relation to the probability of death from Covid-19, which is about one thousandth for the entire population, for the population of people over 70 years old the probability is drastically higher, about one hundredth, and for those under 30 years drastically lower, about one hundredth thousandths. For an individual, the probability for his age group better describes his chance of dying from Covid-19 than the probability for the entire population. This dependence of the probability of an event on the population in relation to which we observe it has no effect on the estimates of the relative frequencies of the event in the populations, but it influences the significance of the probability for an individual.

Despite these shortcomings of the concept of probability related to predicting what will happen in an individual case – that probability makes predictions only for the population and not for the individual, and that this probability depends on the population to which the individual belongs – we can still apply this understanding of the concept of probability to the decision to vaccinate. Ideally, for each individual, we could determine such a narrow reference population to which they belong, and for which the probability of death from vaccination for a person from that group is equal to 1 (everyone from that group will die if vaccinated)

[4]The graph is derived from the data on the 2021 population census of the The Croatian Bureau of Statistics and data on mortality from COVID-19 from the Croatian Institute of Public Health.

or 0 (everyone from that group will not die if vaccinated). If science could find such a narrow group for each person, then we would know exactly who can and who cannot receive the vaccine. However, too many parameters are involved, and the processes are too complex for us to have full understanding and control over the outcomes. It can be said that the probability models we currently have are also measures of our knowledge: the more specific the models, the greater the knowledge. In the short time it had at its disposal, science managed to 1) determine the probabilities of death for not particularly specific groups (the simple model described above is the crudest such model), 2) give general instructions about behaviour, and 3) identify specific groups that could be extremely vulnerable to vaccination or to the COVID-19 disease. Thus, science has given a clear instruction: if the person does not belong to an extremely vulnerable group for vaccination, they should be vaccinated.

3 The concept of probability and crisis in statistics

The scientifically based concept of probability described above is highly successful within the limits of its applicability. However, these limits are very strict and probability models cannot be applied to many situations to which we would like to apply them. Real random phenomena only approximately correspond to random phenomena that we can always reproduce under the same conditions. The samples we use to make inferences about a population often deviate too much from random samples, preventing credible conclusions to be drawn. Furthermore, in more complex situations we would need many assumptions to associate a probability model with a random phenomenon. If the assumptions are not met then we have no guarantee that the predictions based on the model are correct. When it comes to an individual case, probability models lose their power and the predictions they provide can only be one of the indicators to guide us.

The problems of complexity and of the single case of a random phenomenon are especially important for disaster risk assessments because no matter how similar they may appear, disasters are always complex and unique phenomena. In the article Freedman and Stark [2003] it was shown how powerless statistics is in such cases. The article begins with the following text:

> What is the chance that an earthquake of magnitude 6.7 or greater will occur before the year 2030 in the San Francisco Bay Area? The U.S. Geological Survey estimated the chance to be 0.7 ± 0.1 (USGS, 1999). In this chapter, we try to interpret such probabilities.

and ends with the following words:

> Another large earthquake in the San Francisco Bay Area is inevitable, and imminent in geologic time. Probabilities are a distraction. Instead of making forecasts, the USGS could help to improve building codes and to plan the government's response to the next large earthquake. Bay Area residents should take reasonable precautions, including bracing and bolting their homes as well as securing water heaters, bookcases, and other heavy objects. They should keep first aid supplies, water, and food on hand. They should largely ignore the USGS probability forecast.

After a detailed analysis of how the U.S. Geological Survey came to this probability estimate, Freedman and Stark showed that due to the complexity of the mechanism of the earthquake, many assumptions and subjective assessments had to be made, which completely devalued the established model and the obtained probability estimate.

David A. Freedman is one of the well-known statisticians who focused on the issue of the correct use of statistics, pointing out today's wrong practice of statistics where statistics are used "everywhere" and "unlimited" in such a way that "without much trouble" researchers arrive at mostly wrong answers. In contrast, Freedman advocates a balanced combination of qualitative and quantitative research, rather than blindly accepting statistical inferences based on untested assumptions.[5] Statistical models and methods should be formulated carefully: their assumptions should be explained, their validity evaluated, and experimentally verified on several samples. The results obtained in this way should be viewed through qualitative analysis and research in order to finally obtain credible conclusions.[6] Freedman called this approach the *shoe leather approach*.

The above consideration shows that Kolmogorov's models have strict limits to their applicability, and even where they can be applied, they often require a shoe leather approach. This makes classical statistics a "hard" science with limited possibilities. And this is precisely where the cause of the crisis in statistics and its application lies: in the conflict between these characteristics of statistics and the needs and desires of modern society to solve as many problems as possible and in as little time as possible with statistical methods. The conflict occurs in two segments: where statistics can be applied and where statistics cannot be applied in a scientifically objective manner.

Where statistics can be applied in a scientifically objective way, in the analysis of mass phenomena, the applications are not done with sufficient quality, either be-

[5] "But perhaps the most serious source of error lies in letting statistical procedures make decisions for you." [Good and Hardin, 2012, p. 3].

[6] "Combining qualitative insights and quantitative analysis - and a healthy dose of scepticism - may provide the most secure results." [Freedman, 2008, p. 313].

cause of ignorance and irresponsibility, but also because of unethical behaviour.[7] That is why today the scientific community places more and more demands on financiers and academic institutions to ensure an adequate system that would not encourage unethical activity[8], and would support more rigorous scientific research: "(1) more courses on methodologically robust and transparent scientific research in student curricula and training of established researchers; (2) increase in the involvement of experienced methodologists, statisticians and data stewards on projects by, for example, securing funding for such personnel or establishing advisory bodies that would provide advice and guidance for funded projects; (3) better technical/infrastructural support for enabling open science practices, rigorous reporting, archival of all elements of research and creating linkages among them" [Purgar et al., 2022, p. 1396].

Far more worrying is the ubiquitous use of statistics where its scientific power is very weak — in predicting what will happen in a particular case under conditions of uncertainty. Kolmogorov's models can give the probability of whether something will happen in a particular case only if that case is the realization of a well-defined and repeatable random phenomenon. But even then, those probabilities do not mean much. Only when these probabilities are close enough to one or zero can we practically be sure that something will happen or not happen. Otherwise, it is reasonable to stick to probabilities in predicting only when we do not have better deterministic indicators. However, uncertain situations are frequent and very important, and require our reaction, especially if they are crisis situations. This creates a strong need to try to provide predictions as a basis for appropriate action in such situations. Since classical statistics is almost unusable there, there was an accelerated development of Bayesian statistics, as an alternative to classical (frequentist) statistics. Bayesian approach is based on a completely different concept of probability, the so-called concept of subjective probability, which will be briefly explained below. Such a concept of probability allows Bayesian statistics to be applied everywhere. That is why to many researchers Bayesian statistics seems to be the "holy grail" of statistics which solves all problems almost algorithmically. The danger lies in the fact that the truth about Bayesian statistics is exactly the opposite: its meaningful use requires an even stronger shoe leather approach compared to frequentist statistics. The danger that Bayesian statistics

[7] For example, a recent comprehensive survey of science in the Netherlands Gopalakrishna et al. [2022] showed that in the last three years approximately every second scientist participated in at least one qualitatively questionable research, while every twelfth scientist faked or fabricated their research at least once.

[8] Unethical activity is largely encouraged by the existing system of financing and evaluation of scientists, which does not respect equality and diversity in science and sets narrow bureaucratic evaluation systems. This has already become such a big problem that there is a distinct trend in the scientific community to completely change the system of doing science and its evaluation.

carries is vividly stated in [Gelman, 2008, p. 447]: "...recommending that scientists use Bayes' theorem is like giving the neighbourhood kids the key to your F-16". It should be kept in mind that almost everyone except very experienced statisticians are "neighbourhood kids" here, and that the "F-16" flies through vital areas of human society: from politics, judiciary, economy and finance to health, environmental protection and natural and social threats.

Unfortunately, the crisis is not only in inappropriate application of statistics. In statistical science itself, there has been a crisis due to the division among statisticians regarding the preference for classical or Bayesian statistics and criticizing the other.[9] Of course, this crisis also produces additional confusion in the application of statistics. The situation becomes even more dramatic with the advent of *Big Data*, which poses new major challenges for statistics.[10] The statistical community is aware that the time has come to overcome the crisis.[11] Understanding the various concepts of probability is crucial here, especially Kolmogorov's concept of probability and Bayesian concept of subjective probability. In the next section I will argue that Kolmogorov's interpretation differs significantly from the frequentist and propensity interpretation. Thus, it does not fall under the criticism that these other two interpretations fall under. In Section 5, I will highlight some essential characteristics of Bayesian interpretation that determine its place in statistics. The correct understanding of Kolmogorov's and Bayes' interpretation indicates the way out of the crisis.

4 Kolmogorov's interpretation versus frequentist and propensity interpretation

Kolmogorov's interpretation of probability is usually placed in the frequentist interpretation of probability elaborated by von Mises in 1919 (Von Mises [1957]). However, one "detail" significantly separates Kolmogorov's interpretation from the standard von Mises frequentist interpretation. Von Mises postulated that the relative frequencies $\frac{n_D}{n}$ of an event D in a series of repetitions of a random phenomenon converge to a certain number in the sense of the mathematical concept of limit and that this very number is the probability of the given event:

[9] "Basically, there's only one way of doing physics, but there seems to be at least two way of doing statistics, and they don't always give the same answers." [Efron, 2005, p. 1].

[10] "Perhaps Statistics should stand up for its responsibilities before a Big Data Disaster" [Fraser and Reid, 2016, p. 7].

[11] "This will be a challenging period for statisticians, both applied and theoretical, but it also opens the opportunity for a new golden age, rivalling that of Fisher, Neyman, and the other giants of the early 1900s." [Efron, 2005, p. 1].

$$P(D) = \lim_{n\to\infty} \frac{n_D}{n}$$

This postulate is experimentally unfounded because neither an infinite number of repetitions of a random phenomenon is possible nor experimentally obtained finite sequences of relative frequencies support such a claim. Criticisms of the frequentist interpretation are mainly criticisms of this postulate. This postulate is simply "too strong". In addition, this postulate gives the concept of probability a completely objective meaning in the sense that probability belongs to a random phenomenon in the same way as, for example, the number of elements of a set belongs to that set. In contrast to such an approach, Kolmogorov's interpretation of the concept of probability has a completely different basis. It rests on the idea of modelling: probabilities are ideal numbers within a probabilistic model that approximate the relative frequencies well enough:

$$P(D) \simeq \frac{n_D}{n} \qquad (1)$$

Using (1), we can experimentally set up a probabilistic model for the given random phenomena, as well as check whether the probabilistic model is good enough for the given random phenomena. And this is enough – Kolmogorov's interpretation does not go beyond this scientifically based and verifiable setting of probabilistic models of random phenomena. In this interpretation, the probabilities are as objective as the above connection is.[12] Although von Mises' and Kolmogorov's formulas for $P(D)$ seem to be remarkably similar, their interpretive basis, and thus the concept of probability, are fundamentally different.[13]

Likewise, the propensity theory, whose most famous representative is Karl Popper (see e.g., Popper [1959]), at first glance seems to be only an addition to Kolmogorov's interpretation in the part that refers to the individual realization of

[12] I would point out that most other scientific concepts have the same kind of objectivity as probability. For example, we associate the length s of the travelled path with free fall. However, s is the distance between two points in Euclid's ideal geometric model of space. This number is as objective for free fall as the connection of two points in Euclidean space with the beginning and the end of the fall is objective. In macroscopic conditions, this connection is strong, but in microscopic conditions, instead of fixed points, we have molecules in constant oscillation, so we have an indeterminacy in what is the initial and what is the end point of the fall. This connection becomes even looser if we go to even smaller dimensions where the laws of quantum physics dominate. Thus, like probability, the length of the travelled path in free fall is an ideal element of the corresponding physical model which is as objective as the concept of the travelled path is objective.

[13] Kolmogorov's interpretation is often mistakenly identified with the so-called finite frequentism, according to which (1) is taken as the operational (empirical) definition of probability. A probability model is a much more subtle concept than the operational "definition" of probability, so the corresponding interpretations of probability differ significantly.

a random phenomenon. However, this addition leads to a completely different understanding of probability. Namely, Kolmogorov's models do not say anything about an individual realization, but only predict ratios in a sequence of such realizations. This is paradoxical at first sight - the sequence consists of individual realizations, and how can regularity appear in the sequence if it is not present in the individual realization? Popper introduces the term propensity (tendency) to give probability a meaning for a particular realization of a random phenomenon. According to Popper, the conditions that determine random phenomenon are "endowed with a tendency, or disposition, or propensity, to produce sequences whose frequencies are equal to the probabilities" [Popper, 1959, p. 35]. According to Popper, propensities are present in every realization of a random phenomenon, just as, for example, the tendency to fight for survival is present in living beings. Thus, probabilities as measures of these propensities are also present in every realization of a random phenomenon. In a series of realizations, these propensities are manifested as tendencies to obtain relative frequencies equal to the stated probabilities. This addition to Kolmogorov's interpretation of probability, like frequentism, introduces the concept (propensity) which is experimentally unverifiable, and which gives an objective interpretation to the concept of probability. Thus, the propensity interpretation, as well as frequentism, is not a completion of Kolmogorov's interpretation, but it cancels its basic philosophy derived from the modelling of random phenomena and replaces it with a completely different concept of probability.[14]

5 Subjective interpretation, Bayesian statistics and Bayeseanism

In contrast to Kolmogorov's interpretation of probability, which through the formula $P(D) \simeq \frac{n_D}{n}$ has its objectivity in the sense of checking whether it corresponds well enough to reality, Bayesian statistics rests on a completely different concept of probability according to which probability is a subjective measure of our belief in the truth of a statement. We use this interpretation in everyday life, for example when we say that it is more likely that there is life outside our planet than that there is not. If we are talking about whether an event will happen, for

[14] In addition to unverifiability, the concept of propensity has another important drawback: it is in contradiction with the problem of referential random phenomena. The probability of an event depends on the conditions by which we determine the random phenomena. Under one set of conditions, a random process will have one probability, and under another a different probability. Thus, propensity cannot be an intrinsic characteristic of a particular process, but a reflection of its relationship to the conditions under which we determine the random phenomena, which often depend on our modelling.

example when I say that I am almost 80% sure that it will snow tomorrow, then the stated percentage is a subjective measure of my belief that the event will happen. The concept of probability that dominated until the beginning of the 20th century belongs to the subjective concept of probability: probability is a measure of our ignorance. Such an interpretation is a product of an era in which, under the influence of Newtonian mechanics, it was believed that processes in nature take place deterministically.[15] Frequentist conception of probability was affirmed in the first half of the twentieth century, primarily due to its successful application in statistical and quantum physics, as well as in classical statistics. The subjective conception of probability appears in a new form through the works of de Finetti[16] and Savage[17], no longer as a measure of our ignorance, but as a measure of our belief in the truth of various claims. The axioms of probability now have the role of rational conditions on the subjective assignment of probability. For example, axiom $A \subseteq B \longrightarrow P(A) \leq P(B)$ now has the following interpretation. Let A and B be two statements such that if A is true then B is also true. Then the statement B must have a greater or equal subjective probability to be true than does the statement A. When, based on our knowledge or experience, we use probabilities to determine how much we believe some statements to be true, the calculus of probabilities allows us to consistently calculate the probabilities that some other statements are true. Specially, if we are dealing with predictions in a random phenomenon, this calculus allows us to calculate the subjective probabilities that various events will happen.

A whole series of questions are raised, to which this concept of subjective probability has not yet given a satisfactory answer: 1) Can we measure our beliefs with numbers at all? 2) Are these numbers uniquely determined by our beliefs? 3) How correct is it to assume that these numbers satisfy Kolmogorov's axioms, i.e., to what extent is Kolmogorov's probability calculus a rational calculus of our beliefs?[18] However, the most important of all is the question of what meaning the subjective probability that a statement is true has. For example, we may have various beliefs about person X, the potential perpetrator of the crime we are investigating. If we can express these beliefs with some numbers, subjective probabilities, and if we can apply to them a probability calculus that will calculate the subjective probability that X is the perpetrator of the crime, what does this subjective probability give us? He did or did not commit a crime, and the calculated subjective probability of claiming that he committed a crime is at best a reflection of our subjective attitude towards it. A more correct way is the one used in trials: to complete the argumentation (evidence) to the point where we are sure of his

[15]The history of the concept of probability is nicely presented in the book von Plato [1994].
[16]See for example de Finetti [1970]
[17]See for example Savage [1954]
[18]In Freedman [1995], one can find arguments that give negative answers to these questions.

guilt "beyond all reasonable doubt".

The problems presented above also refer to the subjective probability of an event in a random phenomenon. We have seen that Kolmogorov's probability cannot predict whether an event will occur in a particular realization of a random phenomenon, except in extreme situations when the probability of the event is close to 1 or 0, and when the phenomenon is replicative. However, it can give predictions for a sequence of realizations of such a phenomenon. Subjective probability cannot predict what will happen in a particular case, even when the subjective probability is close to 1 or 0, nor what will happen in a sequence of repetitions of a random phenomenon. Thus, it is inferior to the Kolmogorov probability in predicting the occurrence of an event in a sequence of repetitions of a random phenomenon. In predicting whether an event will occur in a particular realization of a random phenomenon, both interpretations are weak. However, the Kolmogorov probability retains at least some objectivity based on objective knowledge of what happens over a sequence of repetitions and almost certainly gives a correct prediction if the probability is close to 1 or 0. Subjective probability only expresses our attitude towards the occurrence of that event and is not an objective measure of that occurrence, no matter how we calculated it. However, as a subjective measure, it can have a significant impact on our further action.

The calculus of subjective probability is often presented as the logic of reasoning. Classical logic deals with the truth of declarative statements. If in classical logic we have proved a statement X from some assumptions, then we are sure that if the assumptions are true in a certain situation, the statement X will also be true. This has an objective meaning. If we experimentally established that the assumptions are true, we know that X is also true. If we experimentally established that X is not true, then at least some of the assumptions are also not true. Just as classical logic allows us to calculate the truth of the statement X from the truth of the assumptions, so the calculus of subjective probability allows us to calculate the probability of the statement X from the probability of some other statements. However, there is no objective verification here because the subjective probabilities do not say anything about the truth of the statements, but only about our beliefs in their truth.

It follows from the above that the subjective concept of probability is "tempting" because, unlike Kolmogorov's probability, we can apply it everywhere. However, it is not scientifically based because it cannot predict whether a statement is true or not, that is, whether an event will happen or not, or even what its relative frequency is in a sequence of repetitions. It only has a heuristic value that can only subjectively influence our further actions. But even then, even if an expert determines subjective probabilities for a certain area, they must be only one set of parameters used to guide further action. When it comes to situations in which wrong actions can have profound consequences, then additional research should

be done that will almost determine what will happen, and decisions should be made whose correctness we are sure of, based on the acquired knowledge, and not relying on subjective probability, as clearly argued in Bunge [2008]. In short, Kolmogorov's probability is a successful result of mathematical modelling of repeatable random phenomena, while subjective probability is a questionably successful result of mathematical modelling of our beliefs in the truth of statements, and this determines the limits and way of applying these concepts.

The subjective interpretation of probability is the basis of Bayesian statistics. Thus, Bayesian statistics inherits the characteristics of subjective probability. This basis enables it to be applied everywhere, but it also determines that its results have only heuristic and not scientifically based value. The specificity of Bayesian statistics is that it introduces a certain dynamic mechanism on this basis, which has its driver in Bayes' formula.

To state Bayes' formula, we need the notion of conditional probability. For each event A that has a non-zero probability, we can define a new function $P(\quad|A)$ on the events space that assigns a number $P(X|A)$ to each event X:

$$P\left(X|\ A\right) = \frac{P\left(X \cap A\right)}{P\left(A\right)}$$

This function also satisfies the probability axioms and is called the *conditional probability*. In Kolmogorov's interpretation, in a sequence of repetitions we only look at how many times $n_{X\cap A}$ an event X happened in those n_A occurrences when an event A happened. The conditional probability corresponds to the relative frequency

$$P\left(X|\ A\right) \simeq \frac{n_{X\cap A}}{n_A}$$

In Kolmogorov's interpretation, this connection gives the conditional probability the same objectivity as the probabilities of the original probability model. In the subjective interpretation, $P\left(X|A\right)$ determines how confident we are that statement X is true if statement A is true.

Bayes' formula follows from the probability axioms:

$$P\left(H|\ A\right) = \frac{P\left(H\right)}{P\left(A\right)} P\left(A|\ H\right)$$

In Kolmogorov's interpretation, Bayes' formula has a precisely determined objective meaning. In a sequence of repetitions, it connects the relative frequency of an event A under the condition that an event H has occurred with the relative frequency of the event H under the condition that the event A has occurred. The importance of Bayes' formula is that we can determine the probability of an event in a narrower group from knowing the probability of an event in a wider group.

And we have seen how important narrowing of groups (increasing the conditions for a random occurrence) is for predicting what will happen to an individual from the group (what will happen in a particular realization of a random occurrence). As an illustration, let us take the probability of death from vaccination against Covid-19 for a given person. Let H be the event that a person from a certain population will die from vaccination, and let A be that he has certain physical characteristics (vulnerability to certain allergies, advanced age, weak immunity, etc.). If we know for the entire population the probability of death from vaccination $P(H)$, the probability $P(A)$ of physical characteristics A and the probability $P\left(A|H\right)$ that a person had these characteristics if he died from vaccination (all of the above can be experimentally estimated via relative frequencies), then Bayes' formula gives the probability $P\left(H|A\right)$ of death from vaccination for a narrowed group, the part of the population that has characteristics A. By finding additional characteristics of a given person, we can again apply Bayes' formula to find the probability of death from vaccination for a given person compared to an even narrower group. In this way, we not only get probabilities for smaller groups, but we also update probabilities for an individual (a single realization of a random phenomenon). If we thereby get probabilities closer and closer to 1 or 0, then we can practically determine with certainty whether a person will die from vaccination or not. This is the real power of the Bayes' formula (and in general, Bayesian analysis on Bayesian networks).

However, the unlimited application of this formula in the subjective interpretation of probability is precisely what characterizes the philosophical doctrine of *Bayesianism*, while its application in the subjective interpretation of probability to statistics characterizes *Bayesian statistics*. It should be noted right away that it is questionable whether the Bayes' formula can be applied to statements at all because it is derived from Kolmogorov's axioms, for which it is also questionable whether and under what conditions they can be applied to statements. In subjective interpretation H is usually a hypothesis while A is a verifiable fact. Specifically, in Bayesian statistics, H is a hypothesis about some parameter of a random phenomenon or about a model of a random phenomenon, while A is a record from a sample of that random phenomenon or population. Then $P(H)$ is the so-called a priori subjective probability that the hypothesis H is true, while $P\left(H|A\right)$ is the posterior updated subjective probability that H is true after it has been recorded that A is true. In this way, Bayes' formula allows us to update the subjective probability of the truth of H with each new knowledge. However, a new problem arises here: it turns out that this updating is highly dependent on the initial subjective probability. Or in the words of D. A. Freedman [Freedman, 2009, p. xiv]: "to pull a rabbit from a hat, a rabbit must first be placed in the hat." Moreover, it can be seen from the Bayes' formula that with an appropriate choice of a prior probability we can obtain any desired a posterior probability, so "... any reaction to

any experiences can be justified in advance. Thus, Bayesianism implies 'anything goes'…" [Albert, 2003, p. 114]. That is why not only classical statisticians but also Bayesian statisticians warn of the dangerous consequences of irresponsible use of Bayesian statistics. Even when an expert of a field determines the initial probabilities according to his beliefs and revises these probabilities based on new records using the Bayes formula, all the obtained results remain closed in the subjective relationship of the researcher to the phenomenon under investigation. The results have no objective weight, but only a heuristic weight the only meaning is that it can guide the researcher in further research using other methods.

Making conclusions only based on Bayesian analysis with subjective probabilities, and not yet supported by the experience of researchers but by black box algorithms that run on computers for which the user often does not know what exactly they are doing, is simply the generation of nonsense that is sold for correct conclusions. The unbearable lightness of Bayesing consists precisely in the fact that such "science" can be done by anyone in any field, which is very dangerous. That is why Bunge writes: "…if the U.S. Food and Drug Administration and the various agricultural experimental and forestry stations were ever to be dominated by Bayesians, they would become public perils rather than guardians of public health…" [Bunge, 2008, p. 173], and "subjectivism … is a mark of either anti science or pseudoscience. Learned ignorance is still ignorance. In particular, diagnosis with the help of made-up numbers is not safer than without them; and trial by numbers is no more fair than trial by water or by combat. Thou shalt not gamble with life, justice, peace, or truth." [Bunge, 2008, p. 173]. A recent disastrous example of Bayesianism is the scandal in the Netherlands, when between 2013 and 2018, the tax authorities wrongly accused tens of thousands of parents of fraudulently obtaining tax benefits. Some parents had to repay tens of thousands of euros to the state, which pushed many families into a financial and psychological crisis: from loss of housing to divorce. It all started when, in 2013, the tax authority introduced a fraud detection algorithm based on the so-called "risk classification model" that performed a Bayesian analysis with subjective probabilities that included, among other things, racist and ethnic prejudices (Amnesty International [2021]).

The heuristic value of Bayesian analysis with subjective probabilities, to guide us in the search for the correct theoretical model, also has its limits. Hume already showed that we cannot discover a theoretical model (universal laws) by any form of induction based on evidence (Hume's problem of induction), and the Bayesian mechanism tries to do just that.[19] Furthermore, Pierre Duhem (Duhem [1954]) showed already at the beginning of the twentieth century, and Willard Van Or-

[19] "Bayesian rationality is just a complicated restatement of Hume's irrationalism" [Albert, 2003, p. 107]

man Quine (Quine [1951]) later generalized it to a wider context (the so-called Duhem–Quine thesis) that every theoretical model must be seen as a whole. If the model incorrectly predicted a result, then it basically fails as a whole, and that fail cannot be attributed to just one hypothesis in the model. Usually this is followed by "repairing" the model and in the final repair one part is changed, maybe only one hypothesis. Bayesian analysis reduces updating the model to a single hypothesis in advance, and is therefore limited.

The responsible use of Bayesian analysis with subjective probabilities and Bayesian statistics derives from its heuristic value. As with Kolmogorov's models, if we know the limits of applicability of Bayesian analysis, how it can help us and how it cannot, it can be very useful. It should only be clear that due to its subjective nature, it can only play a heuristic role in the search for a theoretical model of a phenomenon, and when it comes to a random phenomenon – the corresponding Kolmogorov model. Combined with other considerations, it can help us find the correct model. But the final test of the correctness of the model is the experimental test – confronting the model with the reality it is trying to describe – and here there is no more room for Bayesian analysis with subjective probabilities.

6 Conclusion

Kolmogorov's concept of probability is the only scientifically based concept of probability. It has clear conditions of its applicability and forms the basis of classical statistics. Bayesian statistics is based on the subjective concept of probability, and as such can only have a heuristic value in searching for the truth, but it cannot and must not replace the truth. The following quote succinctly illustrates the different role of classical and Bayesian statistics: "The FDA , for example, doesn't care about Pfizer's prior opinion of how well it's new drug will work, it wants objective proof. Pfizer, on the other hand, may care very much about its own opinions in planning future drug development." ([Efron, 2005, p. 1]). The way out of the crisis and a new synthesis of statistics as a scientific discipline should take Kolmogorov and Bayesian analysis as elements, each of which has a well-defined and limited use. Only together with qualitative analysis and other types of quantitative analysis, and combined with experiments, they can contribute to reaching correct conclusions. (see e.g. Gelman and Shalizi [2013] and Little [2006]).

References

M. Albert. Bayesian rationality and decision making: A critical review. *Analyse & Kritik*, 25(1):101–117, 2003.

Amnesty International. Xenophobic machines: discrimination through unregulated use of algorithms in the Dutch childcare benefits scandal. Technical report, October 2021.

E. T. Bell. *The Development of Mathematics*. McGraw-Hill, 1945.

M. Bunge. Bayesianism: Science or pseudoscience? *International Review of Victimology*, 15(2):165–178, 2008.

B. de Finetti. *Theory of Probability: A Critical Introductory Treatment*. New York: John Wiley, 1970.

P. M. M. Duhem. *The Aim and Structure of Physical Theory*. Princeton: Princeton University Press, 1954.

B. Efron. Bayesians, frequentists, and scientists. *Journal of the American Statistical Association*, 100(469):1–5, 2005.

D. A. S. Fraser and N. Reid. Crisis in science? Or crisis in statistics! Mixed messages in statistics with impact on science. *Journal of Statistical Research*, 48(1):1 – 9, 2016.

D. A. Freedman. Some issues in the foundation of statistics. *Foundations of Science*, 1(1):19–39, 1995.

D. A. Freedman. On Types of Scientific Inquiry: The Role of Qualitative Reasoning. In *Oxford Handbook of Political Methodology*, pages 300–318. Oxford University Press, 2008.

D. A. Freedman. *Statistical Models and Causal Inference: A Dialogue with the Social Sciences*. Cambridge University Press, 2009.

D. A. Freedman and P. B. Stark. What is the chance of an earthquake? *NATO Science Series IV: Earth and Environmental Sciences*, 32:201–213, 2003.

A. Gelman. Objections to Bayesian statistics. *Bayesian Analysis*, 3(3):445 – 449, 2008.

A. Gelman and C. R. Shalizi. Philosophy and the practice of Bayesian statistics. *British Journal of Mathematical and Statistical Psychology*, 66(1):8–38, 2013.

P. Good and J. Hardin. *Common Errors in Statistics (and How to Avoid Them)*. Wiley, 2012.

G. Gopalakrishna, G. ter Riet, G. Vink, I. Stoop, J. M. Wicherts, and L. M. Bouter. Prevalence of questionable research practices, research misconduct and their potential explanatory factors: A survey among academic researchers in The Netherlands. *PLOS ONE*, 17:1–16, 02 2022.

S. Greenland, S. J. Senn, K. J. Rothman, J. B. Carlin, C. L. Poole, S. N. Goodman, and D. G. Altman. Statistical tests, p values, confidence intervals, and power: a guide to misinterpretations. *European Journal of Epidemiology*, 31:337 – 350, 2016.

J. P. A. Ioannidis. Why most published research findings are false. *PLOS Medicine*, 2:0696–0701, 08 2005.

A. Kolmogorov. *Foundations of the Theory of Probability*. Chelsea Publishing Company, 1956.

R. J. Little. Calibrated Bayes: A Bayes/Frequentist Roadmap. *The American Statistician*, 60:213–223, 2006.

D. G. Mayo. *Statistical Inference as Severe Testing: How to Get Beyond the Statistics Wars*. Cambridge University Press, 2018.

R. Peng. The reproducibility crisis in science: A statistical counterattack. *Significance*, 12:30–32, 06 2015.

K. R. Popper. The propensity interpretation of probability. *British Journal for the Philosophy of Science*, 10(37):25–42, 1959.

M. Purgar, T. Klanjscek, and A. Culina. Quantifying research waste in ecology. *Nature ecology & evolution*, 6(9):1390—1397, September 2022.

W. V. O. Quine. Two dogmas of empiricism. *The Philosophical Review*, 60:20 – 43, 1951.

L. J. Savage. *The Foundations of Statistics*. Wiley Publications in Statistics, 1954.

G. Shafer and V. Vovk. The Sources of Kolmogorov's Grundbegriffe. *Statistical Science*, 21(1):70 – 98, 2006.

R. Von Mises. *Probability, Statistics, and Truth*. Dover Publications, 1957.

J. von Plato. *Creating Modern Probability: Its Mathematics, Physics and Philosophy in Historical Perspective*. Cambridge University Press, 1994.

R. L. Wasserstein and N. A. Lazar. The ASA Statement on p-Values: Context, Process, and Purpose. *The American Statistician*, 70(2):129–133, 2016.

Science & Philosophy Volume 11(1), 2023

On abduction, dualities and reason

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Abstract

We integrate dualistic conceptions of the real with Peirce's perspectives about reality and abduction, emphasizing the concept of reason underlying Peirce's thoughts. Peirce's abduction is related to the notions of retrogression and grounding in Hegel, later re-encountered in Hansonian-abduction. Abduction in turn is considered in relation to abstraction acquiring its fullest sense as a stage in the process of producing a theory. The process is iterative and self improving, it incorporates "turbid thinking" making it increasingly "clear" at successive iterations that incorporate the lessons taught by failed predictions, i.e., refutations. The cycle of thoughts promoted by doubts comes to rest when belief is reached. We discuss how this coming to rest depends on a criterion for cessation of doubts. The observation is illustrated with two criteria, one proposed by Mach that only demands analogy and the criteria of dualists such as Goethe and Whewell that inspire the present work. Hence, it is possible to produce, and socially accept, imperfect theories unless we demand the highest level of rationality, avoiding any leftover of the turbid thoughts that have been used in the early developments. Influenced by a constructivist, Piagetian, perspective of science, we propose and discuss conditions that are characteristic of rational abduction: rules for the rational construction of theories. We close arguing that there is an urgent need to develop a critical epistemology incorporating dualistic perspectives.
Keywords: theory building; rules of reasoning; epistemology[1]

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[1]Received on May 15th, 2023. Accepted on June 21st, 2023. Published on June 30th, 2023. doi: 10.23756/sp.v11i1.1217. ISSN 2282-7757; eISSN 2282-7765. ©The Authors. This paper is published under the CC-BY licence agreement.

1 Introduction

Abduction or retroduction[2] is indissolubly linked to the name of Charles Peirce (1839-1914) who studied scientific thinking from his pragmaticist perspective. Among his influential readings, Peirce indicates Aristotle (Peirce, 1994, CP 1.22 and several other paragraphs) Kant (Peirce, 1994, CP 1.4) and Hegel, about whom he said "My philosophy resuscitates Hegel, though in a strange costume." (Peirce, 1994, CP 1.42). Peirce's works must then be contextualised within the Enlightenment. In [CP 2.191][3], he writes

> *In studying logic, you hope to correct your present ideas of what reasoning is good, what bad. This, of course, must be done by reasoning; and you cannot imagine that it is to be done by your accepting reasonings of mine which do not seem to you to be rational. It must, therefore, be done by means of the bad system of logic which you at present use.*

This is a declaration that conforms with the main requisite of the Enlightenment according to Kant's view of Illustration (Kant, 1783) and somehow reminds us of Wilhelm von Humboldt's view (von Humboldt, 1792 (1854 Printed, p. 20):

> *Whatever man is inclined to, without the free exercise of his own choice, or whatever only implies instruction and guidance, does not enter into his very being, but still remains alien to his true nature, and is, indeed, effected by him, not so much with human agency, as with the mere exactness of mechanical routine.*

Peirce's ideas about the process of grasping what knowledge means is very much exemplified in his own work, which –as much as the work of Aristotle [CP 1.22]– is *evolutionary*. This has been described as successive changes in Peirce's view of abduction (shifting occasionally the name from hypothesis making, to induction, abduction and retroduction; see e.g., (Paavola, 2005)).

Since in Peirce thought is promoted by doubt and comes into a (temporary) rest when belief is reached, we must conclude that Peirce died leaving his work unfinished. Those, like the present authors, that attempt to (somehow) continue his work must be aware of Goethe's dictum (von Goethe, 1906, #556):

> *A man does not need to have seen or experienced everything himself. But if he is to commit himself to another's experiences and his way of putting them, let him consider that he has to do with three things – the object in question and two subjects*

[2] Following Peirce, we use these words interchangeably. See however (Peirce, 1994, CP 1.65).

[3] To avoid extensive repetition, we will often quote Peirce by indicating the paragraph (e.g., [CP 1.65]) in (Peirce, 1994).

Thus, in every continuation of Peirce's thoughts there is something that comes from the reality of knowledge, something that comes from Peirce and something that is provided by the new subjects. There are at least two forms of continuation so far attempted, that have been called "Hansonian and Harmanian abduction" (Paavola, 2006).

Those authors that relate with Peirce by their inclinations as logicians emphasise the early syllogistic approach as in (Redding, 2003), where a correspondence is made among syllogisms in Aristotle, Hegel and Peirce. Authors inclined towards logic relate abduction to the following structure (Peirce, 1994, CP 5.189):

> *The surprising fact, C, is observed; But if A were true, C would be a matter of course, Hence, there is reason to suspect that A is true.*

The reasoning grants the proposal of A the name of *abductive inference*. However, to raise this expression to a definition leaves abduction abandoned to free interpretation. It must be recalled that for Peirce, [CP 2.195],

> *Logic came about for the sake of reasonableness, not reasonableness for the sake of logic.*

This is: the main concern is reason, not logic (as Paavola emphasizes in (Paavola, 2004)). This view directs us towards Hansonian abduction and away from Harman's views.

The adoption of explanatory hypotheses is indissolubly linked to the adoption of beliefs and the cessation of doubt, the latter being the motor of thoughts. Peirce is clear in distinguishing the beliefs he pursues from religious and other common beliefs; he offers three characteristics of them:

> *First, it is something that we are aware of; second, it appeases the irritation of doubt; and, third, it involves the establishment in our nature of a rule of action, or, say for short, a habit. As it appeases the irritation of doubt, which is the motive for thinking, thought relaxes, and comes to rest for a moment when belief is reached. But, since belief is a rule for action, the application of which involves further doubt and further thought, at the same time that it is a stopping-place, it is also a new starting-place for thought. [CP 5.397]*

All these elements are essential to Peirce's notion of belief and as such, none of them can be dropped (not even in didactic examples) when regarding abduction, which is an act of thought. Further, Peirce sustains,

> *Thought [...'s] sole motive, idea, and function is to produce belief, and whatever does not concern that purpose belongs to some other system of relations. [CP 5.396]*

Thought, doubt and belief refer to our inner senses. They are to some degree defined in relation to each other. Abduction or retroduction in Peirce is also a part of scientific thinking. He provides more insight into it:

> *These three kinds of reasoning are Abduction, Induction, and Deduction. Deduction is the only necessary reasoning. It is the reasoning of mathematics. ... Induction is the experimental testing of a theory. The justification of it is that, although the conclusion at any stage of the investigation may be more or less erroneous, yet the further application of the same method must correct the error. The only thing that induction accomplishes is to determine the value of a quantity. It sets out with a theory and it measures the degree of concordance of that theory with fact. It never can originate any idea whatever. No more can deduction. All the ideas of science come to it by the way of Abduction. Abduction consists in studying facts and devising a theory to explain them. Its only justification is that if we are ever to understand things at all, it must be in that way. (Peirce, 1994, CP 5.145) [emphasis added]*

Further, the abduction of hypotheses in Peirce has as sole goal to put the hypotheses to test, and consequently to abandon them the moment they are refuted, continuing with the search for new hypotheses. This reflects in a cyclic or iterative process (Peirce, 1994, CP 7.220) where the subsequent proposal of hypotheses occurs from a different ignorance level: At least we know that all the previous attempts were inappropriate and we know where they first failed in the testing phase. In other words, the abductive reasoning does not "stop" at the first hunch but rather when belief is attained and a new and richer theory is proposed.

Dualism, reason and retroduction Kant's dualistic view about the emergence of knowledge (Kant, 1787):

> *Understanding cannot intuit, and the sensuous faculty cannot think. In no other way than from the united operation of both, can knowledge arise*

was further elaborated by W. Whewell (Whewell, 1858) as the "fundamental dialectic"

> *In all human KNOWLEDGE both Thoughts and Things are concerned. In every part of my knowledge there must be some thing about which I know, and an internal act of me who know... Man is interpreting the phenomena which he sees. He often interprets without being aware that he does so*

and further propagates in time into the views of Piaget and García (Piaget and García, 1982)

> *Un hecho es, siempre, el producto de la composición entre una parte provista por los objetos y otra construida por el sujeto [Original version].*
>
> *A fact is always the product of the composition between one part provided by the objects and another constructed by the subject [Our translation].*

There is no evidence of Peirce being deeply aware of the intervention of the subject in the production of facts. Peirce permanently refers to "observed facts", hence ignoring the participation of the subject in the production of facts alongside what comes from the external senses. We found only an indication of awareness in paragraphs concerning self-consciousness as a result of a clash between an outward and inward motion [CP 8.41]. This absence represents a substantial drawback that needs to be repaired since it is in this process where –according to Piaget and García as well as Husserl (Husserl, 1983)– the process of ideation occurs, this is, where the observed is registered as a fact after (quite often unconscious) rationalisation. The introduction of a dualist vision of knowledge (Solari and Natiello, 2022) makes enough room to incorporate pre-rational elements such as (simple) intuition, habits, epistemological frames, pre-existing theories, phantasy, imagination and in general the elements that participate in the initial production of facts but belong to the subject and not to the object[4].

These pre-rational elements participate along with reason in the process, yet, in the ideal final product where the phases of abduction, deduction and induction as described by Peirce can be identified, the contributions of the "turbid" thoughts have been made transparent by reason, leaving only the distinctive clear thinking. There will be room as well for the flux of error and the iterative refinement of theories.

Little can be gained however if we cannot make somewhat objective what is meant by reason. *Scientific*, for Peirce, means here what really directs us to satisfy the aims of those "to whom nothing seems great but reason" and see nature as "a cosmos, so admirable, that to penetrate to its ways seems to them the only thing that makes life worth living" [CP 1.43]. Thus, reason is essential to science and appears as associated to the making a cosmos from the chaos that reaches our senses.

This will be the focus of the present work. We highlight that reason is a mandatory part of understanding, and that understanding is a name for having a theory

[4]In this sense, (Paavola, 2005) recognises "a clearer change in Peirce's views than from evidential to methodological perspective concerned the role of instinct in abduction."

in which we can believe, recalling that belief in Peirce establishes rules of action. We will advance in the present project producing rules for the control of the rationality in retroduction. For Peirce [CP 5.384] the concept of reality (see Section 4.1.1) is his sole hypothesis, although he claims that "...the method must be such that the ultimate conclusion of every man shall be the same". Putting things together, the current logic of any human should be of such kind as to allow them to improve it and reach an intersubjective level of understanding in all matters concerning reality. Peirce closes his paragraph with

> *Experience of the [scientific] method has not led us to doubt it, but, on the contrary, scientific investigation has had the most wonderful triumphs in the way of settling opinion. These afford the explanation of my not doubting the method or the hypothesis which it supposes; and not having any doubt, nor believing that anybody else whom I could influence has, it would be the merest babble for me to say more about it. If there be anybody with a living doubt upon the subject, let him consider it.*

Peirce's optimistic view is based upon his conception of the scientist. However, much of what is labelled as scientific today does not fully meet Peirce's criteria exposed in "The scientific attitude" [CP 1.43–1.45] but rather what is described in [CP 1.45] as non scientific. Thus, reason is essential to science, and what reason means in the present context needs to be further explained if the confusion that enters our minds through interests in conflict is to be avoided[5] .

We will adopt a constructivist approach influenced by Piaget's work. A reason without consciousness of its own constructive efforts will consider its scientific activity to be the discovering of the laws of the universe, perhaps without noticing that their efforts are pre-formatted by their own rules of reasoning and their own criteria of considering an argument to be correct/convincing/acceptable. Thus, there is a level of meta-scientific criteria that needs to be explored and explained. We owe the idea regarding the existence of rules or norms to Piaget, as Gruber and Vonèche (1995, p. 739) write:

> *Rules or norms are generally considered as dependent on structures in the subject. They do not depend on the structure of physical reality for their validation but are instead entirely determined by a principle of deduction that is not empirical in nature.*

In the coming Sections, we start by connecting abduction and rationality, recalling the views of Hegel and Peirce. Further, we consider the relation of abstraction

[5]We mean the utilitarianism indicated by Peirce in [CP 1.45] as well as the careerism imposed onto academics by governing/administrative bodies (Solari et al., 2016) and the social pressure exerted by the scientific field (Bourdieu, 1999).

and idealisation with the abductive process, as well as the role of analogy. Then we present a few rules for rational retroduction as recognised by our eidetic seeing (the production of ideas by intuition Husserl (1983, Ch. One)), discussing examples in several fields. Finally, we summarise the discussion in Section 5.

2 On Hegel, Peirce and rationality

The mysterious phrase (quoted in the introduction) regarding Hegel's philosophy in relation to Peirce's own philosophy (Peirce, 1994, CP 1.42) deserves some inquire. We read in (Hegel, 2001):

> *(§ 101) ... progress in philosophy is rather a retrogression and a grounding or establishing by means of which we first obtain the result that what we began with is not something merely arbitrarily assumed but is in fact the truth, and also the primary truth.*
>
> *(§ 102) It must be admitted that it is an important consideration −one which will be found in more detail in the logic itself− that the advance is a retreat into the ground, to what is primary and true, on which depends and, in fact, from which originates, that with which the beginning is made.*
>
> *(§ 1707) So far, then, it must be said that cognition, once it has begun, always proceeds from the known to the unknown.*

These ideas correlate with (Peirce, 1994, CP 5.189) (quoted in the introduction) as follows: that "we began with" is C. Thus, progress means to find the A that makes C true and not arbitrarily assumed and that is also grounded to our pre-existing knowledge base. Further, notice the occurrence of "retrogression", the backward motion implied as well in retroduction. Later, Hegel gives precisions when discussing analytic and synthetic cognition:

> *(§ 1720)... Analytic cognition is the first premise of the whole syllogism −the immediate relation of the Notion to the object; identity, therefore, is the determination which it recognises as its own, and analytic cognition is merely the apprehension of what is. Synthetic cognition aims at the comprehension of what is, that is, at grasping the multiplicity of determinations in their unity. It is therefore the second premise of the syllogism in which the diverse as such is related.*

Peirce [CP 4.85] in turn will take (as much as Hegel) synthetic cognition from Kant (1787, p. 37) [6]. Along the development of his ideas, Peirce [CP 2.629]

[6]Notice that because of a difference in translations Peirce adopted "ampliative judgments" while the referenced paragraph says "augmentative judgments".

writes :

> *So, an hypothesis is really a subsumption of a case under a class*

If we consider that the analytic judgment carries no other novelty than making explicit what was already contained in the premises, the progress of science is linked to the synthetic judgment. And, if in addition, abduction is the "only logical operation which introduces any new idea" [CP 5.171], making the intersection of the claims, rational abduction is of the order of "ampliative abduction" (see for example (Aliseda, 2004)).

It is apparent that from Hegel to Peirce the grounding of the hypothesis has been lost or at least it has been de-emphasised. Explanation is not the only goal in Hegel as he wants to remove arbitrariness. An hypothesis which is arbitrary but explains the observed and is not refuted by other implied facts would not achieve the desired elimination of arbitrariness but only a translation of arbitrariness from the fact to the hypothesis. Since arbitrariness is "the quality of being based on chance rather than being planned or based on reason" (Cambridge dictionary) or "existing or coming about seemingly at random or by chance or as a capricious and unreasonable act of will" (Webster dictionary), it appears as a safe measure to request the abductive hypothesis to be rational. A requirement that only puts us at the beginning of a quest: how to determine intersubjectively the reasonability of an hypothesis?

If one is set to understand the "logic of science", which is certainly Peirce's intention, one is obliged to adopt abduction as implying not only the logical rule of [CP 5.189] but the additional requirements for hypotheses to be ampliative and rational. Peirce [CP 7.220] requests of the hypothesis first to "be capable of being subjected to experimental testing" and second it "must be such that it will explain the surprising facts we have before us which it is the whole motive of our inquiry to rationalize". Thus, our observation to Peirce is that rationalisation is not completely achieved by producing an explicative hypothesis, since such an hypothesis may very well be irrational itself.

Hanson (Hanson, 1965) distinguishes three ingredients in the logic of discovery

> *1) proceeds retroductively, from an anomaly to*
>
> *2) the delineation of a kind of explanatory H which*
>
> *3) fits into an organized pattern of concepts*

Thus, Hanson's view recovers the "grounding" present in Hegel but not so evident in Peirce. We will try in the coming sections to move towards the recovery of a self-critical rationality which is the ultimate exercise that allows us to improve our science. In section 4 we propose some minimalistic principles of rationality.

3 On the relation of abstraction and ampliative hypotheses

The word abstraction (from Latin *abstrahere* "to drag away, detach, pull away, divert;") can be read at least in two forms. A first form, procedural, in which we eliminate properties leaving a less determined, more general, idea. This procedure leads to the question: what is then left when all properties are withdrawn? Such thing has been named the "thing-in-itself", a metaphysical entity already criticised by Sartre[7] as devoid of any meaning. The problems with this procedure have been already indicated by Hegel (2001, § 22). A different connection with the etymology is to extract, to pull out from the concrete form, its essence. Consider the first form, stopping before hitting emptiness. Let us say we start with an object and stop with a general idea of the object, an *abstraction* of it. Because of its sub-determination, chances are that other objects, after a similar operation match our abstraction as well. In this way, a relation is established between them: they belong to the same class (the relation is easily shown to be transitive). For example, suppose I am holding a purring thing in my arms and say: this is my cat. The same saying can be used by every cat owner despite all the possible differences among cats. We look now to what we have achieved: to put in relation the singular with the general, the particular with the universal. A particular cat is a cat because it can be put in relation with the abstract (general/universal) idea of cats while the general idea is such because it is something that can be put in relation with all the particular forms of cats. The idea of a cat cannot pre-exist the particular cats from which it is abstracted, but the particular cats are in no form recognised as cats if there is no general idea of them. Thus, in a cognitive sense, the abstract form and the particular realisations are created at the same time. Yet, the unrecognised things exist even if we have not yet recognised them as cats. This is an example of what Solari and Natiello (2018) called "dialectical opening" in which two or more concepts are produced simultaneously because such relation is useful to organise the observable input. In the particular case of abstraction,

[7] *Force, for example, is not a metaphysical conatus of an unknown kind which hides behind its effects (accelerations, deviations, etc.); it is the totality of these effects. Similarly an electric current does not have a secret reverse side; it is nothing but the totality of the physical-chemical actions which manifest it (electrolysis, the incandescence of a carbon filament, the displacement of the needle of a galvanometer, etc.). No one of these actions alone is sufficient to reveal it. But no action indicates anything which is behind itself; it indicates only itself and the total series. The obvious conclusion is that the dualism of being and appearance is no longer entitled to any legal status within philosophy. The appearance refers to the total series of appearances and not to a hidden reality which would drain to itself all the being of the existent. And the appearance for its part is not an inconsistent manifestation of this being. To the extent that men had believed in noumenal realities, they have presented appearance as a pure negative. It was "that which is not being"; it had no other being than that of illusion and error.* (Sartre, 1966, Introduction)

in its more general form corresponds to the dialectic "universal-particular" or the relation between the one and the multiple.

Incidentally, the Meno paradox has been considered in relation to abduction in (Paavola and Hakkarainen, 2005). The paradox is:

> *If you know what you're looking for, inquiry is unnecessary.*
>
> *If you don't know what you're looking for, inquiry is impossible.*
>
> *Therefore, inquiry is either unnecessary or impossible.*
> *(consulted December 14th 2022)*

The dialectical opening means that we create the form (the idea) because in a pragmaticist sense it serves the purpose of organising the observable. The idea is born out of the inquiry itself. The duality does not pre-exist, it is created in a single unitary act and it is justified because of its appropriateness. Dialectical openings dissolve the possibility of applying the paradox since the paradox presuposses the existence of one term before the other.

Abstraction does not explain, it only organises, then abstraction is not abduction despite it being pragmatic as well. At the same time, theories cannot be made with respect to a unique event, the singular. Before deserving further study each experiment must be reproduced, and by reproduction it is understood not an impossible new production in exactly the same conditions (including time, space, personal, apparatus, ...) but rather the production of a new experiment related to the original by an abstract form. It is the abstract form what is reproduced[8].

Establishing this relation represents the essence of abstraction, the abstract form into which other forms of putting in relation can be mapped, as for example *cognitive surpass* (Piaget and García, 1982) (see Section 4).

Abstraction is not performed without guidance, when abstracting we have in consideration some matters of concern that lead our quest. For example, we all know that tigers are cats, but if what is in consideration is the ability of purring, then tigers are not that kind of cats as they do not have this ability because of physiological reasons. Thus, any particular being relates to a multitude of abstract forms.

The dialectic particular-universal pervades science. Every time we "discover" a "regularity" of nature we can say with identical precision that we have established a new abstract form for organising nature.

[8]It is not unusual for experiments to be irreproducible. In such cases what often happens is that the abstract experiment does not completely describe the determining circumstances. Some determining conditions have not been controlled, much less communicated, as they are outside what deserves control in terms of the theoretical background underlying the design and development of the experiment. Then, the theoretical background must be rejected, being considered at least incomplete.

By the name *experience* we usually designate the construction of an abstract form that relates to a finite sequence of events. By the way of abstraction, events known in isolation become particular realisations of the same experience. Thus, experience is in part abstraction. Abstraction enacts the identification of the different. When the abstract form has been established we can ask whether new events correspond to this form or not. In case they do, we can translate to them, caring for their particularities, the results of theories that correspond to the abstract form.

Theories actually relate ideas, abstract forms, and it is this character of abstract what allows us to relate them to new particular events. An explanatory hypothesis introduced to explain only a singular event does not constitute a theory. When we propose hypotheses to explain a unique event but do not establish a belief that rules our future actions, we are not constructing theories, and we are not in the process where scientific retroduction belongs. The ground for advancing hypotheses is prepared by abstraction or must be performed alongside of, or before, abstraction.

But if abstraction is not abduction, and abstraction produces a new idea in our consciousness, how is it possible that abduction is the only creative moment of science? Since abduction and abstraction are synthetic judgments, the right to be called the only creative moment of science corresponds to the synthetic judgment. Have we come back to Kant?

Consider the equation of state of ideal gases,

$$PV = n(kT)$$

where P stands for pressure, V for volume, n number of moles, T is the absolute temperature and k is a constant such that (kT) represents energies. The equation has a clear abstraction since it applies to all diluted gases irrespectively of their chemical nature and the form of the container (at least). All diluted gases map into the same expression, but only in the limit of infinite dilution the expression matches experiments, hence it is an idealisation in the sense of Galileo (Galilei, 1914). Finally, it is a synthetic relation. Each one of the elements introduce ideas into our consciousness and concurrently produce an interesting relation that explains observations. But idealisation is not a synthetic judgment.

Idealisation and abstraction produce indeed new ideas. However, they enter into explanation only through abduction. Thus, thinking in terms of the production of theories (explanations) the abductive step can be synthesised with abstraction and idealisation as they are complementary when the goal is understanding nature.

3.1 Abstraction and analogy

> *Analogy is the inference that a not very large collection of objects which agree in various respects may very likely agree in another re-*

> *spect. For instance, the earth and Mars agree in so many respects that it seems not unlikely they may agree in being inhabited. [CP 1.69]*

Between two similar problems, analogy makes a direct connection. In contrast, abstraction makes indirect connections conditioned to the possibility of producing an universal form which can be particularised in each of the different problems originally perceived as potentially related. In so doing, abstraction opens the possibility of a manifold of connections other than those initially considered, largely enlarging the possibility of performing empirical contrastive comparisons. In the quoted example, if instead of producing the inference we propose a (tentative) abstract form consisting of the class of objects that have the identified set in common (call it *habitable planets*), the route just started leads us into attempting to prove that the characteristics selected to define the class can, by themselves, determine the possibility of life on the planet. If this is the case, the analogy is correct, if not, it is incorrect. The analogy lacks the element of rationality which is present in "clear thinking", this is, abstract thinking, thinking using abstractions.

3.2 Abstraction and phantasy

The English spelling phantasy (Greek: $\phi\alpha\nu\tau\alpha\sigma\acute{\iota}\alpha$, Latin: *imaginatio*) is predominantly associated with "imagination, visionary notion" (Oxford). The Latin etymology of *imaginatio* relates it to *imitare* (to copy). According to Hume (Hume, 2011, p. 7), we think in terms of elements pertaining to imagination which, according to Aristotle (Aristotle, 1907, p. 123, see 3.3–3.15), lies close to both perception (Impressions in Hume) and belief, but not to clear thinking. We further learn from Husserl (1983, Ch. One) that the production of ideas by intuition (eidetic seeing) can be triggered by both the real (observable) world as well as by phantasy. Very much like Aristotle, Husserl reminds us that whatever predicate having to do with "matters of fact" must be grounded on experience ("And thus not even the most insignificant matter-of-fact truth can be deduced from pure eidetic truths *alone*." Husserl (1983, p. 11)).

In short, concerning the study of nature (physics) there are two possible approaches at least since Aristotle: "clear thinking" and "phantasy". The former struggles for being correct while the latter may be correct or not, and its correctness cannot be established without the participation of clear thinking[9].

[9]Notice that the current use of fantasy (modern spelling) does not correspond well with Aristotle's use. Phantasy here does not mean fantasy as in day-dreaming for example but rather imagination as it is praised in [CP 1.46].

3.3 When abstraction was left behind

As the XIX century advanced a new social type irrupted in the scene. By 1833, the words physicist and scientist were coined by W. Whewell, a philosopher of nature (Yeo, 1993). Science became a matter of interest for the State and then, the conditions that according to Kant (Kant, 1798) favoured the development of reason in the minor faculty disappeared for science. The philosopher of nature faded out.

During the second half of the XIX century, two forms of thinking had evolved without a neat distinction, differing in the relation among clear thinking and phantasy. Both of them using the word *idea* but meaning different things with it. The requisites for achieving belief, or the cessation of doubt are expected to be unlike as well. The subtleties of the different meanings may emerge when we push our reasoning to its limits. We call *imaginative thinking* to the form originating in the *Bild* concept (D'Agostino, 2004), where images (often called ideas) were the central tool in developing knowledge, and *abstract thinking* to the form supported by abstraction (cognitive surpass (Piaget and García, 1982, Introduction)).

Abstract thinking requires the development of abilities from within, in the form in which Peirce indicated that our current logic must approve its own improvement. Abstract thinking is then linked to W. von Humboldt's *bildung* (self formation) (Sorkin, 1983). As it comes from within, self formation does not lend itself for massive education. In contrast, always according to Kant, the formation of professionals requires them to master the use of established ideas, to think with their master's ideas. The emphasis at the Prussian universities first, and later in the rest of Europe, changed from bildung into instruction (Helmholtz, 1908, VI On academic freedom in German universities). The focus of higher education becomes not as much clear thinking but rather *certified beliefs*.

The investigation of the influence brought about by the second industrial revolution into science deserves an independent inquire. We will only provide an example here.

An example of the different meanings associated to understanding, coupled with the introduction of auxiliary concepts, comes from mechanics. Newton's mechanics can be introduced to students in several forms. Some will rest upon "absolute space". Einstein (1924) and Boltzmann (1974, p. 102), for example, believed that absolute space was essential to Newton's mechanics. In his treatise of mechanics, Mach (1919) rejected absolute space as nonsense and introduced as reference the fixed stars (whatever they are [10]). In both cases, a first reference for motion allowed the introduction of inertial systems in which Newton's laws were claimed to hold. In abstract terms, "absolute space" refers to any belief that indicates that there is a primordial reference for motion. In this abstract form,

[10] Actually, Newton had considered the proposition and rejected it.

Mach believes in absolute space[11] . Perhaps more importantly, the notion of space connects directly with the intuition of the child who organises relative positions of objects in space using as reference her/himself. Yet, Newton's mechanics is based upon the notion of "absolute motion" which is *not* motion in absolute space and it is rather close to relative motion (Newton, 1687; Thomson, 1884; Solari and Natiello, 2021). Thus, while for a relevant group of physicists the auxiliary notion of space and a first reference for motion are necessary elements for the understanding of classical mechanics, yet, others can understand without those elements or with a suppressible version of space.

Absolute space was defended by Bertrand Russell in his early period as well. Russell (1901, p. 274) writes:

> *En ce qui concerne les nécessités de la pensée, la théorie kantienne semble amener ce résultat curieux, que tout ce qu'on ne peut s'empêcher de croire est faux. Dans le cas actuel, ce qu'on ne peut s'empêcher de croire, c'est quelque chose qui se rapporte à la nature de l'espace, non pas à celle de notre esprit.*

Despite Russell's obfuscation, it is clear that all that we can observe are spatial relations, and from them, we can construct a form of description of these spatial relations in terms of the relations between the intervening bodies and a main body and its surroundings. We owe this representation (in abstract form) to Descartes: the *space*. In the words of Kant:

> *By means of the external sense (a property of the mind), we represent to ourselves objects as without us, and these all in space.(Kant, 1787, p. 51)*

Thus, space is a phantasy: a representation of the real observable in the mind of the observer. By erasing the own body from the perceived scene, the observer idealises (creates) the space out of the observed spatial relations with the intervening bodies (Solari and Natiello, 2018). Space exists only in our minds but relates to the perceived as Aristotle dictates for all phantasies. Space is not real, and it is not entirely imagined either, it contains both nature and some invention as well.

Poincaré (1913, p. 185-186) summarised the situation at the beginning of the XX century:

[11]This is another example on how by considering how a specific idea (or observation) enters in a theory, we can reach insight into its abstract form. Moreover, in this case forms that were perceived to be in opposition become actually two particular realisations of the same abstract form. Such situation is quite common, it can be used for self-criticism: when exposing a criticism of something perceived as belonging to a different perspective than ours, we can ask under which abstract form both perspectives are just different realisations of this form. The abstraction quite often produces a symmetrisation of the opponents, thus removing arbitrariness.

> *Most theorists have a constant predilection for explanations borrowed from physics, mechanics, or dynamics. Some would be satisfied if they could account for all phenomena by the motion of molecules attracting one another according to certain laws. Others are more exact: they would suppress attractions acting at a distance; their molecules would follow rectilinear paths, from which they would only be deviated by impacts. Others again, such as Hertz, suppress the forces as well, but suppose their molecules subjected to geometrical connections analogous, for instance, to those of articulated systems; thus, they wish to reduce dynamics to a kind of kinematics. In a word,* they all wish to bend nature into a certain form, and unless they can do this they cannot be satisfied. *Is Nature flexible enough for this? [Emphasis added]*

Concluding this section, it must be asserted that the desires of Peirce in [CP 5.384] for science to be a method upon which "the ultimate conclusion of every man should be the same" cannot be fully carried out in current scientific practice since the requirements for the cessation of doubt are possibly different for different persons. The fade out of reason (Horkheimer, 1947; Feyerabend, 1987) during the XX century has completely changed the scene.

3.4 Glossary

Before moving on we summarise our use of polysemous words:

- Abstract (verb): The mental activity that produces relations between the multiple particulars and the universal form. It creates the association and produces relations between the particulars.
- Analogy: The inference that objects which agree in various respects agree in another respects. It produces a direct relation between the analogous elements not mediated by an universal form.
- Arbitrary: Not produced by reason. In conflict with reason.
- Critical thinking: The reasoning directed towards the fundaments (as in (Hegel, 2001, § 101)). The discovery of the hidden assumptions that frame our thoughts (epistemic frames, habits, simple intuitions, phantasies, ...) and their subsequent removal or rationalisation, making our thoughts clearer.
- Phantasy/imagination: An idea not firmly grounded in observations but necessary for our thinking. A posteriori they may be grounded, rejected or

remain as phantasies. The negative sense usually associated to them corresponds to: something created by our mind to avoid questioning our theories or fundamental beliefs.

- Reason: The mental faculty which is used in adapting thought or action to some end; the guiding principle of the mind in the process of thinking. Frequently contrasted with will, imagination, passion, etc. (Adapted from the Oxford dictionary).

- Turbid thinking. The construction of ideas by not completely conscious and rational methods such as: simple intuition, habit (usually unconscious), imagination/phantasy, analogy and the dogmatic use of epistemological frames and pre-existing theories.

- Understand: To have a rational theory that explains the matter in question.

4 Science, reality and the rules of rational retroduction

We have illustrated the existence of different approaches to the cessation of doubt, and consequently different *sciences*. They cannot be considered equivalent since one is based in clear thinking while the other resorts to non-rational ingredients. In order to develop a rational retroduction it is mandatory that the very notion of rationality becomes objective and intersubjective. We attempt here a proposal for the objective determination of rationality.

We further notice that for Peirce explanation can be equated to rationalisation as it is evident from the following quotation:

> *I think I have now said enough to show that my theory – that that which makes the need, in science, of an explanation, or in general of any rationalization of any fact, is that without such rationalization the contrary of the fact would be anticipated, so that reason and experience would be at variance, contrary to the purpose of science – [that this theory] is correct, or as nearly so as we can make any theory of the matter at present. (Peirce, 1994, CP 7.201)*

4.1 Science and reality

The task of understanding involved in scientific theories requires some precision on what we mean by reason and the requisites for inference.

4.1.1 The principle of reality

In the first place, we must indicate that the attempt of constructing a cosmos out of sensorial input implies the assumption that there is something real that reaches us through the senses, this is to say, that there are subject and object. While the truth of this statement is debatable, we can consider the dangers involved in accepting or rejecting it. Little damage is done if accepting reality were an error and it turns to be that everything is part of a unique encompassing being. On the contrary, if we were in error when rejecting reality, we would become completely dysfunctional and miss one of the greatest opportunities in life. The principle is addressed in:

> *Such is the method of science. Its fundamental hypothesis, restated in more familiar language, is this: There are Real things, whose characters are entirely independent of our opinions about them; those Reals affect our senses according to regular laws, and, though our sensations are as different as are our relations to the objects, yet, by taking advantage of the laws of perception, we can ascertain by reasoning how things really and truly are; and any man, if he have sufficient experience and he reason enough about it, will be led to the one True conclusion. The new conception here involved is that of Reality.(Peirce, 1955, p. 18)*

Reality in Peirce can be seen as a duality. In front of us we have what is perceivable (observable but not yet "observed") and what is elaborated by ourselves from this input: the ideated or ideal (*facts* in (Piaget and García, 1982)) [12].

The progression of knowledge

A schema for the progression of knowledge is depicted in Figure 1.

According to this schema, to grasp reality we need the sensible world (SW) that we perceive "out there", its ideated or intuited forms or ideal world (IW) which rest within us and a form of correspondence from one world with the other: the phenomenological map, Π, Γ (see Figure 1). We also need to include in reality as a primary element the consciousness of our mental operations as they are not ideas produced by elaboration of input from the senses –they are neither in SW nor in IW– and are not part of the phenomenological map, but rather its producer [13]. In natural science we restrict the study to the development of the relation between IW and SW, something that is not possible if we want to study cognition or

[12] This traditional view goes back at least to Goethe's aphorisms: "Experience is only half of experience" and "Everything factual is already theory".

[13] Thus, reason does not belong to the real world (SW, IW) but rather to an internal world which acquires other sort of reality in self-consciousness.

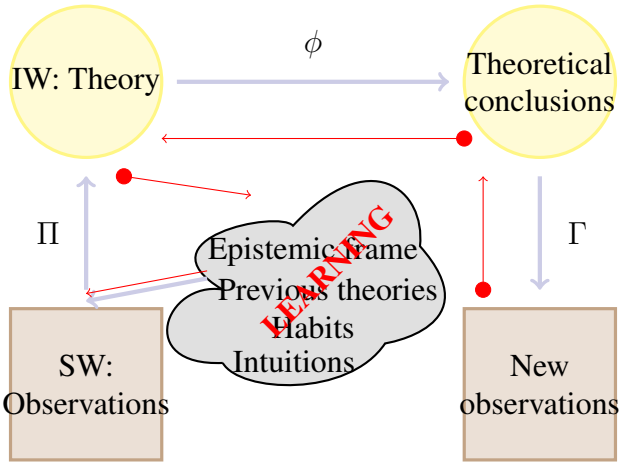

Figure 1: Schema for the progression of knowledge. Π is a projection that produces the real out of the observed, ϕ stands for a theoretical elaboration (which eventually can be empty, in such a case ϕ is the identity Id) and Γ is the interpretation that produces an expected observation. The red circuit indicates the effect of refutations, eventually leading to an improved version of Π .

psychology ignoring self-consciousness. Notice that whatever is in IW, it is not what is sensed, it is clearly not in SW. Hence, we can think of IW as a negation of SW, and the dialogue through the phenomenological map between the two forms of the real constitutes what science is. We have included a cloud of "turbid thinking" in Figure 1. The turbid thinking provides suggestions on how to produce facts and theories from observations. Sooner or later these precursors of the final ideas must be brought to our conscience to be examined and depurated by reason. The situation becomes mandatory when the theory is refuted. The observable events cannot be changed; in contrast, the facts we associated to the observations must be changed. The rational option is not to doubt about reason but rather doubting the pre-rational elements. Out of the process more observations are sought and, hopefully a renewed (more rational) theory emerges. We usually say that we have learned from our mistakes. Finally, ϕ represent theoretical elaborations, basically ruled by mathematical logic.

4.1.2 Scientific reasoning

The casting of science into the forms of dialectics, performed in Section 3, is leaving out an important fact. The ideal world shares a fundamental characteristic with living things: it is self-reproducing, it entails creative production, *poiesis*. We call this reproductive act reasoning, an activity that produces new ideas out

of previous ideas or observations. It is then the poiesis of our conscience what opens up the duality IW/SW. In other words, IW is a result of the dialectic corresponding to the opening Ego-SW, where Ego is the knowing and SW is the knowable. The destiny of IW is then to change permanently, ideas generating experiences and experiences generating ideas. Our beliefs are not stable, and every time we try to see whether they come from the reasoning ego or from SW we end up finding the opponent [14]. This ever changing IW is then part of the dialogue (*becoming* (Hegel, 2001, § 134)) between Ego and SW, accounting in this form for the mixed character of experience and facts. Then, if reasoning is the activity that institutes new ideas in IW, the sensorimotor cognitive activity of children in their earliest times in full contact with SW must be considered as reasoning, since it institutes the idea of self (ego), and alter (not ego), the idea of the permanent (the identity, what remains unchanged through perceived changes) and the transition between states of permanency (change), at the same time they conceive space and time (Piaget, 1999)[15]. These ideas frame all further knowledge. The development of early cognition just presented certainly belongs to IW and was developed by Piaget from hints obtained by the observation of SW. We can then say that it is reasoning what institutes the duality we call reality, and it does so through the sensorimotor activity of the child.[16]

In this sense, abduction is the kind of inference entering the construction of theories in science and not any kind of inference as discussed in Sections 2 and 3. It corresponds to say that, according to the abstract mind, the cognitive activity we call science aims at the production of cognitive surpasses (see a detailed discussion in Section 4.2.3). Consequently we can call *scientific knowledge* to the

[14] Reason casts doubts on observations and observations cast doubts on reasoning. They continually "negate" each other and strive to explain themselves to the other (to agree) to preserve our unity. In this "becoming" they construct reality. Beliefs are held when this becoming rests for a while.

[15] We return to the issue of pairs of opposite concepts in Subsection 4.2.2.

[16] Peirce (1994, CP 8.41) discusses Kant's a-prioris of Space and Time concluding that something of the kind of Will, for which he finds no better word than volition, enters into these sensations. A sense of collision or clash between an inward and outward motion, a "consciousness of duality" or a "duality of consciousness". This duality leads to a critic of Hegel: "The capital error of Hegel which permeates his whole system in every part of it is that he almost altogether ignores the Outward Clash". Peirce writes: "Feeling is simple consciousness" which can be linked to the "simple intuition" in (Husserl, 1983) and the consciousness of the duality to "philosophical intuition" (the "lower and higher consciousness" in Pierce). He recognises as well that "conceptions which are proved to be indispensable in Formal logic, must have been already rooted in the nature of the mind when reasoning first began". A thought in the same direction as Piaget's ideas and well aligned with Hegel (2001, § 4) where "how to think" is put at the same autonomous level than digestion and moving. Thus, as an innate activity with no need for education in logic. All these philosophers appear to present particular expressions of an abstract idea not completely apprehended.

outcome of this activity.

The notion of scientific understanding we have coined contrasts with the notions of assimilation and accommodation. Both these forms of cognition are present in the child's development. The idea of assimilation and accommodation belongs to the family of imitation (Gruber and Vonèche, 1995, Introduction) which is within the same realm as analogical thinking. It is present since early times in life and is in use by the time of the development of abstract thinking, likely a pre-requisite and precursor. Abstract thinking is characterised by the overpassing increasingly present in the adolescent formal thinking[17], since the universal is reached by form of abstraction which is to put the actual as a case of the possible, being then the possible the universal form of the actual.

4.2 On the relation between subjective, intersubjective and objective

4.2.1 The no arbitrariness principle

If we introduce some arbitrary decisions in the scientific discourse (be it for the sake of the argument or with the aim of facilitating an explanation), the set of possible arbitrary elements must have the internal structure of a group[18], being then the set of all possible presentations of the argument a representation of the group and as such all of them equivalent. Further, it is shown that the facilitation of the relational concept of space due to Leibniz produced by the introduction of a privileged observer introduces a (useful) subjective element, the *subjective space* (the space in all elementary physics texts) along with a series of properties of this space as well as conditions that the statements regarding physical laws must satisfy if they are going to remain rational.

[17] *Formal thinking is both thinking about thought (propositional logic is a second-order operational system which operates on propositions whose truth, in turn, depend on class, relational, and numerical operations) and a reversal of relations between what is real and what is possible (the empirically given comes to be inserted as a particular sector of the total set of possible combinations). These are the two characteristics—which up to this point we have tried to describe in the abstract language appropriate to the analysis of reasoning— which are the source of the living responses, always so full of emotion, which the adolescent uses to build his ideals in adapting to society.*(Gruber and Vonèche, 1995, p. 438)

[18] For example: We can say that the relations in the invariant relational space are lifted into relations in the subjective spaces by arbitrary decisions, but since the subjective statements must remain equivalent, there must be a group of transformations, T, that allows us to move from one presentation to the other. If we conceive now a theory as a space of statements, E, relating different concepts belonging to our subjective presentation, what is real in them is only the core that remains when we remove (mod out) the arbitrariness, $D = E/T$, which is the result of identifying statements that only differ by the introduced arbitrariness. Thus, D is invariant while E is equivariant with respect to T.(Solari and Natiello, 2018)

When constructing a theory we have to make an early decision: are we going to introduce arbitrariness or not? The decision has not much relevance if we keep track of the introduced arbitrariness, and acknowledge the necessity of (and the methods for) removing it. However, if we lose consciousness of our constructive effort, we might inadvertently enter into the realm of arbitrariness. No amount of mathematics will take us ever out of the subjectivist cage, since the necessary step is not an analytic/deductive judgment but rather a synthetic/critical one. This is, we need to understand not what the consequences of our beliefs are, but rather which is the foundation of our beliefs.

The rejection of arbitrariness is a condition put on every rational construction (Solari and Natiello, 2018).

Principle 1. [No Arbitrariness Principle (NAP)] *No knowledge of Nature depends on arbitrary decisions.*

A criticism of empiricism A property is a quality proper of something. Whenever there is a property, there is something to which it belongs. If s stands for something and p for property, the basic enunciation is: "s is p". The set of properties, $\mathcal{P}$ is the set of all possible values of p irrespective of the s. It is true that the enunciation "s is" (produced after elimination of all the properties) is meaningless, an argument that is found in Carnap (1959, The significance of a sentence), but it only indicates that the search for the essence by depriving the object of its attributes is the wrong path. In the same form in which we admit a set of properties, we are forced to admit the set of objects constituted by all those things, $\mathcal{S}$, pointed by s in statements of the type "s is p", regardless of the property p. Doing otherwise is an instance of arbitrariness, since –as already discussed– the universal of something is nothing but the set of all particular forms of the matter/object under consideration[19]. It is important to notice that here as well as in Sartre, the metaphysical (and Kantian) "thing-in-itself", the noumenon, is eliminated as in Mach and Carnap, but the abstract in Sartre survives.

The elements in S bear all of them in common an undeniable property which cannot be suppressed, a essential property in the words of Mach: all members of S can be used in statements of the form "s is p" for some well selected $p \in \mathcal{P}$. The set of well selected properties regarding an object s, call them $\mathcal{P}_s \subseteq \mathcal{P}$ is the bundle of properties associated to the object in Mach. Reciprocally, the intersection of all $s \in \mathcal{S}$ having the property p is the only possible indication of the property. It then entails the same risks to admit the existence of $\mathcal{P}$ than the admission of the existence of $\mathcal{S}$, we must admit both or none of them, for otherwise we incur in arbitrariness. Mach restricts these considerations to regard

[19] A similar discussion is found in (Sartre, 1966, p. 3), see footnote 7.

observable objects, which is mere willingness and not a logical demand, for if it were true, we could never speak of the properties of mathematical objects such as vector spaces or numbers. In conclusion, the fact that the search for the essence in Mach's method fails does not mean that there is no essence, it only means what it shows: the search cannot reach the target, it is an inadequate searching method. Having failed to grasp the universal, Mach is then forced to pick one of the particulars (the "simplest one" in the words of Hertz) and to think in terms of it extending the results obtained to the whole class by invocation of analogy[20]. There is then no abolishment of metaphysics but rather what is abolished are higher levels of abstraction at the cost of introducing subjectiveness.

[20]It is interesting to compare the present view with Mach's position in (Mach, 2012, The economical nature of physical inquiry). We read:

> *Nature exists once only. Our schematic mental imitation alone produces like events. Only in the mind, therefore, does the mutual dependence of certain features exist.*
>
> *Let us endeavor now to summarise the results of our survey. In the economical schematism of science lie both its strength and its weakness. Facts are always represented at a sacrifice of completeness and never with greater precision than fits the needs of the moment. The incongruence between thought and experience, therefore, will continue to subsist as long as the two pursue their course side by side; but it will be continually diminished. In reality, the point involved is always the completion of some partial experience; the derivation of one portion of a phenomenon from some other. In this act our ideas must be based directly upon sensations. We call this measuring.*

In Mach "schematic mental imitation" corresponds to the role of abstraction, now exercised by blurred images. Rather than decorative detail or particularities, what is sacrificed –according to Mach– is completeness. This action in Mach parallels the action of Π. The restitution of the particulars that corresponds to Γ becomes in Mach "the derivation of one portion of a phenomenon from some other", which requires analogy and imagination. Thus, the central difference is Mach's relying on "imitation" as opposed to our relying on abstraction. Mach (2012, The principle of comparison in physics) explains:

> *The adoption of a theory, however, always involves a danger. For a theory puts in the place of a fact A in thought, always a different, but simpler and more familiar fact B, which in some relations can mentally represent A, but for the very reason that it is different, in other relations cannot represent it. If now, as may readily happen, sufficient care is not exercised, the most fruitful theory may, in special circumstances, become a downright obstacle to inquiry.*

Mach will soon name the substitution described as "analogy".

4.2.2 The mediation principle and the dialectical openings to understanding

Dialectical openings Our discussion of the construction of science is based upon the repeated action of synthetic cognition (Hegel, 2001, §1720).

This consideration takes as given the multiplicity of determinations, the observable. It then underplays the fact that in order to perceive as multiple what can be clearly argued that is different, we need to disregard some part of what is determined in each element of the multiple. The creation of concepts that do not refer to previous understanding but rather are inter-defined (usually, just two concepts indicating the ideal and opposing extremes of a perceived difference), is called a *dialectical opening* (Solari and Natiello, 2018, Note 4). Abstraction, the grasping of something as a particular case of an universal ideal and the synthesis of the particulars in universals is a dialectical opening. However, not all openings are abstractions. The opening that recognises an Ego and an external world (SW) is more complex. When we recognise ourselves and at the same time that "there is something out there" whose action reaches us through the external senses, we become conscious of SW and create a dual of it, IW, our ideas of the world which lie in our consciousness alongside of the idea of self, this is, self-consciousness. At this point our road begins to depart from Hegel[21], as he addressed not IW but rather self-consciousness. The basic dialectical opening of natural science corresponds to the creation of the duality (SW, IW). However, the most striking form of dialectical opening is the one performed by the child conceiving space and time (see Section 4.1.2). This operation requires that there is a something (name it relative position with respect to ego, or position in space) that is not permanent, that is a non-permanent property of the object. Further, if there are non-permanent matters, the idea of non-permanent becomes the idea of change, later *time*. Any attempt to explain one element in the dualities ego-alter, permanence-change calls for the other term, any attempt to explain position requires an idea of time, and an idea of object. Thus, the elements of the descriptions are interdependent, they have been constructed by idealising (taking to extremes) perceived differences and all of them together open the possibility of organising what reaches our senses. A dialectical opening institutes the terms that make possible to organise the idealised world and with it the sensorial world, it makes understanding possible.

Notice that dialectical openings operate on the basis of perceived differences which are ideated into complementary options within their universe of application. Being complementary, both of them are the Universe minus its complement: the negation of each other. We emphasise that the differences are perceived, they belong to SW. Notice further, that the frequently encountered duality essence-appearance is not a dialectic opening when the essence is thought of as the *noumen*. In such a case, it leaves all the perceived as appearance, as opposed

[21] Hegel addresses self-consciousness in his first book, The phenomenology of spirit.

to a metaphysical entity: the essence, the "thing-in-itself". In this sense, dialectical openings realise the elimination of metaphysics as the Vienna Circle sought, but preserve the abstract with a necessary nexus to the observable. But if we say: "the essence of a key is to open doors" we are constructing a valid duality where essence corresponds to "function" (relation with other objects) and we are leaving its material form in the appearance.

Mediation principle We do not usually accept as reasonable that which appears out of nothingness as self-evident assertions. We normally request a new rational belief to be derived (mediated) by acceptable argumentation from accepted beliefs. This recurrent form of reasoning cannot be pursued indefinitely. It comes to an end when we reach a point in which beliefs can no longer be derived from other accepted beliefs. At this point there seems to be only one option: Either we make explicit a layer of arbitrary assumptions (axioms) which is the opaque end that reason lets us see, or we find a set of opposing concepts and ideas that in their interplay constitute the foundation of our discussion; the dialectical openings.

Axiomatisation turns natural science into exact science, physics into mathematics, by removing the links between IW and SW. However, a purely abstract science is void. Instead of pushing physics into the exact sciences we must consider mathematics as a natural science, being the fundamental elements of mathematics the idealisation of quantitative relations in the observable world, which are always in relation to qualities (Usó-Doménech et al., 2022). Thus, projecting out the quality in SW we obtain the quantity. The operation requests us to conceive the dialectical opening quality-quantity along which we make the projection.

4.2.3 Cognitive surpass

The introduction of explanatory hypothesis, the process of abduction, is subject to the control of rationality and to the condition that the newly introduced hypothesis explains a class of problems larger than the one that motivated it, this is, that the hypothesis bears some of the main ingredients of *cognitive surpass* (Piaget and García, 1982) and offers itself more openly to refutation. However, the requisites for the acceptance of explanatory hypotheses (i.e., to be able to stand in front of refutation attempts) say little about the method of production.

4.2.4 The continuity principle (reduction to the obvious/evident)

Argumentations are constructed in such a way that they rest upon small units we consider evident or obvious. Yet, what is obvious or evident for some, may not be so for others. One of the forms in which we usually identify potentially irrational arguments is by detecting hiatus or *lacunæ* in the argumentation. The

request "please fill in the gap" quite often reveals a belief that cannot be supported, while being necessary for the argument. On the contrary, the rational argumentation proceeds to fill the gaps by explaining how they consist of the concatenation of smaller pieces, iterating the process until the pieces are accepted as evident or obvious. This self-similar form corresponds to what in mathematics is called *continuity.*

4.2.5 Logical action in front of contradictions

Whenever a chain of deductive reasoning arrives to a contradiction, the whole chain is rejected. When the contradiction results from comparing theoretical prediction and experimental reality we speak of experimental refutation. The logical scheme can be depicted as $A \Rightarrow [\text{consequences}] \Rightarrow B$ and B evaluates to $False$. No matter how pleasant the intermediate consequences are, there is no support for them. The most evident example is the hypothesis of the ether which is fundamental for the proposition of Maxwell's displacement field. Discarding the existence of the ether (following empirical evidence) under the present principle would mean the refutation of the hypothesis as well as its consequences. Yet, in general $A = a_1 \& \ldots \& a_n$, i.e., A may be a composite statement consisting of different parts. Only the hypothesis and consequences involved in the deduction of B are necessarily affected by the falsity of B. Thus, part of the theory survives and only part needs to be constructed under new hypotheses.

There is another instance of the same logical scheme which is not usually considered, namely when the contradiction stems from the logical structure of the theory (e.g., inconsistent postulates). Assume A is True, then $-A$ is False. The construction $A \Rightarrow [\text{consequences}] \Rightarrow (-A)$ discloses an internal contradiction of the theory and, as above, it forces us to reject the full chain.

Again, it is worth to realise that a refuted theory may require only some minor repair since usually A is a composite statement. It is enough for one of its terms to be wrong for the theory to be refuted. Refutation does not mean "throw away all your thoughts".

4.2.6 Example: demarcation of a non-scientific belief

Let us show how the requisites proposed in this Section change our perception of what is acceptable as scientific and what is not. Suppose we have a belief, T such as "All swans are white", and we have a form of determining what a swan is without considering its colour, call it A; we have that $T \& A \Rightarrow A \& W$, meaning that if we believe the theory it "explains" that the swan I am observing is white. The most immediate reason why such a belief is to be called non scientific is

that has not been explicitly linked to observations, thus, we cannot recognise the construction of a theory, which is, at the end, what is to be subject to appraisal.

Let us now give reasons for our belief: we have been observing fowl during ten years at a lake nearby our home. In these years of observations we have recognised N swans (mostly by their neck, beak and swimming, say) and the totality of them were white. Call these observations O and we have conjectured T out of O, this is our basic theory. Would now our belief be scientific (given the fundaments)? Our observation consists of a triple: a statistics, a place and a time frame. The theory T is produced by projecting out place and time frame. In order to confront the theory with new data we have to produce statistics in other places and time frames. Let us check the requirements of rationality. The initial violation of the mediation principle has been repaired in our second attempt. Is there continuity? What allows us to go from the observed into the idealised theory? As we shall presently see, the answer is: a rudimentary version of probability theory.

Actually, we have no support to disregard the alternative explanation that the observed fact occurs only in the lake we observe or in some lakes or period of time, all doubts that tell us that our theory is not under a firm ground. We may restrict the theory to our lake and the observed period of time. During that period other bird-watchers might have collected data as well. In this case, statistics would allow no more than establishing a bound, p^*, on the probability, p, of detecting an individual not being white in the experimental situation we are exploring. Let $P(p; N)$ be the probability of observing non-white swans in N trials. Hence, for a null observation record, given P we can estimate p^* as the solution of the equation $P(p^*, N) = \frac{1}{2}$. For all $p < p^*$ it is more likely not to observe a non-white swan in N trials than observing it. Hence, the observations only allow us to say that having *not* observed a non-white swan is not just bad luck but rather what it is expected for such a probability p. But then, why have we chosen $p = 0$ in our theory T? We meet arbitrariness once again. With the sole support of statistics we cannot make such a bold theory. We would have to make then a third version of the theory which changes our belief for something in terms of probabilities, which eventually will cast doubts about the quality of our statistics: Do we have bias in our sampling?

The example shows how we proceed from an initial belief, a hunch, critically searching for its fundaments using some of the rules for reasoning that are not (at least in this presentation) formal logic. The lesson gained from the observation of white swans in some place and period of time is: If things do not change too much since I made my observations, I am likely to encounter only white swans at that place next time. This suggests ways to improve the theory through further enquiry: I might suspect genetic similarities among the swans and also its counterpart: That there may be more genetic diversity in swans at other locations (or different epochs of time, but changing location is feasible while moving to "another time" is not).

The "hunch" and its criticism trigger a research programme by putting together other knowledge and the awareness of the limitations of my observations. This generates an ampliative hypothesis to investigate.

4.2.7 Example: the principle of relativity

Most physicists, including us, accept the principle of relativity as correct. Why is it so? While Einstein does not offer any argument (Einstein, 1905), Poincaré does (Poincaré, 1913, Ch. VII), when he states:

> *The movement of any system whatever ought to obey the same laws, whether it is referred to fixed axes or to the movable axes which are implied in uniform motion in a straight line. This is the principle of relative motion; it is imposed upon us for two reasons: the commonest experiment confirms it; the consideration of the contrary hypothesis is singularly repugnant to the mind.*

Poincaré comes to no better argument after several pages dwelling in Newton's mechanics as it was taught at his time (based upon absolute space). No search in the realm of mechanics will serve the purpose of finding the foundations of the principle after Newton's axioms. The foundations are to be found behind them, a matter Newton did not discuss at large. Moreover, the little he did discuss was misunderstood, such as the notion of "true motion" which was shadowed and finally replaced by the notion of "motion in absolute space" which is not in Newton (Solari and Natiello, 2021).

The idea of the relativity principle as proposed by Poincaré and others under various names (such as "symmetry principle" (Mach, 1919)) is a belief coming from the habit instructed to physicists by the teaching of Newton's mechanics. Observational inferences such as "All swans are white" can be put to experimental test (and in this case proved wrong by e.g., displaying black swans from Australia or black-necked swans from South America). On the contrary, the relativity principle is not observational. To assess its truth value we must seek its foundation in the demands of reasoning. The principle can be regarded as a special case of the no arbitrariness principle (NAP) since it states that any choice of reference frame within the class of "admissible systems" is as good as any other. To pick a system is an arbitrary decision, then arbitrary decisions should be transparent for the laws of physics. For Newton's laws of dynamics this amounts to the Galilean group of transformations that relate positions and velocities as recorded by any (inertial) system without altering the physical laws (Newton's equations). The transformations must form a group since the composition of valid transformations is required to be another valid transformation.

At those times, the issue was how to merge electrodynamics with the principle of relativity. Maxwell's equations were known to obey a symmetry with respect to Lorentz transformations. Hence, it appeared as Lorentz transformations were the needed connection between admissible systems. It is interesting to examine the argument in (Einstein, 1940):

> *The so-called special or restricted relativity theory is based on the fact that Maxwell equations (and thus the law of propagation of light in empty space) are converted in equations of the same form when they undergo Lorentz transformations. This formal property of Maxwell's equations is supplemented by our fairly secure empirical knowledge that the laws of physics are the same with respect to all inertial systems. This leads to the result that the Lorentz' transformations – applied to space and time coordinates– must govern the transition from one inertial system to any other.*

In the first place, the conclusion is not deducible from the premises. Secondly, the Lorentz transformations (LT) do not form a group, since the associative law fails [22]. The Lie algebra associated to the group of Poincaré-Lorentz symmetries has dimension six and what is needed has dimension three. [23]

Third, there is nothing such as "...empirical knowledge that the laws of physics are the same with respect to all inertial systems". Inertial systems, as well as the laws of physics, are abstract concepts. The invariance of natural laws with respect to the choice of inertial system is a matter of reason and of habitus. Einstein refers to the habitus developed when studying Newtonian mechanics where the concept of "inertial system" was originated. What belongs to the habitus and what to the empirical knowledge was in any case clearer for Poincaré than for Einstein.

The student in physics and the learned physicist know about Galilean transformations in the context of Newton's laws. They can legitimately ask: why this symmetry must be the symmetry of space instead of some other set of symmetries? What textbooks fail to indicate in this respect is that Newton aimed at describing relative motion, an aim that the facilitation of Newtonian physics forgot. Relative

[22] This observation already indicates that LT's cannot connect different inertial systems, since such connections are automorphisms of the inertial systems and as such must form a group (this is today an elementary theorem in Category theory).

[23] A defender of relativity would argue that the three group generators not considered correspond to rotations. This is true in abstract terms, but the necessary correspondence with rotations in the sensible world is not present. The rotations correspond to $L(-(u \oplus v)) \circ (L(u) \circ L(v))$ (Gilmore, 1974, p. 503), where $\oplus$ stands for Einstein's addition of velocities and $L(u)$ is a Lorentz transformation based on the velocity u. To imagine in our minds the consecutive application of three Lorentz transformations does not enact the rotation of physical objects. There is no correspondence between actually rotating a given object and the rotation group regarded as a subgroup of the Poincaré-Lorentz group.

motion relates to the SW in a direct form, it is real in the terms presented here. If, in order to facilitate mathematical expressions, we introduce a Cartesian frame (space), the reference point of the frame can be changed almost arbitrarily with time (provided we satisfy proper continuity conditions) and this is done without altering the relative motion (let us call this group the *inertial group*). It is this set of transformations what matters to the representation of the observable-real. A subgroup of this group corresponds to Galilean transformations, that preserve as well the form of Newtons equations. Thus, any transformation aiming at replacing Galilean transformations must be a subgroup of the inertial group, or otherwise it must present the form in which the new space relates to the observable making room for the replacement transformations proposed. Educated habits play a fundamental role in this matter. We teach in physics to represent motion by a graph, this is, we create a pedagogical space (not a movie) called space-time: $\mathcal{R}^{1+1}$. This opens for mistaking time with a second spatial coordinate. Indeed, if the student is asked to represent a trajectory of constant speed going from (x_0, t_0) to (x_1, t_1) they will efficiently draw a straight line. However, if we ask: which was the distance travelled by the represented body? they might answer $d = |x_1 - x_0|$ more likely than coming to realise that there is not enough information to answer the question. Notice that in any other representation (y, t) with $y = x + z(t)$ the answer would become $d' = |x_1 - x_0 + z(t_1) - z(t_0)|$ depending on the arbitrary election of frame used for the representation (d actually corresponds to the change in the relative position between body and origin of coordinates, it is not a property of the body). The information in space-time is not enough to reconstruct distances and relative positions. Space-time is subjective, it depends on the observer, it is not directly linked to SW but rather it is the result of intuitions cemented by the teaching of physics.

Being such the case, there is a possibility for other rules of reasoning being broken by Special Relativity. The exploration points to the meaning of the velocity in a Lorentz transformation. First, the meaning of velocities in the context of Electromagnetic theory changed from "relative velocities" in experiments, to velocities relative to the ether later and finally to velocities with respect to a reference frame. Such changes are a signal of trouble in itself (Assis, 1994). It is not possible to connect any observable, objective, velocity to provide meaning to the velocity involved in a Lorentz transformation (Solari and Natiello, 2022). This matter puts us in front of the dilemma: either Special Relativity is imperfect or we have to abandon the hopes for science to be based only in observations and reasoning. Historically, the second alternative was taken.

Indeed, Einstein advocates that there is no abstraction (or any other relation) between observations and the theories at the time of production (Einstein, 1936), they arise by free invention and are validated by their results. The failure to recognise this problem originates in the suppression of abstraction:

> *An adherent to the theory of abstraction or induction might call our layers "degrees of abstraction"; but, I do not consider it justifiable to veil the logical independence of the concept from the sense experiences. The relation is not analogous to that of soup to beef but rather of wardrobe number to overcoat. (Einstein, 1936)*

Einstein gives "logical independence" to the concept from its conception originated in our sense-experiences. Adopting "free invention" implies to break the connections with nature, to have purely abstract concepts, detached from their conceptualisation. Science would then no longer be a matter of understanding nature, but rather a sort of game. In Einstein (1936) words:

> *It is an outcome of faith that nature – as she is perceptible to our five senses– takes the character of such a well formulated puzzle.*

4.3 The "marvellous self-correcting property of Reason"

Laudan (1981, p. 188) has stated that

> *No one was able to suggest plausible rules for modifying earlier theories in the face of new evidence so as to produce demonstrably superior replacements*

in support of his general idea that Peirce's "Self-corrective thesis" (Laudan, 1981, Chapter 14) cannot be demonstrated. He claims further that (Laudan, 1981, p. 239):

> *Peirce, in short, gives no persuasive arguments to establish that qualitative induction is either strongly or weakly self-corrective. [...] What the facts do not show, of course, is how the hypothesis is to be altered so as to bring it closer to the truth.*

Laudan's criticism to Peirce is rather a criticism to Laudan's own interpretation of Peirce. Indeed, Peirce writes

> *So it appears that this marvellous self-correcting property of Reason, which Hegel made so much of, belongs to every sort of science, although it appears as essential, intrinsic, and inevitable only in the highest type of reasoning, which is induction. (Peirce, 1994, CP 5.579) [the part quoted by Laudan is highlighted, and Laudan's sentence finishes with: 'and every branch of scientific inquiry exhibits "the vital power of self-correction".(Peirce, 1994, CP 5.582)']*

Laudan's selective quotation left behind a number of fundamental ingredients, criticising thereafter a weaker version of self-correction rather than Peirce's developed concept. It is not clear whether Laudan restricts science to the science recognised as such by Peirce [CP 1.43–1.45] or not.

The connection with *all* reason, with logic [CP 2.191] and with Hegel are missing, the latter being important to grasp abstraction, cognitive surpass and the grounding of hypotheses (see 2). Further, Laudan focuses his criticism in a version of inductive reasoning isolated from other reasoning processes, hence disregarding the "vital power" of reason as a unity. In all, the possibility of learning from our mistakes and improving on them with the aid of reason is degraded, if not neglected.

The self-correcting property belongs to reason and it is inherited by science only as much as science inherits reason. In this Section we highlight the existence of "rules of reasoning" restricting science in the same form in which Peirce did. Along this work, we have shown how the concept of abstraction can be made a little bit more abstract (Section 3), i.e., offering a closer focus on the essence/nature of the concept, and how this abstraction immediately opens the possibility of showing e.g., that Mach's relationism is actually a secular form of absolute space. We have improved the "Relativity principle" by showing that in terms of clear thinking it is not a separate principle but a particular application of the, more demanding, No-arbitrariness-principle. We have further shown how one classical example of Inference to the best explanation can be polished by making it rational according to the given rules (Section 4.2.6).

In short, when the production of true beliefs as a process, science, and logic are regarded –inspired in Peirce's ideas– as particular expressions of reason following a few identified rules, the "self-correcting property of Reason" can hardly be denied.

4.4 Multiple abstract projections and the case of science

The idealisation or abstraction of an observed phenomena is performed with the aim of organising our view of it, linking the new facts to pre-existing matters in our understanding. Such operation is motivated by the need of answering questions regarding the phenomena. Thus, both the questions being posed and the pre-existing knowledge suggest which features of the phenomena carry the potential for *explanation* (providing an answer to the questions) and which do not. This process is followed by logical elaboration and interpretation that provides the opportunity for contrasting the ideal with the observed, and, in case of refutation it triggers a new attempt at producing understanding. The process is directed by the posed questions, and as such, different idealisations are possible for different sets of questions. The observable real is then crossed by several idealisations,

each one can be said to correspond to a *dimension* of the phenomena. The associated projections on IW characterising these aspects are in principle considered independent of each other, something that will later be modified by synthetic judgment, that confronts the alleged independence. Let us illustrate this process with the idea of "science as it is practised".

The notions of science so far discussed correspond to an ideal, flawless functioning, science. The practice of science develops in a society which is part of a civilizational movement, thus there is a science idealised in terms of its relation to the society at large. Science is practised by human beings that constitute a particular field of symbolic production (Bourdieu, 1999). Thus, we easily find three different dimensions in the consideration of science.

From the point of view of society in general the goals of science are often related to the production of goods and practices that enhance well being. Central to well being is techno-science, geared towards the production of new goods, enhancing comfort and capabilities. Techno-science frequently adopts the criteria proper of technology and focuses on predictive success. The quality of this science is hence rooted in prediction. If something *works*, this is taken as support for it being *correct*. The foundation of scientific theories is subordinated to their success capabilities. In the schema of Figure 1, the focus is on Γ.

In addition, science is requested to guide some important decisions. For example, decisions in matters of global warming, epidemics, nuclear energy safety, human environmental impact and the extinction of species. In such endeavours, the contrastive comparison of the predictions is not possible. This aspect has been called "science in the post-normal age" (Funtowicz and Ravetz, 1993; Waltner-Toews et al., 2020). Such practice is forced to root its quality in the elements Π, ϕ of Figure 1, since Γ is not available.

The most traditional perspective is that of science as the search for harmony and understanding. All three elements Π, ϕ, Γ are then equally important and they cooperate (e.g., via auto-correction) to enhance understanding.

Thus, differences in epistemology are to be expected in correspondence with the demand put on science by society at large.

This situation is a constant source of misunderstanding. It may be argued that the "correct" relation between theory and observation is the one reflecting the current practices of the community of scientists, as if the practices of scientists were not conditioned by the necessity of justifying science in front of the supporting society (society at large, governments, granting institutions, etc.) or were not conditioned by the need to conform to established practices of their scientific social field. There have been attempts at explaining science as a practice directed towards the acquisition of knowledge in terms of features of the social structure of the field, such as competition for resources and social respect. A third source of misunderstanding is to believe that what has been observed for science in some

age (say after World War II) can be used to explain the development of science in another age (e.g., before the second industrial revolution). To consider science as "that which is analogous to what is currently observable" is to operate against the process of abstraction, which, as Piaget taught us, is geared toward the discovery of the possible as opposite to the given. It should then be considered a political act of conservatism that deprive us of ideals and the exercising thoughts directed towards the search of the foundations: the critical thinking.

5 Final thoughts

The idea in Peirce that it is possible to agree about the real depends on the criteria for the cessation of doubt and the admissibility criteria for hypotheses. We have shown that there are different criteria in use for both actions and as a consequence we are not reaching truth but rather opinion. If (the pragmaticist's) Truth is to be achieved, clear thinking must take the ultimate word above the turbid thinking that leads to opinion. The restoration of critical thinking requires the rejection of arbitrariness and the recovering of a rationality that goes beyond the instrumental reason. The arc of the construction leads then to investigate reason in its objective form rescuing the role of abstraction, indicating it as a pre-requisite for rational abduction.

In Section 3.3 we discuss how spatial relations link to a deeper abstraction level than the traditional notion of space, by discussing Ernst Mach as a representative of empiricism. In several respects, Mach is simply unable to understand Newton and/or the relational space; he needs a first reference of position and motion, and he boldly sustains the "fixed stars" as such reference when confronted with more abstract ideas such as those of Lange. However, space is only a production of the child, made out of spatial relations and the suppression of her/himself from the total picture. In an early stage of development we fail to perceive us as one arbitrary particular of a universal, we fail to produce abstraction. Spatial relations are real, their observable form corresponds to relative positions of objects, space is only a convenient form of representing them. The idea that space does not exist as such, which is clear in Kant and later in Piaget, simply obfuscates a great mind such as a young (30 years old) Bertrand Russell. Actually, the idea that the form in which we ordered the observable in our early infancy might not be the universal form for understanding appears as inconceivable to some minds. To sustain physics on the phantasy of a space that is no longer linked to completely observable events, rather than on the observable spatial relations, "simply" requires more phantasy: things that are unobservable except for their alleged consequences, the observable facts. We have already been warned by Faraday that what began by being a conjecture too often becomes a belief just by habituation:

> *But it is always safe and philosophic to distinguish, as much as is in our power, fact from theory; the experience of past ages is sufficient to show us the wisdom of such a course; and considering the constant tendency of the mind to rest on an assumption, and, when it answers every present purpose, to forget that it is an assumption, we ought to remember that it, in such cases, becomes a prejudice, and inevitably interferes, more or less, with a clear-sighted judgment. (Faraday, 1844, p. 285)*

Is it possible for a science based upon reason and experience to recovered the lost track? How is rational retroduction different from other forms of inference? We discussed some characteristics of rational abduction/retroduction in Section 4. We have made an effort to produce a few rules of rational thinking, and showed how they help to construct more solid beliefs. We hope it is just the beginning of a collective task long overdue, and that other scientists and philosophers will contribute their own rules. In front of us rises the most formidable task: to rethink the possibilities of humanity and the life on Earth. To believe that the same science that gave us the menace of nuclear destruction, global warming and an accelerated extinction of species will give us the means to avoid catastrophe is only the characteristic insistence of the dogmatic. Critical thinking, a critical philosophical attitude and critical science are urgently needed alongside techno-science.

If we drop the requirement for explanations to be rational, we can then include elements of turbid thinking as explanations, for example, we may accept to stop doubting when we have an analogy. It is not the formal part of abduction – the logic in abduction– what changes but rather its quality. Once rationality has been removed from hypothesis making and from theory testing, we preclude clear thinking from taking us back into reason.

What we call rational retroduction is not merely a reasoning step, but rather the integrated process of generating abductive hypotheses grounded in reason and in previous knowledge while accepting them tentatively only after all efforts to refute them have failed. The rules of reasoning summarise the guidance given by reason when attempting to improve theories. We present a dialectical view of abstraction, contesting Mach's criticism. If making abstractions is a necessity for understanding, abstraction cannot be rejected.

Acknowledgements

We thank Alejandro Romero Fernández, Olimpia Lombardi and Federico Holik for valuable discussions.

Declarations

- Funding: MAN acknowledges a grant from Kungliga Fysiografiska Sällskapet.
- Conflicts of interest/Competing interests: On behalf of all authors, the corresponding author states that there is no conflict of interest.
- Availability of data and material: not applicable
- Code availability: not applicable

References

A. Aliseda. Logics in scientific discovery. *Foundations of Science*, 9(3):339–363, sep 2004. ISSN 1572-8471. URL https://doi.org/10.1023/B:FODA.0000042847.62285.81.

Aristotle. *De Anima*. Cambridge at the University Press, 1907.

A. Assis. Weber's electrodynamics. In *Weber's Electrodynamics*, volume 66 of *FundaMental theorfes of physics*. Springer, 1994. ISBN 978-94-017-3670-1.

L. Boltzmann. *Theoretical physics and philosophical problems: selected writings*, volume 5 of *Vienna Circle Collection*. D. Teidel Publishing Company, 1974. Translations from the German by Paul Foulkes.

P. Bourdieu. The specificity of the scientific field and the social conditions of the progress of reason. In M. Biagioli, editor, *The Science Studies Reader*, chapter 3, pages 31–50. Routledge, New York, 1999. Translated from an original in French (1975) by Richard Nice.

R. Carnap. The elimination of metaphysics through logical analysis. chapter 3, pages 60–81. The Free Press, Glencoe, Illinois, 1959.

S. D'Agostino. The bild conception of physical theory: Helmholtz, hertz, and schrödinger. *Physics in Perspective*, 6(4):372–389, 2004.

A. Einstein. On the electrodynamics of moving bodies. *Annalen der Physik*, 17 (891):50, 1905.

A. Einstein. Über den Äther. *Verhandlungen der Schweizerischen Naturforschenden Gesellschaft*, 105(2):85–93, 1924. URL http://www.askingwhy.org/blog/speeches-of-einstein-and-schrodinger/concerning-the-aether-einstein/. English translation.

A. Einstein. Physics and reality. *Journal of the Franklin Institute*, 221 (3):349–382, 1936. ISSN 0016-0032. doi: https://doi.org/10.1016/S0016-0032(36)91047-5. URL https://www.sciencedirect.com/science/article/pii/S0016003236910475.

A. Einstein. Considerations concerning the fundaments of theoretical physics. *Science*, 91(2369):487–492, 1940.

M. Faraday. *Experimentl Researches in Electricity (Vol II)*. Richard Taylor and William Francis, 1844.

P. Feyerabend. *Farewell to reason*. Verso, 1987.

S. O. Funtowicz and J. R. Ravetz. Science for the post-normal age. *Futures*, 25 (7):739–755, 1993.

G. Galilei. *Dialogs concernig Two New Sciences*. The Macmillan Company, 1914. Translated by H. Crew and A de Salvio.

R. Gilmore. *Lie Groups, Lie Algebras, and Some of Their Applications*. Wiley, New York, 1974.

H. E. Gruber and J. J. Vonèche. *The essential Piaget*. Jason Aonson Inc., 1995.

N. R. Hanson. Notes toward a logic of discovery. In R. J. Bernstein, editor, *Perspectives on Peirce; critical essays on Charles Sanders Peirce*. Yale University Press, New Haven, USA, 1965.

G. F. Hegel. *Science of Logic*. Blackmask Online, 2001. URL http://www.inkwells.org/index_htm_files/hegel.pdf.

H. v. Helmholtz. *Popular lectures on scientific subjects. (Second series)*. Longmans, Green and Co., 1908. Translated by Edmund Atkinson.

M. Horkheimer. *Eclipse of Reason*. Oxford University Press, 1947.

D. Hume. *A treatise of human nature*, volume I. Oxford, 2011.

E. Husserl. *Ideas Pertaining to a Pure Phenomenology and to a Phenomenological Philosophy. First book.* Martinus Nijhoff Publishers, 1983. Translator F. Kersten.

I. Kant. What is illustration? Berlinischen Monatsschrift, Dicember 1783. URL http://www.columbia.edu/acis/ets/CCREAD/etscc/kant.html. Translated by Mary C. Smith.

I. Kant. *The Critique of Pure Reason*. An Electronic Classics Series Publication, 1787. translated by J. M. D. Meiklejohn.

I. Kant. The conflict of the faculties (the contest of the faculties). Der Streit der Fakultäten. Hans Reiss, ed., Kant: Political Writings, 2d ed. (Cambridge: Cambridge University Press, 1991), 1798. URL `la.utexas.edu/users/hcleaver/330T/350kPEEKantConflictFacNarrow.pdf`.

L. Laudan. *Science and hypothesis*, volume 19 of *The University of Western Ontario series in the philosophy of science*. 1981.

E. Mach. *The Science of Mechanics. A Critical and Historical Account of its Development*. The open court publishing co., Chicago and London, 1919. Translated by Thomas J McKormack.

E. Mach. *Popular Scientific Lectures*. Project Guthemberg, 2012.

I. Newton. *Philosophiæ naturalis principia mathematica ("Mathematical principles of natural philosophy")*. London, 1687. Consulted: Motte translation (1723) published by Daniel Adee publisher (1846). And the Motte translation revised by Florian Cajori (1934) published by Univ of California Press (1999).

S. Paavola. Abduction as a logic and methodology of discovery: The importance of strategies. *Foundations of Science*, 9(3):267–283, 2004.

S. Paavola. Peircean abduction: instinct or inference? *Semiotica*, 2005(153): 131–154, 2005.

S. Paavola. Hansonian and harmanian abduction as models of discovery. *International Studies in the Philosophy of Science*, 20(01):93–108, 2006.

S. Paavola and K. Hakkarainen. Three abductive solutions to the meno paradox–with instinct, inference, and distributed cognition. *Studies in Philosophy and Education*, 24(3):235–253, 2005.

C. Peirce. *The Philosophical Writings of Peirce*. Dover Publications, 1955. Selected and edited by Justus Buchler.

C. Peirce. Collected papers of charles sanders peirce. Charlottesville, Va. : InteLex Corporation,, electronic edition edition, 1994.

J. Piaget. *The Construction Of Reality In The Child*. International Library of Psychology. Routledge, 1999. ISBN 0415210003,9780415210003.

J. Piaget and R. García. *Psicogénesis e historia de la ciencia*. Siglo xxi, 1982.

H. Poincaré. *Science and Hypothesis*. The science press, project gutenberg ebook edition, 1913. URL http://www.gutenberg.org/ebooks/37157. Translated by W.J.Greenstreet.

P. Redding. Hegel and peircean abduction. *European Journal of Philosophy*, 11 (3):295–313, 2003.

B. Russell. L'idée d'ordre et la position absolue dans l'espace et le temps. In *Bibliothèque du Congrès International de Philosophie*, volume 3, pages 241–277, 1901.

J.-P. Sartre. *Being and Nothingness*. Washington Square, New York, 1966. Translated by Hazel E Barnes.

H. G. Solari and M. Natiello. Science, dualities and the fenomenological map. *Foundations of Science*, 2022. URL https://doi.org/10.1007/s10699-022-09850-4.

H. G. Solari and M. A. Natiello. A constructivist view of newton's mechanics. *Foundations of Science*, 24:307, 2018. URL https://doi.org/10.1007/s10699-018-9573-z.

H. G. Solari and M. A. Natiello. On the relation of free bodies, inertial sets and arbitrariness. *Science & Philosophy*, 9(2):7–26, 2021. ISSN 2282-7757, eISSN 2282-7765. URL http://eiris.it/ojs/index.php/scienceandphilosophy/article/view/669/851.

H. G. Solari, M. A. Natiello, A. Romero, and O. Lombardi. La ciencia administrada. *Sociología y tecnociencia*, 2(6), 2016. URL http://sociologia.palencia.uva.es/revista/index.php/sociologiaytecnociencia/article/view/135.

D. Sorkin. Wilhelm von humboldt: The theory and practice of self-formation (bildung), 1791-1810. *Journal of the History of Ideas*, 44(1):55–73, 1983.

J. Thomson. On the law of inertia; the principle of chronometry; and the principle of absolute clinural rest, and of absolute rotation. *Proceedings of the Royal Society of Edinburgh*, 12:568–578, 1884.

J. Usó-Doménech, J. A. Nescolarde-Selva, and H. Gash. Dialectical hegelian logic and physical quantity and quality. *Foundations of Science*, 27:555–572, 2022. doi: https://doi.org/10.1007/s10699-021-09790-5.

J. von Goethe. *The maxims and reflections of Goethe*. The MacMillean Company, 1906. URL `http://www.archive.org/details/maximsreflection00goethrich`.

W. von Humboldt. *The Sphere and Duties of Government (the Limits of State Action)*. The online library of liberty, 1792 (1854 Printed). URL `http://oll.libertyfund.org/EBooks/Humboldt_0053.pdf`.

D. Waltner-Toews, A. Biggeri, B. De Marchi, S. Funtowicz, M. Giampietro, M. O'Connor, J. R. Ravetz, A. Saltelli, and J. P. van der Sluijs. Post-normal pandemics: why covid-19 requires a new approach to science. *Recenti progressi in medicina*, 111(4):202–204, 2020.

W. Whewell. *The history of scientific ideas*, volume 1. JW Parker, 1858. Third Edition.

R. Yeo. *Defining science: William Whewell, natural knowledge and public debate in early Victorian Britain*. Ideas in context. Cambridge University Press, 1993.

Science & Philosophy Volume 11(1), 2023

New Thermodynamics: Pictet, Epistemology and Philosophy

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Abstract

Pictet's experiment was front and center in the 18th/19th century debate concerning whether heat is a wave, or a particle. Pictet's experiment is best understood by realizing that thermal radiation energy plays a significant role in heat transfer. It is argued that this readily ignored experiment should have long ago alerted us to issues concerning our understanding of thermodynamics. This questions the rationale behind modern statistical thermodynamics, which describes all of a gaseous system's energy purely in terms of the kinematics of that system's gas. Not only is the philosophy of statistical mechanics now questioned but so too are those associated with entropy and its mathematical accomplice the second law. After raising questions, a simpler explanation as to what is witnessed will be discussed. An explanation that relegates statistical mechanics to a valid approximation for sufficiently dilute closed systems of gas, such as those often used in experiments. An explanation that remains void of the mathematical simplifications that statistical mechanics provides. Ultimately, the accepted epistemology of our sciences will be verbally challenged.

Keywords: Pictet's experiment, Radiative heat transfer, Wave-particle duality, Statistical thermodynamics, Entropy, Second law. **

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**Received on December 28, 2022. Accepted on June 21, 2023, Published on June 30, 2023. doi:10.23756/sp.v11i1.1037. ©K.W.Mayhew. This paper is published under the CC-BY licence agreement.

1. Introduction

The fine line between scientific theory and philosophy is often a matter of social importance and time. The concept of radiant heat (radiative energy transfer) originates with the legend of Archimedes focusing the Sun's rays onto invading ships, thus allegedly destroying the Roman fleet. Although founded in such illustrious history, our understanding of radiative heat and its transfer remains problematic.

The term "radiant heat" was envisioned by Swiss chemist C.H. Scheele, with the understanding that it adheres to the same laws as rays of light. [1] This was based on experiments performed in the last quarter of the 18th century, which demonstrated that radiant heat transfer differs from both convection and conduction [2]. The debate arose as to whether heat is a fire-like element called "phlogiston" (followed by "caloric") or is it a wave (undulation) i.e., similar to light.

The above predates wave-particle duality conceptualizations that are now accepted throughout physics, e.g., quantum physics. Note that conduction has been coined "kinematic heat transfer" [3] to clearly separate it from "radiative heat transfer".

Standing in the sunlight, one witnesses the warmth of radiant heat. Our Sun's rays that penetrate through our atmosphere are predominantly in the visible spectrum. That being the part of our Sun's blackbody spectrum that tends to be partially reflected and partially absorbed (as heat) by most matter.

In Marc-Auguste Pictet's (1752-1825) experiment, two concave metallic mirrors (9" dia.) were placed 10 ft apart. They faced each other, [2] as shown in Fig.1. A hot (or cold) object is placed at mirror 1's focal point, while a thermometer is placed at mirror 2's focal point.

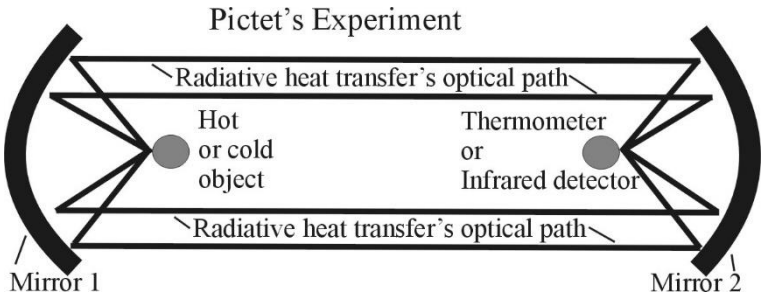

Fig. 1: Shows Pictet's experiment of placing two mirrors such that Mirror 1's focal point is towards an object (hot or cold) and Mirror 2's focal point is towards a thermometer (or infrared detector).

Radiated heat from hot objects causes the thermometer's temperature to increase. Conversely, the placement of cold objects resulted in the decrease of

the thermometer's temperature. This sparked research for "frigorific rays" those being cold particles. This also led to Pictet's colleague, Pierre Prevost writing in 1791: "Memoire sur l-equilibrium du feu". That being a description of heat transfer as some two-way transfer of particles.

Due to the reflections to a focal point, a contemporary interpretation should consider that the heat transfer in Pictet's experiments involves heat transfer behaving as waves rather than particles. Note that for both the hot and cold object's placement, the mirror's temperature remained constant [2].

A modern version of Pictet's experiment has been described using an infrared detector in place of the thermometer [1]. The flux of infrared radiation increased when a hot item was placed at mirror 1's focal point. Conversely, the flux of infrared radiation decreased when cold ice was placed at the mirror 1's focal point [1]. Confirming that:

- Infrared radiant heat obeys optical laws of propagation.
- Changes to infrared radiation is what was witnessed.
- Infrared radiation is associated with radiative heat transfer and temperature.

There is nothing revolutionary about the above points. However, accepting the statistical thermodynamic principle that all of a gas' thermal energy can be defined solely in terms of the gas molecule's kinematics, has just become troublesome. Obviously, both heat transfer and temperature change have a radiative component that is not properly described in statistical thermodynamics, which limits all of a system's energy to its kinematics.

We shall return to statistical thermodynamics, but before we do let us discuss two enshrined concepts based upon statistical paradigms.

2. Entropy

Entropy-founded arguments are too readily accepted. This is especially troublesome when one considers all its various definitions, each lacking full intelligibility. Entropy (S) signifies the disorder within a system. Its definitions include, "randomness of matter in incessant motion" [4], "the dispersal of a system's molecular energy" [5], "S is a measure of the quality of that energy; low entropy implies higher quality, while high entropy implies lower quality" [6].

Intermolecular collisions do result in the dispersal of gas. Is this an entropy increase, or, is it simply a dispersal of those gas molecules? Entropy remains a mathematical construct first described by Clausius and eventually emboldened in statistical mechanics. Yet it remains a contrivance [7],[8] without any real tangible philosophy.

Various discussions concerning entropy can be found. The Standford Encyclopedia of Philosophy points out that "Even in phenomenological

thermodynamics, the definition of thermodynamic entropy is difficult " (first written 2009). The encyclopedia also discusses that entropy is the arrow time, processes all move from order to disorder etc. This has led to claims of pessimism such as the inevitable "thermal death" of either our planet or the universe. Such asymmetry of time concepts become embedded in entropy and its change. Embedded in the thermodynamic parameter (*S*) that remains void of any verbal clarity.

Philosophical debate concerning entropy tends to focus upon the notion of disorder and its representation as the arrow of time [9]. This author agrees with Ben-Naim that the concept of randomness is an arbitrary concept, with the description of randomness laying in the eyes of the beholder [10],[11]. Hence, randomness as a concept is not particularly scientific.

A reason entropy (both Clausius's and Boltzmann's) has been embraced is it enables logarithmic functionality. This endowment is required throughout thermodynamics. This author has pointed out that logarithmic functions in thermodynamics generally concern rates. For two systems in thermal contact, the rate of heat transfer decreases as the temperatures of two system's approach each other [7]. For two systems in physical contact, the rate that one system can perform work upon another, decreases as the two system's pressures approach one another [7].

Furthermore, entropy-based equations and their differential shuffling lend themselves to free energies, as used in physical chemistry. Other, simpler explanations for free energies exist, please see [12]. Their relations to physical chemistry should be reconsidered by those involved.

Due to Shannon's endeavors, entropy has transitioned from thermodynamics to information theory. When Shannon asked what to call his measure of information, Von Neumann famously answered "You should call it entropy, for two reasons. In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important, no one really knows what entropy really is, so in a debate you will always have the advantage" [13]. The term entropy is now shared because they share a similar mathematical structure.

3. The Second Law

Pictet's experiments could be claimed as proof that heat transfer is from hot to cold, with the accepted reasoning being the second law i.e., entropy always increases. This also lends itself to arguments such as all higher quantum microstates of a hotter body are already filled and cannot be raised by lower

energy photons from some lower energy body [14]. Such arguments ignore radiative heat transfer.

Second law challenges exist [15],[16]. Recent defiance considers the Meissner Effect in superconductivity [17]. These all dare the wisdom of Arthur Eddington's famous statement (1915): "The law that entropy always increases holds, I think, the supreme position among the laws of Nature" [18]. A bold statement in light of entropy's ambiguity.

Based on lost work ($W_{lost}=PdV$) being energy lost by an expanding system into the surrounding atmosphere, this author has challenged the second law at its most fundamental level [7]. Our atmosphere has mass, therefore any expanding system must lift that mass. This results in a potential energy increase of the overlying atmosphere [19]-[23]. Any work involved in lifting that mass is forever lost by that expanding system [7],[22].

The second law is also used to explain why perpetual motion cannot exist. Lost work, friction (both internal and external, e.g., drag) [7],[19]-[23], along with the inherent inefficiency of using expanding gases to power devices [19], is often all that is necessary to understand our reality. Lost work also helps one understand why thermodynamic processes are irreversible and differentiates the magnitudes for the latent heat of vaporization from condensation [7].

Although enshrined in our epistemology, any concept of the second law being theoretically validated is superficial. As Daniel Sheehan wrote, "the second law of thermodynamics is an empirical law. It has no fully satisfactory theoretical proof. This being the case, its absolute validity depends upon its continued experimental verification in all thermodynamic regimes." [24]. Have we been measuring inefficiencies due to lost work, friction and/or the inherent inefficiencies of powering devices with expanding gases, and incorrectly attributing it all to the second law's mathematical enormity?

The currently accepted philosophies concerning the second law parallel those discussed concerning entropy in Section 2.

4. Statistical Thermodynamics

Statistical mechanics relies upon probabilities. This has led to many philosophizing the true meaning of its probabilistic assertions. Due to its thermodynamic ramifications, one often loses sight of the possibility that probabilities may only be a grand method for approximation.

Statistical thermodynamics expresses all of a gas' energy in terms of its kinematics (gas' translational, rotational and vibrational energies). Yet, Pictet's experiment clearly demonstrates a significant temperature change resulting from radiative heat transfer.

The total energy associated with photons dispersed between gas molecules tends to be minute in comparison to the total energy of a gas' kinematics. Thus,

in terms of a gaseous system's total energy there is validity in approximating the system's total energy by its kinematics [25], i.e., statistic mechanics.

Photons travel at the speed of light, thus although having a minute total energy, the importance of radiative heat transfer cannot simply be ignored. This queries statistical mechanics as some universally applicable justification.

Statistical thermodynamics is founded upon unquestionable brilliant math envisioned by a combination of Boltzmann and Maxwell. Like Clausius, Boltzmann wanted to show that entropy always increases, while Maxwell was more concerned with atomic theory.

Accepted statistical mechanics is enshrined in assumptions [7],[26], e.g.:

- The colliding molecules/atoms can be treated as point particles.
- The velocities of such colliding point particles are not correlated.
- Their velocities are independent of both their position and origins.
- The point particle collisions are elastic.

Such assumptions enable mathematical simplification. The fact that gas molecules are not some dimensionless point, raises concern. Is statistical thermodynamics an abstraction or clarification of reality?

Consider that molecular collisions are inelastic. Inelastic collisions imply that other forms of energy reside in gaseous systems, e.g., radiative energy (photons). The mathematics required to describe a gaseous system where both gas molecules and photons scatter/interact with each other, would be horrendously complex (perhaps untenable).

From its outset, statistical thermodynamics has remained oblivious to both radiative heat and photons transferring energy into matter. Again, Pictet's experiment clearly shows the importance of radiative heat transfer.

Without its assumptions the simplification that statistical thermodynamics provides, fails. Why does statistical thermodynamics not falter on a more regular basis? Again, statistical thermodynamics provides a good approximation when describing a gaseous system's total energy. Its validity depends upon:

- How closely a gas approximates dimensionless points particles.
- The gas' kinematic energies must be significantly greater than that associated with surrounding photons (radiation).
- Gas-wall molecule collisions dominate the interactions in the system, e.g., sufficiently-dilute closed gaseous systems [20],[25].

It should be emphasized that:

- Theoretically: Elastic collisions enable one to express all of a gaseous system's energy solely (and forever) in terms of its gas molecule's kinematics.
- Mathematically: Elastic collisions enables a two-particle distribution function to be reduced to a product of one-particle distributions.

Up to this point the reader has been enlightened concerning why Pictet's experiments challenge the very foundations of accepted thermodynamics. Let us enhance our new understandings.

5. Inelastic, Illusion and Blackbody Radiation

We have discussed that statistical thermodynamics is valid as an approximation for sufficiently-dilute closed gaseous systems, e.g., most experimental systems. Those being systems where the "illusion of elastic collisions" exists. Our reality is that collisions (molecular and otherwise) tend to be inelastic. Conservation of energy tells us that inelastic molecular collisions (both inter and intra) result in the creation of photons, [7],[20],[25].

An ensemble of such inelastic molecular (and/or atomic) collisions will result in a spectrum of radiation. Often a blackbody spectrum, as defined by the Stefan-Boltzmann equation. The illusion exists because the spectrum's photons are either reflected or absorbed by the closed system's walls. The reflected photons simply return inwards back towards the gas molecules.

The energy of the absorbed photons adds to the wall's vibrational energy, thus increasing the wall's temperature. In thermal equilibrium, this energy is eventually returned back into the gas through gas-wall molecular collisions, or through the colliding wall molecules emitting blackbody radiation [7],[25].

This challenges accepted doctrine, which considers blackbody radiation as residing inside a Jean's cube. That being a box with a hole in it, through which observers can witness any blackbody radiation within. The implication being that blackbody radiation resides in closed systems surrounded by crystalline walls. Strangely, all sufficiently warm objects (enclosed or otherwise) emit blackbody radiation. This includes everything from a rat in a field to our glorious Sun. Complex explanations for this can be had. Are they necessary?

What is the mechanism by which collisions generate photons? At this point, one can only speculate. Perhaps, it has to do with distortions of electron clouds around molecules/atoms. Perhaps, it is something else. Whatever the final conclusion, one should accept that collisions tend to be inelastic.

6. Wave-particle duality and Thermal Photons

It is accepted that infrared photons behave as waves, hence interact with lopsided charge distributions in gases. This is the basis of infrared spectrometry where the absorption of discrete frequencies is well-known. Such discreteness enables infrared spectrometers to identify gases.

Photons possess a particle-wave duality. Acting as a particle, one only has to consider the photo-electric effect, photons pushing some solar sail through outer space, or even the pressure exerted by a photon gas [27]. It has been

pointed out that infrared photons acting as particles increase one's understanding of radiative heat transfer [7], [25].

As a particle, a photon's momentum/energy is absorbed by matter (both condensed and gaseous). These absorbed photons are "thermal photons", those being photons that become part of the absorbing matter's vibrational energy [7],[25]. This signifies an infinitesimal temperature increase within that matter.

Thermal photons universality helps one to understand matter's heat capacities. Specifically, the heat capacities of gases are more dependent upon the number of atoms in a specific gas molecule [28],[29] than that gas' charge distribution [7], [25]. Similar principles apply to the heat capacities of condensed matter. Accordingly, thermal photons better explain the empirically measured heat capacities of all matter, then lopsided charge distribution (photons acting as waves) ever could.

Blackbody radiation emitted by matter is countered by the absorption of thermal photons. This enables thermal equilibrium to exist both in terms of thermal radiation and kinematics of matter. Without this, the concept of thermal equilibrium approaches nonsensical, i.e., matter emitting but not absorbing radiation is too one-sided. One might argue that matter radiates energy while absorbing kinematic energy. Then ask them to imagine equilibrium of matter in a vacuum, radiating while not absorbing.

Therefore, in thermal equilibrium matter:

- Radiates radiation (often blackbody) [25].
- Absorbs thermal photons [25].
- Pass energy onto its surrounding matter via molecular collisions.
- Absorbs energy from its surrounding matter via molecular collisions.

Understandably the first two points concern radiative heat transfer, while the last two concern kinematic heat transfer (conduction, if one prefers). Convection also distributes heat by the flow of matter.

Consider kinematic heat transfer. Higher temperatures imply greater vibrational energies within matter (condensed or polyatomic gas). Therefore, hotter matter has a greater ability to pass kinematic energy onto objects in thermal contact, than colder matter. Again, there is no need for the over-complications associated with expressing the directional heat transfer in terms of entropy, or its change.

If the hotter matter is condensed while the colliding objects are gas molecules, then the condensed matter (e.g., system walls) will tend to impose their kinematics upon the gas molecules. This is similar to the mechanism described by this author in his new improved kinetic theory, where the larger structured wall molecules impose their kinematics upon the smaller gas molecules. In this author's new kinetic theory, the resultant equations are a superior fit to known empirical findings for all heat capacities of gases, when compared to the accepted equations of traditional kinetic theory [28],[29]. Note

that traditional kinetic theory is founded upon degrees of freedom, that now arguably becomes mathematical conjecture.

7. Infrared Spectrometry Blunder

In infrared spectrometry one evacuates the system, then measures its blackbody radiation. The gas in question is inserted and measurements are taken. The initially measured blackbody radiation is automatically subtracted, creating the final output spectrum. This innocuous act has led enabled confusion in the sciences.

Accept that blackbody radiation is created and absorbed by any polyatomic gases within a spectrometer. When in thermal equilibrium the gas' absorbed radiation energy equals the gas' radiated energy. The gas is also in equilibrium with the spectrometer's walls. This means that the system's walls and gas molecules are all absorbing and radiating a similar blackbody spectrum, i.e., related to the same temperature. Remember this spectrum is one associated with photons acting as particles.

Obviously, the blackbody spectrum that was subtracted thus creating the final output. This often being the subtraction of both the spectrometer's and the gas' radiative heat signatures. That being their interactions with photons behaving as particles. Accordingly, the spectrometer's final output only concerns photons acting as waves.

Another way of viewing this is that the sciences have incorrectly been treating the blackbody radiation as if it is not part of a gas' energetics. However, in thermal equilibrium it is the gas's thermal radiative signature [7], [25].

Is this a theoretical, or philosophical mistake? Whatever the answer. One understands that statistical thermodynamics mathematically places all a gases energy upon its kinematics. Thus, by the time one is taught how to use a spectrometer, he/she is not even considering the existence of thermal photons, yet their interactions with gases.

The infrared spectrometer blunder is not the subtraction of the blackbody spectrum. Rather, it is not fully comprehending what one is subtracting. Imagine that the blackbody radiation was not subtracted. Then all resulting spectrums of all gases would be dominated by their temperature defined blackbody spectrum. In which case their similarity would prevent one from determining what gases are present.

The real blunder is thinking that the resultant spectrum shows which gases absorb infrared photons and which gases do not. This will make more sense after reading Section 11 (Radiative Heat and Allmendinger).

8. Probabilities

If statistical thermodynamics is challenged, then what of its probability-based foundations? Interestingly in 1894 Planck wrote [30]: "It is completely unfounded, simply to assume that changes in Nature always proceed in the direction of lesser to greater probability."

Although Planck inevitably altered his position. The debate as to what degree probabilities govern the universe may need a rethink. Furthermore, whether or not quantum mechanics is actually a complete theory actually is still debated into the 21st century. This includes EPR (Einstein, Podolsky and Rosen) arguments [31].

Interestingly this author has realized that the probability of a molecule evaporating in a boiling process should consider the likelihood that a molecule obtains sufficient energy from all of its neighboring molecules, at some instance. This is contrary to the accepted Boltzmann factor-based probabilities, which only considers the act of obtaining energy from a solitary neighbor. The energy exchanged (kT, k being Boltzmann constant) from a solitary neighbor being more than several times too small when compared to the energy required for vaporization.

This does not remove probabilities from the sciences but it only questions how one writes and theorizes them [32]. Again, a valid mathematical approximation or something else. Herein, [33] probabilities are briefly discussed by this author. A major issue being that when using functions like Boltzmann's factor, one could use the wrong energy function and still be able to normalize it to match one's empirical findings. Such is both the power and weakness of using logarithmic functions.

9. Quick Discussion

Again, by showing the true importance of radiative energy, Pictet's experiment strikes at the very heart of accepted thermodynamics.

Consider the incorrect yet accepted notion that a vacuum has no temperature. A vacuum's temperature is not readily definable in statistical mechanics, simply because there are no gas molecules/atoms to define. However, if one places a thermometer in a vacuum, one measures a temperature. If the blackbody radiation is isotropic, then mathematically a vacuum's temperature can be clearly defined by taking the fourth root of the Stefan-Boltzmann's equation. This applies to systems that are vast enough that a thermometer's thermal energy does not alter one's temperature measurement.

Note that issues do arise when measuring temperatures in systems dominated by anisotropic radiation, e.g., upper atmospheric measurements [34].

For emphasis, consider one standing on the moon. No lunar atmosphere means no kinematic energies, hence statistical thermodynamics physics does not apply. Yet, the dark side of the moon it is too cold, while on the bright side it is too hot, for man to survive without some thermal protection. All due to the anisotropic radiation emanating from the Sun (too hot).

Arguably, no gas near the moon's surface thus there is no temperature. Unfortunately, one is then riddled by, what did too hot, or too cold, actually mean?

10. Pictet and New Thermodynamics

All emitted blackbody spectrums have a temperature dependence as defined by the Stefan-Boltzmann equation. The hotter an object is, then the:

- Higher its radiated energy's peak frequency is (defined by Wein's law).
- Greater the total flux of emitted energy will be.

In Pictet's experiment; when a comparatively hot object is placed at mirror 1's focal point, it radiates a greater amount of thermal photon's total energy towards mirror 2. Mirror 2 focuses that energy and the thermometer heats up. This is all due to radiative heat transfer.

Accept that both the thermometer and the hot object radiate thermal energy (generally blackbody radiation). Then it is just a case of the radiative energy flux from the hot object being greater than the radiative heat flux from the cooler thermometer. The result being the heating of the thermometer and the cooling of the hot object.

Conversely, when a comparatively cold object is placed at mirror 1's focal point, it radiates less thermal radiation energy towards mirror 2's focal point, than the thermometer radiates from its location at mirror 2's focal point. This is not the cooling by "cold emanations from a flask of snow" [2] (or frigorific rays). It simply concerns a non-equilibrium situation where the thermometer absorbs less radiative energy than it emits.

The explanation for what is witnessed in Pictet's experiment is that simple. Hotter objects radiate a greater flux of thermal radiation energy than colder objects do. This applies to both the thermometer and the object.

One does not require the over-complications elicited by statistical mechanics, i.e., entropy or the second law. It is temperature alone (not entropy) that determines the net direction that heat flows when considering heat transfer (both radiative and kinematic).

In thermal equilibrium the total thermal energy (heat) into a system must equal the total thermal energy out of that system. The total thermal energy (in or out) being some combination of radiative and kinematic heat transfer. Once more, using either entropy or the second law to explain what is witnessed will

lead to unnecessary over-complications. Note that the absorbed and radiated spectrums may not always be exactly the same but the total energy in must equal the total energy out.

If heat transfer only involved kinematic heat transfer (as is traditionally insinuated), then the temperature changes in Pictet's experiments would be immeasurable. The total energy associated with thermal photons remains minute in comparison to the kinematic energies of the surrounding gas. However, as previously stated, it is the immensity of a photon's speed that renders it relevant when contemplating heat transfer.

It is inarguable that photons reflecting off of the mirrors represent photons acting as waves. Furthermore, the fact that the mirror did not heat up (hot object case) or cool down (cold object case) means that for the case of reflection, photon's acting as waves did not result in the transfer of thermal energy. Hence, photon's acting strictly as waves does not explain the witnessed universality in radiative heat transfer.

Pictet's experiment should have raised red flags to those mathematical geniuses writing science. It seems strange that this has gone unrealized over the centuries.

11. Radiative Heat and Allmendinger

The exact mechanism of photon absorption or its radiation by matter, is presently not fully understood. However, some experiments do provide insights. Of particular interest are Thomas Allmendinger's experiments [35], [36], which clearly show the absorption of thermal photons by gases [25].

Seemingly, such absorption is related to the gas molecule's size, specifically its scattering cross-section [25]. Whatever the final understanding, photons acting particles provide certain universality. Note that a photon's size probably has a frequency dependence, something that has yet to be determined.

Allmendinger shone directional lights (with a strong infrared component) into various gas filled tubes. The tested gases include carbon dioxide (CO_2), air, oxygen (O_2), nitrogen (N_2) as well as some noble gases namely helium (He), neon (Ne), and argon (Ar). All tested gases witnessed a temperature increase.

Allmendinger's findings challenge traditionally accepted notions (philosophy or theory?) that only gases with lopsided charge distributions absorb infrared radiation. Specifically, O_2, N_2 and all the noble gases are supposedly transparent to infrared radiation. This notion of transparency is based upon infrared spectrometry, which only considers photons as waves. Note that the term "opaque" was incorrectly used by this author instead of "transparent" [25].

Allmendinger also determined that different gases had different experimental limiting temperatures. This is most likely due to the experimental

apparatus, i.e., if the tube was infinite in length, or the infrared light's intensity was infinite in intensity, there would be no limiting temperature. Given similar intensity and duration, the differences in limiting temperatures would be due to differences in the various gas's infrared absorption cross-sections [25].

A traditionalist might argue that it was the tube's walls that heated up rather than the gas. Such an argument fails to provide clarity concerning the mechanism by which the infrared photons heat the walls. "Moreover, if the infrared radiation only heated the tube's walls, then based upon accepted traditional kinetic theory, the expectation would be that the temperature increase would be independent of the gas inside of the tube" [25].

Based upon Allmendinger's experiments (namely his Fig. 25 and Fig. 26 [34]) this author has concluded that it is the gaseous atom's/molecule's size that determines both the various gas' rates of heating and their limiting temperatures. Specifically, the larger the gaseous atom's/molecule's size is, then the faster that gas heated, and the higher its limiting temperature was. In other words, larger atoms/molecules have greater scattering cross-sections, thus more photons impact them, thus more momentum/energy is passed onto that gas [25].

This challenges the philosophy/theory behind traditionally accepted radiative heating (based upon photons acting as waves). The implication being that thermal photon's momentum/energy is passed onto the atoms within the gas molecules. Certainly, this fits better with our understanding of heat as it fits with the witnessed universality of heat and its transfer.

12. Greenhouse Gas Experiment

Allmendinger's experiments challenge the notion of the greenhouse effect, in climate change. Other experiments show gases absorbing infrared photons. Google "greenhouse gas experiment," and one finds researchers shining infrared lights upon vessels filled with either CO_2 or air. They claim that so-called greenhouse gases [carbon dioxide (CO_2), water vapor (H_2O), methane (CH_4)] absorb infrared photons while other gases [oxygen (O_2), nitrogen (N_2) and noble gases] do not. This claim is founded upon infrared spectrometry, i.e., previously discussed photons acting as waves with the greenhouse gas molecule's lopsided charge distribution.

As emboldened as they tend to be, scientists and philosophers of climate change [36], tend to be oblivious to certain facts. In greenhouse gas experiments, both the air and CO_2 heat up, with the heating of the CO_2 always being at a slightly higher rate with a greater limiting temperature.

Since air is 99% O_2 and N_2, the heating of air confirms Allmendinger's findings. Specifically, both N_2 and O_2 are claimed to be transparent to infrared radiation. This means that the minute concentration of CO_2 in air (0.04%) is

supposedly enough to enable air to heat at a rate that is approximately 65% that of pure CO_2 [25]. Such an widely embraced explanation is ridiculous.

Consider that air is primarily diatomic (N_2 and O_2) while carbon dioxide (CO_2) is triatomic. Could one not infer that the 65% rate may be indicative of the fact that O_2 and N_2 may roughly be 2/3 the size of CO_2? This rudimentary analysis indicates that their ratio of scattering cross-sections could better explain what is witnessed.

Note that climate change still is anthropogenic. It is just that man's total energy use and not so-called green-house gases (philosophy of greenhouse gases [37]), becomes the root cause [38], [39]. It is inarguable that man's energy use is only a small fraction of our Sun's energy that reaches our outer atmosphere. However, with new insights this author has shown that man's energy use does explain what is known concerning Earth's climate change [39]. This alters our understanding of climate change, bringing it into the context of new thermodynamics understanding as described herein by this author.

Accepting that man's energy use is a root cause of climate change, one must then question the wisdom of using recently proclaimed fusion nuclear energy. The reckless use of such a relatively clean and possibly cheap source of energy may lend itself to a disastrous reality.

13. Seim and Olsen

Seim and Olsen [40] hung two folded pieces of aluminum foil, one untouched and the other painted black, in a box. The box was then enclosed with clear plastic. The box was heated by a 500 W tungsten-halogen lamp emitting radiative heat [25]. The black foil's temperature increased at a faster rate than the untouched foil.

The black foil acted as a blackbody absorbing most thermal photons. Thus, explaining the fact that the black foil heated faster when exposed to infrared radiation. Conversely, the shiny aluminum foil reflects the majority of incident thermal radiation, thus heated much slower.

Just as in Pictet's experiment, the importance of thermal photons is again witnessed. Again, all this is not readily explained using traditionally accepted thermodynamics, which places all the energy upon the gas molecule's kinematics. Our philosophies (or theories) concerning heat transfer has to change, as well as thermodynamics in general.

The concept of wave-particle duality is founded in the differences in math that is used to describe a wave versus that used to describe a particle. A philosophical question being: Is this a weakness in our math, i.e., our math cannot properly describe both phenomena at the same time?

Note that both Allmendinger's and Seim & Olsen's experiments were devised to show that climate change is not a result of so-called greenhouse gas.

They all conclude that climate change is not anthropogenic, a position that this author disagrees with (as previously discussed).

14. Unnoticed Radiative Heat

Why has radiative heat's importance not been previously noticed in closed systems? Imagine blackbody radiation emanating from the walls of a closed experimental system. The radiation will be isotropic. Therefore, on average the energy/momentum from thermal photons will strike a gaseous molecule (or atom) equally from all directions, over the duration that it takes a gas molecule (or atom) to travel across the system. Therefore, on average there will be no net energy passed onto the gas molecule (or atom) between its gas-wall molecule collisions [25]. Therefore, the translational (and probably rotational) energy of the gas atoms/molecules will not be affected.

However, the effects on molecular vibrational energy may be quite different. Realizing that molecules vibrate in and around 10^{13} Hz, means that thermal photons can be absorbed. This assumes that each atom within a molecule is not struck equally from all directions in the duration of its vibration [25].

One might ponder, what happens to the energy of thermal photons that collide with atoms (or molecules) at the same instant from opposite directions? A plausible interesting debate.

15.Conclusions

One may choose to consider what has been discussed as issues with our epistemology, philosophies of sciences, or scientific theory. Nothing was proven, however issues with traditional theory were discussed. Lucidity was provided by improved understanding. Ultimately, the door to questioning our indoctrination has been torn wide open.

Pictet's experiment influenced the 18^{th}-19^{th} century debate as to whether or not heat involves particles or waves. Modern thermodynamics focuses upon statistical mechanics. Thus, the kinematics of matter has become the foundation for explaining both a system's total energy, and processes of heat transfer. Radiative heat transfer is now treated as some addendum.

Lucidity of Pictet's experiment is only obtained by realizing the significance of radiative heat transfer. Although often obscure, radiative heat transfer's true importance lay in a photon's speed rather than the energy associated with all the photons dispersed amongst a system's gas molecules. Implications to our philosophies in sciences become profound. This includes how one envisions

climate change. Note that other experiments also confirm radiative heat transfer's importance, e.g., Allmendinger's, Seim and Olsen's.

Misconceptions are founded upon the assumptions that enabled mathematical simplification by great minds of our forefathers (including Maxwell and Boltzmann). These statistical thermodynamic assumptions have rendered mathematical simplification while manifesting theoretical obscurity.

More realistic understandings are needed. Such as:

- Molecular collisions are inelastic.
- Molecules are not point particles.
- Radiative heat exists and its transfer cannot remain ignored.

Although they improve one's knowledge, such understandings will lend themselves to extremely complex mathematics (possibly untenable) .

The existence of thermal photons provides clarity. Thermal equilibrium involves the absorption and emission of thermal photons. An ensemble of inelastic molecular (and/or atomic) collisions will result in a spectrum, e.g., a blackbody spectrum.

Questions arise concerning over-complications asserted in thermodynamics. Entropy remains a parameter, based upon mathematical brilliance without any viable foundation. Like entropy, the relevance of the mathematically described second law comes into question. For emphasis, a math that is founded upon the placement of all a system's energy and heat transfer, upon the kinematics of matter. A math that is indifferent to the radiative energy placed upon us, including that of our Sun.

The association of entropy change with the direction of heat transfer is misleading. Clarity is obtained by realizing that it is temperature alone that determines the direction of heat transfer, i.e., the net flow of thermal energy (heat) is always from hot to cold.

Thermal energy transfer becomes a combination of radiative and kinematic heat transfers. Radiative heat transfer is dominated by photon's acting as particles. This alleviates issues witnessed throughout thermodynamics. Ultimately, Pictet's experiments demonstrate the wave-particle duality of thermal photons. Profound differences exist between photons acting as waves (e.g., reflections off of mirror) vs those acting as particles. As waves, photons do not necessarily result in heat transfer. Heat transfer does involve thermal photons, those being photons acting as particles.

Taking math and forever trying to squeeze theory out of it can, be problematic. Too often one forgets to first observe, and then and only then, to

formulate one's theories. It is only at that point that one should attempt to elicit their observation's best descriptor.

This all brings forth the need for the sciences to step back and philosophize. What have we done? Over-complication is something we humans are good at. Admitting that we do, not so much.

My Apology and Our Dignity

I must apologize for all the self-referencing. However, when one rewrites thermodynamics, one must explain the published path of logic.

A combination of indoctrination, and human indignity too often prevents those who should know better from knowing. Tolstoy said it best "I know that most men, including those at ease with problems of the greatest complexity, can seldom accept even the simplest and most obvious truth, if it be such as would oblige them to admit the falsity of conclusions which they have delighted in explaining to colleagues, which they have proudly taught to others, and which they have woven, thread by thread, into the fabric of their lives" [41].

It raises the question of, just where does this paper belong?

References

[1] Pimpas, Alexander, V., Mihova, Gergana M., Andreeva, Andreana I., Zografov, Nikolay,N. 2017."Trapping Radiant Cold via Mirrors" Journal of Physics and Technology Vol 1 Number 2 pp 65-69]

[2] Evans, James, Popp, Brian, 1985. "Pictet's Experiment: The Apparent Radiation and Reflection of Cold". Am. J. of Phys., 53(8): 737-753 (1985).

[3] Mayhew, K.W., 2021. "New Thermodynamics: Inelastic Collisions, Lost Work, and Gaseous Inefficiency" Hadronic Journal, 44, pg 67-96

[4] Tilley D.E., 1979. Contemporary College Physics Benjamin Cummings Publishing Don Mills, Ont. Canada 1979

[5] Lambert F.L., 2002. "Entropy is simple, qualitatively". J. Chem. Educ 79 187

[6] Atkins , P,. 2007. Four laws that drive the universe Oxford University Press Oxford England 2007

[7] Mayhew, K.W., 2022. "New Thermodynamics: The Second Law Buried by Illusions" Hadronic Journal 45, 97-116

[8] Mayhew, K.W., 2015. "Entropy an ill-conceived mathematical contrivance" Phys. Essays 28 vol 3, 352

[9] https://thestandupphilosophers.co.uk/what-is-entropy/

[10] Ben-Naim, A., 2008. A Farewell to Entropy: Statistical Thermodynamics Based on Information. World Scientific Publishing Co., London, New York 2008

[11] Ben-Naim, A., 2012. Entropy and the Second law: Interpretations and miss-Interpretations world scientific Publishing Co. London, New York, 2012

[12] Mayhew, K.W., 2020. "New Thermodynamics: Reversibility and Free Energy" Hadronic Journal 43, 51-59

[13] https://mathoverflow.net/questions/403036/john-von-neumanns-remark-on-entropy (Sept. 2022)

[14]http://hockeyschtick.blogspot.com/2014/11/scientist-proved-214-years-ago-that.html#:~:text=THE%20HOCKEY%20SCHTICK%3A%20Scientist%20proved,hot%20body%20hotter%2C%20proved%20opposite (Aug. 2022)

[15] Capek, V., Sheehan D. P., 2005. Challenges to the second law of thermodynamics, Springer Press, Netherlands 2005

[16] Hatsopoulos, George, Beretta, Gian Paolo. 2008. "Where is the entropy challenge?" AIP Conference Proceedings. 1033. 34. 10.1063/1.2979057.

[17] Nikulov, A., 2022. "The Law of Entropy increase and the Meissner Effect", Entropy, 24(1), 83

[18] https://www.goodreads.com/quotes/947685-the-law-that-entropy-always-increases-holds-i-think-the

[19] Mayhew, K.W., 2021. "New Thermodynamics: Inelastic Collisions, Lost Work, And Gaseous Inefficiency", Hadronic Journal, 44, (1)

[20] Mayhew, K.W., 2020 "New thermodynamics: Illusions of Elastic Collisions in the Sciences", EJERS, Vol. 5, 1, pg 87-93

[21] Mayhew, K.W. 2021. "New Thermodynamics: Inelastic Collisions, Lost Work and Gaseous Inefficiency. Hadronic Journal vol. 44 (1), pg. 67-97

[22] Mayhew, K.W., 2015. "Second law and lost work", Phys. Essays 28, vol. 1¸152

[23] Mayhew, K.W., 2020 "New Thermodynamics: Inefficiency of a Piston-Cylinder", EJERS Vol 5, 2, pg 187-191

[24] D. Sheehan, 1998. "Four Paradoxes Involving the Second Law of Thermodynamics" J. Sci. Exploration, 12 (2), 303

[25] Mayhew, K.W., 2021. "New Thermodynamics: Wave-Particle Duality in Radiative Heat Transfer" Hadronic Journal 44, 215-226

[26] https://en.wikipedia.org/wiki/Molecular_chaos Oct., 2021

[27] https://en.wikipedia.org/wiki/Photon_gas#Isothermal_transformations Dec., 2022

[28] Mayhew, K.W., 2017. "A New Perspective for Kinetic Theory and Heat Capacity", Prog. in Phys., Vol. 13 (4), pg 166-173

[29] Mayhew, K.W., 2018. "Kinetic Theory: Flatlining of Polyatomic Gases", Prog. in Phys., Vol. 14 (2), pg 75-79

[30] Hartmann C., "On the 150th birthday of Max Planck: On Honesty towards nature" https://21sci-tech.com/translations/Planck% 20150th%20birthday-Nov.%2014.pdf

[31] Santilli, R., M.., 2021. "Overview of the Einstein-Podolsky-Rosen Argument with Applications in Physics, Chemistry and Biology" APAV

[32] Mayhew, K.W., 2013 "Latent Heat and Critical Temperature: A Unique Perspective". Phys. Essays 26,4. pg 604-611

[33] Mayhew, K.W, 2020. New Thermodynamics: Untangling Entropy's Web, Includes treatise on Global Warming (self-published book)

[34] Mayhew, K.W., 2021 "New Thermodynamics: Questioning Temperature in Open systems, e.g., In Atmospheric Physics". Hadronic Journal vol 44 (1), pg. 431-444

[35] Allmendinger, T., 2016. "Thermal Behaviour of Gases Under the Influence of Infrared Radiation" Int. J of Phys. Sci. Vol 11 (15) pg 183- 205

[36] Allmendinger, T., 2018. "Thermal Radiation of the Atmosphere and Its Role in the So-called Greenhouse Effect" Atm. And Cli Sci. Vol 8, 2

[37]https://www.mofa.go.jp/policy/environment/warm/cop3/joint_2.html (Sep t. 2022)

[38] Mayhew, K.W., 2022. "New Thermodynamics: Rethinking the Science of Climate Change", EJERS, Vol. 5, 5, pg. 569-564

[39] Mayhew, K.W., 2021. "New Thermodynamics: How Mankind's Use of Energy Influences Climate Change" Hadronic Journal 45 (4), 399-421

[40] Seim, T.O. and Olsen B.T., 2020."Unexpected relationships between thermal and radiative Energy Transfer" Atm and Clim, Sci. vol 10 no 2, pg 639-651

[41] Gold, T. 1989. "New Ideas in Science" J.of Sci. Exploration Vol 3 No 2 pp 103-112

Science & Philosophy Volume 11(1), 2023

Gender affirming pathway in Italy: law, health issues and social considerations

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Abstract

The transgender experience predicts that the gender affirming pathway is undertaken. The gender affirmation process is not mandatory, and the process is not the same for all people. Affirmation of gender is a social determinant of transgender and gender diverse (TGD) health, but which also has a multidimensional structure: social, legal, psychological, and medical. At this point, however, it is necessary to understand the type of pathway that TGD people can undertake in Italy, so the purpose of this paper is to make the articulation of the pathway known and explicit, trying to detect the sociological aspects and the impacts that the various components of the gender affirming pathway require. The gender affirming pathway in Italy is characterized by many critical issues: it is appearing to be focused on the affirmation of medical, legal, and psychological dimensions; however, the affirmation of social gender is also important to promote their integration into society, their health and general well-being. In conclusion, it is necessary to develop and implement research and concrete impacts of social gender affirmation, the potential of which is to reduce inequalities, in general, and health, which negatively impact the Italian TGD individuals.

Keywords: gender affirming pathway; transgender studies; Italy; health; law; social impact †

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† Received on January 24, 2023. Accepted on June 30, 2023. Published on June 30, 2023.
DOI: 10.23756/sp.v11i1.1101. ISSN 2282-7757; eISSN 2282-7765. © Davide Costa.
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1. Introduction

Nowadays, more than ever, in terms of diversity, the concept of gender variants finds great application. Gender variances, in this regard, are present in the most archaic societies. In some of them they enjoyed a certain degree of acceptance, occupying even important roles and statuses [1]. In this regard, "While gender has been universally used by societies as a main organizing principle, understandings of the importance of gender, and the criteria used to determine gender conformity and variance have been diverse. Moreover, sexuality is generally seen as an integral component of what constitutes gender, although this, too, has varied significantly" [2, p.181]. For gender variants, all those situations are defined in which there is not coincidence between the assigned sexes and the perceived gender. Although there are many definitions, the following will be used in this work "transgender and gender diverse (TGD) to be as broad and comprehensive as possible in describing members of the many varied communities globally of people with gender identities or expressions that differ from the gender socially attributed to the sex assigned to them at birth. This includes people who have culturally specific and/or language-specific experiences, identities, or expressions, and/or that are not based on or encompassed by Western conceptualizations of gender, or the language used to describe it" [3, p.1].

From a statistical point of view, according to the most updated data, the incidence of TGD individuals is between 0.5% and 1% [4]. Preliminarily, it should be noted that regarding the TGD, and more generally the LGBTQA+ world, they are used many terms with which such people might describe themselves. While the language of gender variance is in constant flux and is important to offer explanations of some of the more commonly used terms to anchor our discussion. In this regard, in the guide for nonspecialists [5] there is a detailed outline of the appropriate or inappropriate terminology to be used, which is proposed again before continuing, to avoid terminological misunderstandings. The appropriate terms are: Gender identity: An individual's internal (i.e., not visible to others) sense of being male, female, or something else; Gender non-conforming: Individuals with gender expression differ from societal expectations related to gender; Transgender: Gender identity, expression, or behaviour is different to the gender assigned at birth; Cisgender: Gender identity, expression, and behaviour conform to those assigned at birth; Gender nonbinary: Not conforming to either binary gender forms of 'male' or 'female'; Trans (gender) men: Individual most likely assigned as female at birth but now identified as a man ('Female to Male'); Trans (gender) women: Individuals were most likely assigned a male at birth but now identified as a woman ('Male to Female'); Gender dysphoria/Gender identity disorder: Terms used in DSM-5 and ICD-10, respectively, describe conditions whereby gender non-conformity leads to distress; Genderqueer: Individual identifies as neither male nor female. The term 'queer' might be viewed as derogatory to some but can also be used to describe a political stance which aligns transgender with lesbian, gay, and bisexual activism; Transition: Time over which a person begins to live as the gender with which they identify rather

than their gender assigned at birth; Crossdresser: Individuals who dress in clothing stereotypically worn by the opposite gender but generally without intent to live full time as the other gender; Drag queen: A man who dresses in female clothing, often for entertainment or performance; Drag king: A woman who dresses in male clothing, often for entertainment or performance. The inappropriate terms are: Transsexual; Non-preferred term for transgender; Transvestite: Non-preferred term for cross dresser; Drag queen: When used to refer to transgender women, this can be derogatory and should be avoided. This clarification is important because, as will be seen later, one of the biggest problems and barriers, primarily in health, that TGD experiences, concerns the use of inappropriate terminology that it generates.

Another clarification, always of a terminological nature, is between TGD people and Disorders of Sex Development (or 'intersex'), which is a term from the Diagnostic and Statistical Manual of Mental Disorders (DSM). Intersexuality encompasses a range of conditions under which individuals are born sexually and / or chromosomal or hormonal anatomy models that do not correspond to stereotyped definitions of 'Male or female'. Regarding TGD people, it is also necessary to resort to the typically sociological distinction between gender and sex. According to common sense, gender, sex, and sexuality are synonymous, and therefore are used and almost always interchanged. Although, a relatively clear understanding can generally be taken from the context in which they find themselves Used when considering people with gender variants, these terms are best treated as distinct, although related, meanings.

The differentiation between what sex means and what gender means are of particular importance, especially regarding transgender. With a simplistic approach, we could argue that by sex we mean the genotypic and phenotypic aspects with which we define men or women; gender, on the other hand, would be the set of social and cultural constructs. Transgender activist Virginia Prince is widely attributed with having quipped “Any kind of carving that you might do on me might change my sex, but it would not change my gender, because my gender, my self-identity, is between my ears, not between my legs”[6, p. 30). Therefore, different types of sex and / or gender can be assigned at birth, or they can be built as identities that are structured and change over time and based on the perception of others. More specifically, “Sex can be comprised of many variables, such as chromosomes, hormones, internal and external reproductive organs, and secondary sex characteristics, all of which may appear in a myriad of combinations” [2, p.182]. In particular, “Furthermore, which characteristics are definitive of the sex of individuals have been the subject of intense public, legal, legislative, and medical debates, with outcomes varying among time and place. The widespread occurrence of such debates highlights that sex statuses are ultimately the result of contingent and socially negotiated agreements, rather than the inevitable results of physiological imperatives” [2, p.182]. Thus, even the concept of sex is no longer considered exclusively “biological”, but also of a cultural, and, above all, social nature. It is known that the sexes are assigned at birth, indeed, from the moment in which from an ultrasound point of view, and therefore from embryonic life. In common parlance, gender is considered synonymous with sex. The

kinds of men and women are considered by many to be natural and unavoidable social attributes based on organic imperatives. From this point of view, women and men are thought to look, think, feel, and act as they do because they have physical sex which leads them to do so [7]. Other, they argued that genres are entirely the result of the forces of socialization [8]. The dominant opinion of experts is that genres are an achievement of a mixture of biological and social influences. The sexes, like sex, can be assigned, they can be identities or can be attributed. Genders are social statuses originally assigned at birth based on the presumed correspondence between sex and gender. Because it is common that sex and gender are two words which are used interchangeably for the same thing, when a sex is assigned at birth based on genital observation, the corresponding gender is attributed. Males are assigned as men and females are assigned as women. Thus, all different gender identities on the acceptance the assigned sex, and based on the good quality of life in relation to the assigned genders. Thus, when an individual accepts both the sex and the assigned gender, and therefore perceives a coincidence between the two dimensions, then the term cisgender can be used. In relation to the term cisgender, it must be remembered that "The prefix "cis" comes from the Latin meaning "on this side of" and is used to refer to people whose gender identities are congruent with those to which they were assigned at birth. Variations on the term cisgender (e.g., cis-man, cissexual) have been adopted as parallel terms to transgender-based terms" [2, p.182]. When, on the other hand, there is no coincidence between the perceived gender and the assigned sex, then the term TGD can be used.

An increasingly growing part of the population does not exactly identify with this binary vision, that is, the concept according to which there are only men and women. In this regard, in fact, we speak of gender, fluid, genderqueer, or nonbinary. It's important to remember that "a nonbinary definition of gender is to expand the number of gender types and to analyze data using a more complex representation of the gender variable" [9, p.6]. Thus, non-binaries do not want them to identify themselves as male / male, female / female, or TGD, even if they can assimilate elements of these gender identities in daily life. Very frequently, they resort to the use of pronouns and neutral terms. "Those who do not identify with any gender may refer to themselves as agender, neutrois, or eunuchs. Those people who were assigned as female at birth and who do not fully identify as females/ women, or have adopted another gender identity, are usually referred to as being on the transmasculine spectrum, whereas those who were assigned as males at birth and who do not fully identify as males/men, or have adopted another gender identity, are usually referred to being on the transfeminine spectrum"[2, p.183].

If gender is socially constructed, so that everyone perceives it in a personal and subjective way, despite their social connotations, sexuality, on the other hand, concerns the real body nature, in which it is identifiable with the genitals, somatic features, etc. [10]. Thus, an individual can have a body, and therefore a male sex, but a female gender. Sexualities involve both body and gender. When only cisgender people are part of the equation, sexual identity and attributions may be relatively uncomplicated: gender and sex align in the usual fashion, and sexual identity and attributions can be made based on

either sex or gender [11]. However, TGD people often have bodies which exhibit non-standard mixtures of sex characteristics, and which do not align in the usual ways with typical gender categories [12]. The bases for sexual identity and attribution thus become considerably more nuanced. Gender diversity, in the case of the transgender experience, passes mainly through the body. Corporeity becomes the main battlefield with oneself and with one's own culture of belonging. Thus, the transgender experience sees in the body the tool with which, on the one hand, they try to align the perpetuated gender with sex, on the other hand, to do this they resort to stereotyped social scripts relating to masculinity. or femininity, so that theirs can be recognized and accepted gender and sex identity, based on the assumption that individuals have a body coinciding with the social representations of the concept of gender [2]. This represents one of the greatest limitations in the social life of TGD people, which, as we will see, has a very negative impact on their health; especially when bodily aspects do not fit the social representations of sexual characteristics, TGD individuals become more susceptible to forms of aggression, stigmatization, and barriers in various contexts such as healthcare [13].

Some TGD people (but not all) decide to intervene on their body to make it more like how they feel through a pathway of gender affirmation that proceeds in stages and can include hormonal and / or surgical treatment [14].

The gender affirmation process is not mandatory, and the process is not the same for all people. We try to adapt the course according to real individual needs (for example, not all people feel the need to undergo surgical treatment) [15]. Before starting the gender affirmation process, the person must be informed about all procedures and therapies available, as well as about the possible risks that this entail and the irreversibility of some of them. In this regard, there are three essential practices to take into consideration before embarking on a gender affirming pathway: self-determination, information, and search for specialized services [13]: Self-determination is an essential practice for TGD people and can help them gain confidence and courage. It is the act by which a TGD individual determines himself as such, without the need for any diagnosis or the beginning of any pathway. It is essential to dedicate time, listen, and understand each other before embarking on a pathway such as gender affirming [15-16]; Information is the second fundamental element of the phase that precedes the pathway: the person must inquire about all procedures and therapies and operations available and above all about the possible risks and the irreversibility of some of them. He must then express written informed consent, governed by Law no. 219/2017, which represents the consent of the interested party to undergo therapeutic treatment. It constitutes the prerequisite for the legitimacy of the physician's activity, from the moment in which in our legal system there is the principle that no one can be subjected to medical treatment at their will (Article 32 of the Italian Constitution) [15]; The person who intends to undertake a pathway of gender affirmation must therefore contact specialized centers, public and private [14-15]; "The Gender Affirmation Framework adds to the minority stress theoretical framework by articulating the importance of gender affirmation in shaping the health of trans communities. The Gender Affirmation Framework hypothesizes that in the context of

widespread stigma, trans people with unmet gender affirmation needs are more likely to engage in risk behaviors and experience adverse mental and physical health outcomes than those whose gender affirmation needs are fulfilled"[17]. Reisner et al.[18], in relation to the gender affirming pathway, argue that not only the affirmation of gender is a social determinant of TGD health, but which also has a multidimensional structure: social, legal, psychological and medical. Briefly "Social gender affirmation, distinct from general social support, occurs when institutions or individuals validate a trans person's identity through, for example, the use of correct names and pronouns. Legal gender affirmation refers to amending names and gender markers on documents such as social security cards, birth certificates, and driver's licenses. Psychological gender affirmation is an intrapersonal experience of gender self-actualization and validation. Finally, medical affirmation refers to hormones, surgery, and other procedures that align the function or appearance of a trans person's body with their identity"[17, p.2].

At this point, however, it is necessary to understand the type of pathway that TGD people can undertake in Italy, so the purpose of this paper is to make the articulation of the pathway known and explicit, trying to detect the sociological aspects and the impacts that the various components of the gender affirming pathway require.

2. Materials and Methods

This was a non-systematic review, using Scopus, Web of science, Google Scholar and PubMed to locate publications deemed relevant for the purposes of this review. Both our literature search and decisions regarding what was included in the final manuscript have been guided by the relevance of the gender affirming pathway in Italy.

3. Results

From the codification of the articles three general, broadly reflecting themes emerged the types of items identified. In particular the theme are: legal and biomedical issues and the role of the Infotrans portal.

3.1 Gender affirming pathways in Italy: legal aspects

The Italian legal system has introduced a law that allows, with a judicial procedure, the possibility of requesting and obtaining a change in sex attributed at birth in the personal data registers: Law no. 164 of 14 April 1982. From a legal point of view, therefore, Italy ranks third after Sweden (1972) and Germany (1980) to have legislated in this matter [14]. Law 164 of 1982 was introduced to regulate the "disorder" that was caused by individuals of the age of male sex, who had undergone surgery abroad, and who resided in Italy with documents not corresponding to their sex, resulting in confusion and embarrassment within institutions and at the relational level. In this regard, we recall two episodes of "unrest": in 1979, in a municipal swimming pool in Milan, Pina Bonanno, a trans leader, staged a sensational protest together with her friends: they took off their

bras and are left with their breasts exposed[19]; the case of Romanina-Romina Cecconi (born Roman), decided by the Court of Lucca on 17/04/1972, which admitted the registry change following a surgical intervention abroad. The sentence argues for this decision based on serious inconvenience, confusion, and prejudice to the social order, and refers to the possible compromise of the protection of the custody of third parties, which could give rise to the insertion into the society of the person with a gender that does not correspond to that of belonging. The sentence reads: He cannot enter the various structures of society as a man without giving rise to serious problems. This does not happen in the opposite case since the law does not provide for a third sex, belonging to one or the other sex can only be resolved by resorting to the prevalence criterion [20].

The 1982 law expressly provided that the change of sex had to occur as a result of changes in sexual characteristics, in a particular art. 1 paragraph 1 of Law 164/1982 established that the rectification referred to in Article 454 of the Civil Code is also done by virtue of a final judgment of the Court that attributes to a person a sex other than that stated in the birth certificate following changes in his sexual characteristics [20]; the law also allowed people who had not changed your body, to ask for a sex change. In this case, the rule expressly provided that, when an adaptation of sexual characteristics through medical or surgical treatment, the Court should have authorized it. The need for authorization using the judge was motivated by the overcoming of the prohibition foreseen to carry out acts of disposition on one's body that limit its integrity and to lift the surgeon from a possible charge of the crime of very serious injury. The law did not provide any specifics as to the type of treatment that should be guaranteed to mediate the adjustment. However, for many years a restrictive interpretation of the norm has been given, not only by requiring surgery, but also by specifying it to be an intervention on the primary sexual characteristics.

The Law of 14 April 1982, n. 164 was then amended in 2011, as part of the reform of the rites of the trial, by Legislative Civil Decree 1 September 2011, n. 150, "Complementary provisions to the Code of Civil Procedure regarding the reduction and simplification of civil proceedings of knowledge", in particular art. 31, "Of disputes concerning the rectification of attribution of sex", in turn modified by the implementing decrees of the Cirinnà Law, ie by Legislative Decree 19 January 2017, of inscriptions, transcriptions and annotations, as well as amendments and regulatory additions for the regulation of civil unions".

Furthermore, this law does not specify what is meant by "medical-surgical treatment", which is hormonal therapy, and the changes of sexual characteristics are sufficient. If until 2015, the judges mostly considered the intervention to modify the sexual characteristics as necessary, subsequently they instead admitted no necessity, also thanks to two rulings of the Constitutional Court (221/2015) and the Court of Cassation (15138 / 2015)[14].

3.2 Gender affirming pathways in Italy: Notes on the legal procedure

The legal procedure first envisages that the judicial request be drawn up, which must be submitted to the Court at the place of residence of the person who intends to start the process; this request is notified to the applicant's family members [14]. In the judicial application, authorization can be requested for gender reassignment surgery and rectification of the name and sex, or only the latter. It is important, however, to prove, with specific documentation (psychodiagnostic and medical), the diagnosis of gender dysphoria and the irreversible identification with the perceived gender and any bodily transformation that has occurred. An endocrinological report must also be attached to this documentation, with the prescription of the hormonal treatment initiated. The personal hearing of the party and the examination of the medical documentation are always arranged. An important aspect is undoubtedly the psychological pathway that leads to the diagnosis of gender dysphoria. It can be done at a public or private facility [21]. Both, at the end of the process, issue a report to be produced necessarily in court. If you choose a public structure (therefore pertaining to the National Health System), it must be said that these use protocols for the transition process, i.e., standard rules that professionals (psychologists, endocrinologists, psychiatrists, etc.) are called to respect [15]. By examining the most recent rulings, a progressive tendency emerges to evaluate the documentary productions of the party as sufficiently exhaustive and convincing, without the need therefore to have technical investigations ex office [21]. The personal appearance of the applicant, with accompanying documentation certifying the hormonal treatment in progress, can favor the conviction of the judge that he finds himself in front of a person with a different appearance from the gender attributed on the documents. At the end of the procedure, the court with a sentence determines the sex of the plaintiff and authorizes the surgical sex reassignment treatment, if required, by ordering the registrar of the municipality where the birth certificate was completed to carry out the rectification in the relevant register [14]. This also involves changing the name and all documents such as the tax code, driving license, school certificates, property deeds, employment contracts, and telephone numbers [15].

3.3 Gender affirming pathway in Italy: notes on health aspects

Gender affirming pathway in addition to the legal sphere, is based, above all, on a series of health aspects that briefly fall into two macro areas: hormonal treatment and surgical treatment. Regarding hormone treatment, there are recommendations (Standards of Care) proposed by the World Professional Association of Transgender Health (WPATH) and international scientific guidelines to which health professionals refer for hormone treatment [22].

The person who intends to undertake a medical pathway of gender affirmation must therefore contact specialized centers [3, 23]. The first aspect of hormone treatment concerns the criteria for admission to treatment: persistent and well-documented gender dysphoria / gender inconsistency, age of majority (for minors, consent to the treatment of both parents or other guardians according to current regulations concerning minors: art.3

of law no. 219/2017) ability to make a fully informed decision and consent to hormone treatment, in the absence of medical or psychological problems not adequately stabilized. To start hormone therapy, evaluation and psychological support and social transition without time limits are necessary [23].

However, the prescribing physician (usually an endocrinologist) has a responsibility to ensure that this is the best way to meet the user's needs and reduce gender incongruity and/or suffering, without creating health problems [24]. TGD people start taking hormones, they tend to claim they have a greater sense of belonging to the gender identity with which they identify [25].

The aim of hormonal treatment is to promote the development of the secondary sexual characteristics of the sex with which a TGD identifies, while progressively reducing the secondary sexual characteristics of the original sex [26]. For these reasons, it is important that physicians work within a team made up of several experts with different skills (such as psychologists, psychotherapists, psychiatrists, endocrinologists, surgeons, etc.) who have adequate experience in this area and who can offer a global support to the person. In Italy, hormone therapy can be prescribed free of charge if the criteria established by the Italian Medicines Agency (AIFA) are met, as described in the AIFA determination no. 104272/2020 and n. 104273/2020 of 23 September 2020 (GU General Series no.242 of 30-09-2020). Briefly, hormone therapy can be masculinizing if a woman intends to become a man, feminizing if a man intends to become a woman; this is made possible in the first case by taking testosterone and in the second case by taking estrogen [27].

Regarding the surgical treatment, please note that "Techniques used by trans* people to express their gender identity may include changes to deportment, body, facial-and head-hair styles, clothing, cosmetics, jewelry, fashion accessories, body fat, and muscularity. Trans* people may also strategically employ voice and speech modifications, padding, concealment devices, sex toys, genital or breast prostheses, genital enhancement or diminishment devices, tattooing, or piercings. More permanent changes may be brought about by hormone therapy, gender confirmation, surgery, and ancillary masculinizing or feminizing procedures–any of which can occur in various combinations"[2, p.188]. As with hormone therapy, also in this case there are standards of care introduced by the World Professional Association of Transgender Health (WPATH) and international guidelines to which health professionals refer for surgical treatment.

The person who intends to undertake a medical pathway of gender affirmation must therefore contact specialized centers. It is important, before embarking on a gender affirmation surgical pathway, that the person is aware that this step is not mandatory and that it is not a surgery capable of fully obtaining the desired sexual characteristics [28]. In fact, gender affirmation surgeries may involve the removal of the genital organs present (uterus and ovaries; testicles and penis), but do not allow the creation of genital organs of the desired gender (for example the creation of a uterus in a person with sex assigned at male birth). Surgical interventions can be reversible or irreversible.

3.4 Gender affirming pathway in Italy: the role of Infotrans portal

In Italy, the gender affirming pathway, since 25 May 2020, has been facilitated by the establishment of the Infotrans portal, i.e. the first portal dedicated to TGD people, the result of a collaboration between the Reference Center for Gender Medicine of the Higher Institute of Health and the National Office against Racial Discrimination – Presidency of the Council of Ministers[29]. This project responds to the need to provide the population with independent, certified and updated information in this field and to promote full social inclusion of TGD people. Briefly, the Higher Institute of Health is the main center for research, control and technical-scientific consultancy in the field of public health in Italy [29].

The Institute's activities are distributed in Departments, National Centres, Reference Centres, Technical-Scientific Services and a Notified Body for the assessment of the suitability of medical devices. Among its structures we find the Reference Center for Gender Medicine which deals with studying the effect of gender on the state of health and illness of each of us. In fact, gender differences are observed both in the frequency and in the symptoms and severity of numerous diseases, in the response to therapies and in adverse reactions to drugs as well as in lifestyles and in the response to nutrients[29].

In line with its objectives, the Center deals with the health and well-being of TGD people by promoting research, training and communication activities to citizens through a close network of collaborations with other institutions, clinical and research centers as well as TGD associations[29]. As regards the Office for the promotion of equal treatment and the removal of discrimination based on race or ethnic origin, its main function is to set up a garrison to guarantee and control equal treatment and the functioning of instruments of protection against discrimination based on race or ethnic origin [29].

For several years, the Office, in implementation of ministerial guidelines and directives, has expanded its range of action by guaranteeing protection against all forms of discrimination also originating from factors such as personal and religious beliefs, age, disability, sexual orientation and gender identity and operates in all public and private sectors of social life, such as work, health care, education, access to goods and services, social protection [29].

Therefore, the Infotrans portal, offers a collection of all the points of reference in the area that offer services dedicated to transgender people, from Associations to Clinical Centers, Consulting Centers and Listening Points. By filling in a specially prepared form, the structures provided information regarding: useful numbers and addresses, offered services, composition of multidisciplinary teams any cost of services, waiting times for acceptance.

The site also contains a lot of updated information regarding prevention, health and the process of gender affirmation (psychological support, hormonal and surgical treatment), the protection of gender identity, the right to exchange documents and the rules know before undertaking any gender affirmation surgeries as well as the main false myths and “hoaxes” circulating on the subject.

Infotrans not only contains information dedicated to TGD people, in fact a section has been prepared containing good practices dedicated to healthcare professionals, employers, trade unionists, journalists and other professional figures [29].

4. Discussion

The gender affirmation process as presented could appear actually simple, in Italy, the criticalities in this regard are multiple and complex. In Italy, according to the estimates of the Higher Institute of Health, there are about 400,000 TGD people[30] and the problems for this population are very much. Recently, regarding the gender transition process, preliminary data emerged from the "Study on the health status of the adult transgender population in Italy" conducted by the Higher Institute of Health, in collaboration with clinical centers distributed throughout the national territory and TGD associations / collectives [30]. This Italian study first of all reveals different types of barriers to access to health services, in particular to cancer screening, with the percentage of those who feel discriminated against reaching 46%. Only 20% of TGDpeople assigned to be female at birth perform the pap smear, while about 40% of TGD individuals suffer from depression and 60% of the cases in the sample analyzed declare that they do not exercise. Furthermore, the results showed that the percentage of TGD people who do not exercise is higher than the general population. 64% of AMAB TGD individuals (transgender women and nonbinary people assigned male at birth) and 58% of AFAB TGD people (transgender men and nonbinary people assigned female at birth) do not exercise compared to 33% and 42 % of men and women in the general population. Regarding cigarette smoking, the population most at risk is represented by AFAB TGD people who report smoking in 37% of cases compared to 25% of men and 19% of women who smoke in the general population.

Binge drinking (excessive alcohol consumption on a single occasion) is more frequent in the TGD population: 23% AMAB and 17% AFAB in the TGD population vs 12.5% men and 5.5% women in the general population.

The differences found between the TGD population and the general population regarding lifestyle are correlated to multiple factors including minority stress, transphobic episodes, and internalized transphobia play a crucial role. Regarding access to health services, 34% of AMAB TGD people and 46% of AFAB TGD people felt discriminated against because of their identity and / or gender expression in accessing or using health services.

This data, at least in part, can explain the low percentage of TGD people who undergo cancer screening: for example, the preventive pap test is performed only by 20% of TGD people assigned female at birth vs 79% of women in the general population. The data relating to the presence of any disease are still being analyzed, but preliminary results indicate significant differences between the TGD population and the general one, an example is given by the depression reported by 40% of TGD AMAB people and 34.5% of TGD AFAB people (figure reaching 60% in both AMAB and AFAB nonbinary TGD

populations) vs 4.74% and 7.7% reported in men and women in the general population, respectively.

As regards HIV infection, the picture is outlined in line with international data which indicate a higher prevalence, particularly in TGD AMAB people, compared to the estimated prevalence in the general population (percentage reported by transgender AMAB people 6.45% vs 0.3 % in men and 0.2% in women in the general population). All these data provide a clear picture of the various issues related to the gender affirmation process, with a series of consequences, not only economic and health, but probably first of all social.

As it has been pointed out, first, the legal dimension of the affirmation process is particularly articulated, and even today it has not found a univocal application. This already represents a great limitation of sociological interest since "health and law are in themselves sites of practice and experiences of social justice—or injustice— at local and global levels. Health systems and all players and forces in them can be analyzed for their impact on human dignity, equality, and freedom as well as for their effectiveness in preventing or treating ill health or disease. Linking health with human rights has become a key for many variously empowered people demanding change in the structures that provide health services and care globally" [31]. It should be noted that the relationship between law, TGD, health, etc. It is not easy, since there is rarely a direct relationship between these dimensions, despite being intersected in ways that result in a plurality of meanings. The discourse on rights and law, for example, includes the notion of identity, behavior, and expression; individuals and groups; claims of actors and responses of states (and supranational bodies).

The law is therefore functionally connected as an instrument of respect, protection, and realization rights. As for the field of health, the issue of (human) rights, and (social) justice towards health requires a discussion of principles, policies, and practices [31].

As for hormonal treatment, however, the problems are many; first of all, of a health and welfare type: One of the main problems with hormone treatment, in general, is that it causes several side effects [32].

In the case of feminizing hormone therapy, there is an increased risk of blood clots (venous and pulmonary thrombosis, embolism) [33], gallstones [34] and liver disease [32], pancreatitis and insulin resistance and glucose intolerance [26] and elevated prolactin levels [32], rarely accompanied enlargement of the pituitary gland or the development of the secreting prolactin pituitary tumors called prolactinomas. Regarding masculinizing hormone therapy, the following side effects are noted: acne [26], weight gain [27], increased erythrocyte mass with possible polycythemia[32], liver disease [26], insulin resistance, fluid retention and edema[27], increases homocysteine levels [25], decreases in arterial reactivity[25], and shift of lipid profiles toward a more maletypical pattern with the potential for increased cardiovascular risk. Elevated prolactin levels have occasionally been reported in FtM transsexuals and may be attributable to breast binding [25].

Regarding hormonal treatment, then, there is a second type of problem relating to the illegal and without prescription intake of sex hormones[35]. Some TGD people take nonprescribed sex hormones but obtained through friends, black market sources, or foreign drug dealers.

Thus "the potential risks, many TGD people are willing to use nonprescribed hormones to achieve the physical and psychological changes they desire. The benefits of nonprescribed hormones can be genuine. For example, Leavitt et al. (1980) reported that TGD individual who used medically unsupervised hormones displayed better psychological adjustment than transsexuals who were not receiving hormone treatment" [31, p.483].

As for the surgical treatment, it is full of potential risks such as: cardiac (heart), pulmonary (lung), venous thromboembolism (blood clots), hemorrhage (excessive bleeding), infection, injury to surrounding structures, poor wound healing, and need for a repeat procedure or return to the operating room. Because complications can occur during any surgery, it is imperative that health professionals develop a trusting relationship with their patient and invest time to educate the patient about all the potential risks involved with each surgery. Another health concern of TGD people linked to the gender affirming pathway regards the problem of liquid silicone injection. Many TGD people resort to injections of liquid silicone with the aim of making one's body more compatible with the perceived gender identity. The most frequent anatomical areas are the hips and buttocks [31], followed by: face, breasts, and legs [26]. According to recent estimates, the total volume of silicone injected is around 8 liters, administered in several sessions [31], with average, TGD had received injections about twice a year[26]. Silicone wings often mix with or are replaced with other fluids such as mineral oil or olive oil[31]. Silicone injections should be carried out by specialized medical personnel but having a cost that is not accessible to everyone, very frequently TGD people have recourse to unqualified personnel, who perform the same service at much lower costs [26]. The existence of a real black market was thus revealed for silicone injections. "Liquid silicone injection has been associated with a variety of devastating complications. Embolism of silicone to the lungs can cause acute pneumonitis, leading to severe respiratory distress or death. Pneumonitis typically occurs within hours or a few days of injection but has been observed up to months or years after injection, sometimes following trauma. Acute silicone pneumonitis has been reported after injection of volumes as small as 10 cc. Facial injection of liquid silicone has been associated with the development of granulomatous reactions and cellulitis and loss of vision. Silicone-related granulomatous hepatitis has been described. Liquid silicone is affected by gravity and can migrate in the body, sometimes resulting in severe disfigurement and disability. Injection or migration of silicone into the legs can cause chronic ulceration and lymphedema, often after a latent period of many years. Multiple cases of Mycobacterium infection have been reported in New York City following liquid silicone injection. In view of the severity of associated complications, TGD people should be strongly counseled to avoid liquid silicone injections" [31, pp.488-489].

What appears evident is that in Italy, following the model of Reisner[18], it is lacking from the point of view of social gender affirming; while, in fact, there is a large literature on legal, health and psychological aspects, on the purely social dimension there is a scarce availability of elements. Since the social dimension of gender affirming is lacking, what is lacking concerns: the choice of the name and pronoun, interpersonal and institutional acknowledgment, and recognition.

Thus, if "Gender affirmation is a unique social determinant of health that affects trans people's lives. Lack of social gender affirmation has been shown to adversely impact health care utilization behaviors among TGD people, including delaying preventive health care screening or avoiding needed clinical care when sick or injured" [18, p.236].

This statement is fully in line with the data cited, which, in fact, confirm this hypothesis. Compared to what has been reported, the experience of the pathway towards gender affirmation, and the critical issues that have been briefly discussed, recalls the concept of embodiment. Embodiment "recogniz[es] the social consequentiality of the body's materiality" and its relationship to identity and social structure [36].

Paine [37] recently introduced the concept of embodied disruption to draw attention to how patient nonconformity to societal gender norms provokes responses from medical personnel that reify normative sex/ gender/sexuality binaries, provoke confusion and distress, and compromise gender nonconforming individuals' access to society.

Thus, the social aspects of the gender affirming pathways are essential because "understanding how social forms of gender affirmation influence health is important, given the high financial costs and overall inaccessibility of medical gender affirmation for those who do desire it[38]. Aside from cost, health system barriers [39] to gender affirmation include lack of insurance coverage, geographic inaccessibility, anticipated and enacted stigma in health care settings, medical contraindications (i.e., history of thrombosis for estrogen use or coronary artery disease for testosterone use), age, and anticipating others' negative reactions" [17, p.2].

In this regard, it is important to remember how lack of social gender affirmation was consistently associated with: "depression found; depression for adult trans women; anxiety symptoms, PTSD, internalization and externalization of problems, and psychological distress; various forms of family acceptance; decreased odds of smoking for transfeminine, but not transmasculine participants; decreased likelihood of delaying health care, depression, and PTSD and increased likelihood of high self-esteem and use of HIV prevention" [17, pp.13-14].

Thus, the social gender statement is not materially tangible in the same way as the medical gender affirmation, people whose social and legal gender affirmation needs are met can be motivated to avoid stigmatizing encounters and therefore negative experiences and health outcomes[38].

Therefore, future research is warranted to examine whether the expected stigma can mediate the association between these forms of gender health affirmation and avoidance, not prescribed use of hormones, mental health, etc.

5 Conclusions

The pathway of affirmation of gender is an important social determinant of TGD life. In Italy, this pathway appears to be focused mainly on the affirmation of the medical, legal, and psychological genre, however, the affirmation of social gender is also important to promote their integration into society, their health and general well-being. It is therefore necessary to develop and implement research and concrete impacts of the social gender claim, the potential of which is to reduce inequalities, in general, and health, which negatively impact the Italian TGD population.

References

[1] Bullough, V. Legitimatizing transsexualism. International Journal of Transgenderism, 10(1), 3–13. 2007.

[2] DeLamater, J., and Plante, R. F. Handbook of the Sociology of Sexualities. New York: Springer Cham. 2015.

[3] Coleman, E., Radix, A. E., Bouman, W. P., Brown, G. R., De Vries, A. L. C., Deutsch, M. B., ... and Arcelus, J. Standards of care for the health of transgender and gender diverse people, version 8. International Journal of Transgender Health, 23(Suppl 1), S1–S259. 2022.

[4] Conron, K. J., Scott, G., Stowell Sterling, G., and Landers, S. J. Transgender health in Massachusetts: Results from a household probability sample of adults. American Journal of Public Health, 102(1), 118–122. 2012.

[5] Joseph, A., Cliffe, C., Hillyard, M., and Majeed, A. Gender identity and the management of the transgender patient: a guide for non-specialists. Journal of the Royal Society of Medicine,110(4), 144-152. 2017.

[6] Prince, V. Homosexuality, transvestism and transsexuality: Reflection on their etiology and differentiation. International Journal of Transgenderism, 8(4), 17–20. 2005.

[7] Davis, E. (2008). Situating “fluidity:” (Trans)gender identification and the regulation of gender diversity. GLQ: A Journal of Lesbian and Gay Studies, 15(1), 97–130. 2008.

[8] Carter, M. Gender socialization and identity theory. Social Sciences, 3, 242–263. 2014.

[9] Chetkovich, C. How non-binary gender definitions confound (already complex) thinking about gender and public policy. Journal of Public Affairs Education, 25(2), 226-252. 2019.

[10] Bahrampour, T. (2018). Crossing the divide: Do men really have it easier (Doctoral dissertation, These transgender guys found the truth was more complex. Washington Post. Retrieved from http://proxy. library. upenn. edu: 2084/apps/doc).

[11] Henderson, S. L., & Jeydel, A. S. Women and politics in a global world. New York: Oxford University. 2014.

[12] Westbrook, L., & Schilt, K. Doing gender, determining gender: Transgender people, gender panics, and the maintenance of the sex/gender/sexuality system. Gender & society, 28(1), 32-57. 2014.

[13] Lombardi, E. Varieties of transgender/transsexual lives and their relationship with transphobia. Journal of homosexuality, 56(8), 977-992. 2009.

[14] Adamo, S., Tigani Sava, E., and Zanfabro, G. Non esiste solo il maschile. Teorie e pratiche per un linguaggio non discriminatorio da un punto di vista di genere. Trieste: Edizioni Università, Trieste.2019.

[15] Murgia, A., and Poggio, B. Saperi di genere: prospettive interdisciplinari su formazione, università, lavoro, politiche e movimenti sociali. Trento:Università di Trento, Trento. 2018.

[16] Loiodice, I., Plas, P., and Rajadell, N. Percorsi di genere. Società, cultura, formazione. Pisa: ETS. 2012.

[17] King, W. M., & Gamarel, K. E. A scoping review examining social and legal gender affirmation and health among transgender populations. Transgender Health, 6(1), 5-22. 2021.

[18] Reisner, S. L., Radix, A., & Deutsch, M. B. Integrated and gender-affirming transgender clinical care and research. Journal of acquired immune deficiency syndromes, 72(Suppl 3), S235-42. 2016.

[19] http://www.liberazione.it/giornale/050626/default.asp(accessed on: 24/08/2022).

[20] Micolano, B. Il diritto antidiscriminatorio nella giurisprudenza della Corte europea dei diritti dell'uomo. Milan: Giuffrè Editore. 2009.

[21] Vantin, S. L'eguaglianza di genere tra mutamenti sociali e nuove tecnologie: percorsi di diritto antidiscriminatorio. Pisa: Pacini editore.2018.

[22] Asscheman H, Giltay EJ, Megens JA, et al. A long-term follow-up study of mortality in transsexuals receiving treatment with cross-sex hormones. Eur J Endocrinol, 164(4), 635-42. 2011.

[23] Martini, L. Encyclopedia of Endocrine Diseases. Cambridge: Academic Press. 2018.

[24] T'Sjoen G, Arcelus J, De Vries ALC et al. European Society for Sexual Medicine Position Statement "Assessment and Hormonal Management in Adolescent and Adult Trans People, With Attention for Sexual Function and Satisfaction". J. Sex Med., 17(4), 570-584. 2020.

[25] Wylie, K., Knudson, G., Khan, S. I., Bonierbale, M., Watanyusakul, S., and Baral, S. Serving transgender people: clinical care considerations and service delivery models in transgender health, The Lancet, 388(10042), 401-411. 2016.

[26] Ducheny, K., Ducheny, C. T., Tajhi Claybren, K., and Parker, C. The essentials: Foundational knowledge to support affirmative care for transgender and gender nonconforming (TGNC) older adults. In Transgender and gender nonconforming health and aging (pp. 1-20). New York: Springer, Cham. 2019.

[27] Wierckx, K., Stuyver, I., Weyers, S., Hamada, A., Agarwal, A., De Sutter, P., and T'Sjoen, G. Sperm freezing in transsexual women. Archives of sexual behavior, 41(5), 1069-1071. 2012.

[28] Hembree WC, Cohen-Kettenis PT, Gooren L, et al. Endocrine Treatment of Gender-Dysphoric/Gender-Incongruent Persons: An Endocrine Society Clinical Practice Guideline. J Clin Endocrinol Metab. 2017;102(11):3869-3903. Erratum in: J Clin Endocrinol Metab. 2018; 103(2): 699. J Clin Endocrinol Metab. 103(7), 2758-2759. 2018.

[29]https://www.infotrans.it/it-schede-1-chi_siamo_infotrans (accessed on: 27/08/2022).

[30]https://www.iss.it/web/guest/comunicati-stampa//asset_publisher/fjTKmjJgSgdK/content/id/7190609 (accessed on: 28/08/2022).

[31] Meyer I. H. Prejudice, social stress, and mental health in lesbian, gay, and bisexual populations: conceptual issues and research evidence. Psychological bulletin, 129(5), 674–697. 2003.

[32] Bidwell, A. J. Chronic fructose ingestion as a major health concern: is a sedentary lifestyle making it worse? A review. Nutrients, 9(6), 549. 2017.

[33] Kerrebrouck, M., Vantilborgh, A., Collet, S., and T'Sjoen, G. Thrombophilia and hormonal therapy in transgender persons: A literature review and case series. International Journal of Transgender Health, 23(4), 377-391. 2022.

[34] Rhoden, E. L., and Morgentaler, A. Testosterone replacement therapy in hypogonadal men at high risk for prostate cancer: results of 1 year of treatment in men with prostatic intraepithelial neoplasia. The Journal of urology, 170(6), 2348-2351. 2003.

[35] Unger, C. A. Hormone therapy for transgender patients. Translational andrology and urology, 5(6), 877. 2016.

[36]Shilling, C. Sociology and the body: Classical traditions and new agendas. The sociological review, 55, 1-18. 2007.

[37] Paine, E. A. Embodied disruption: "Sorting out" gender and nonconformity in the doctor's office. Social Sciences & Medicine, 211, 352–358. 2018.

[38] Costa D. The influence of social capital on health issues among transgender and gender diverse people: a rapid review. Science & Philosophy, 10(2), 109-131. 2022.

[39] Costa D. Transgender Health between Barriers: A Scoping Review and Integrated Strategies. Societies, 13(5),125. 2023.

Science & Philosophy Volume 11(1), 2023

Am I Too Pixelated?

Alethea Black*

Abstract

In 2003, Nick Bostrom published his highly influential "Simulation Argument" in *Philosophical Quarterly* (Bostrom, 2003), an idea taken so seriously that even Bank of America has sent out alerts to its clients. But what, exactly, would that mean? And, more importantly, why is the idea of a simulated universe not being pursued in regard to cancer—and every other disease? We understand, in magnificently precise, granular ways, exactly what is going wrong in the body. But do we understand, in a coarser way, what the granules are made of? In a holographic universe, the images we perceive are not necessarily what they appear to be; they might exist against a background. But the background would create a context that participates in the image that emerges. Green can be rendered as green. Or as "blue yellow blue" or "yellow blue yellow." Perhaps the act of rendering generates variables that have been overlooked in our understanding of illness: scale and spin.

Keywords: simulation argument; reality; emergence theory; cognitive science; consciousness; perception; speed of light.†

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† Received on February 16th, 2023. Accepted on June 21, 2023. Published on June 30th, 2023. doi: 10.23756/sp.v11i1.1138. ISSN: 1592-7415. eISSN: 2282-8214. ©Alethea Black. This paper is published under the CC-BY licence agreement.

1. Introduction

This paper will be an exercise in shifting (for a few minutes) the way we view the world, from matter inside space to light inside time. Max Planck was able to demonstrate light behaving intelligently—choosing the shortest path.

Planck: "The photons which constitute a ray of light behave like intelligent human beings: out of all possible curves they always select the one which will take them most quickly to their goal."

Our foundational models of the cosmos have been based upon circles—orbits.

Matter might be able to travel in a circle. But can light? Once I reach 180°, there is a shorter path for me to take, across the center. If I seek the shortest path, it would be inefficient for me to go around 360°. With time, a more desirable shortcut emerges: the "straight line" path, visible at the eclipse.

Central here is perception—and its limits. We cannot see around corners; for any given observer, a sphere is a dome. If light takes the swiftest route, it cannot travel more than half a circle. For our purposes, the globe is a fiction.

This is just one small, introductory example whereby shedding the presumption that the world is fundamentally matter will shift what we see.

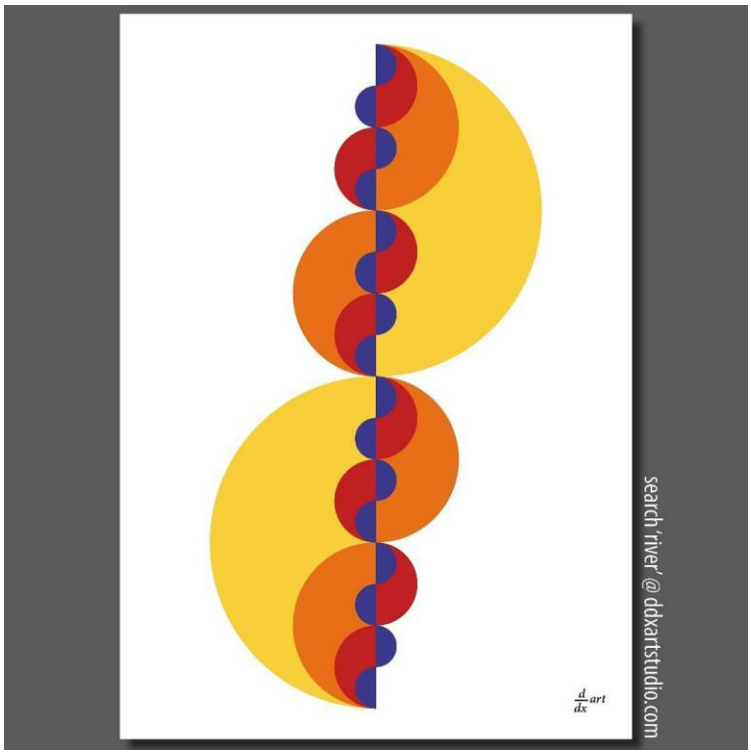

Figure 1 Seeing as light sees. Image: David Lawrence, ddxartstudio.com

There's exciting work being done by researchers such as Dr. Lisa Mosconi on the relationship between Alzheimer's and changes in the female brain during menopause (Mosconi, 2021). My mother has Alzheimer's, and I am in menopause. Earlier this year, I had my first experience of an atypical cognitive lapse. At the time, I noticed that the veins on the backs of my hands were bulging dramatically. The image that came to me was very precise: *My blood,* I thought. *It's too big. It's too big for my brain.*

Years ago, my mother and I both suffered from Reynaud's—where the tips of your fingers blanch in cold weather—and I have a broad familiarity with the feeling of dissonance between the size of my blood and me.

I will be talking a lot about time, and a possible relationship between time and scale. In a way, the sperm and the ovary perfectly exemplify two opposing models of time. When I was born, in the summer of 1969, I had all of my eggs. "Like a purse full of pearls," my mother used to say. Sperm, on the other hand, are made new every day; a man can make 1500 sperm every second.

Blood is more like sperm—constantly being re-written and re-made. I make a whole new batch of blood every 120 days. A brain is more like an ovary. It is more fixed in time. If blood and sperm are more like software, the brain and the ovary are more like hardware. Taken together, the two offer a more robust understanding of time than either would provide individually—like knowing a ship's speed as well as its point of origin. But in order to be taken together, the two have to fit. Perhaps, as I age in an expanding universe, my blood and my brain—like a new sperm and a seasoned ovum—are no longer the same scale.

Weyl invariance (scale invariance, whereby the behavior of small pixels and large pixels is ordained to be the same) does not seem to apply to my biology.

We are unaccustomed to addressing scale in our health calculations. How and why might issues of scale emerge? That will be a focus here.

One characteristic of Alzheimer's is insulin resistance. Insulin is the body's chief anabolic (rebuilding) hormone. If my understanding of time is too long, and oscillating too quickly—if I am making myself new too fast—insulin is equal parts solution and problem.

2. Methods/Results

This model is not about reality. It's about the observer. It's not about some shape in space that exists "out there." It's about images we are creating with our brains (Seth, 2017). The brain is not a passive observer, like a camera lens. The brain actively composes what we see.

Sometimes it is difficult for me to discern if my brain is naming what something *is*, or what it *does*. Would ice accelerating at the speed of fire be hot—or cold? Would fire decelerating at the speed of ice be cold—or hot?

Central here is the idea that the same thing can look different when seen from different directions.

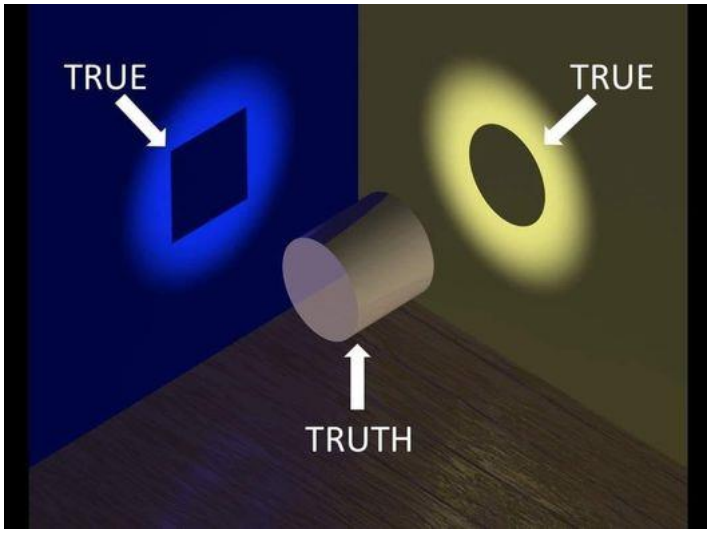

Figure 2 What we perceive is not objective.

In this model, which is holographic (more on that in a moment), the more fundamental perspective will be that of light. The perspectives of matter and energy will be treated as derivatives. Distortions.

Perhaps, in a holographic universe, there are different ways to render the same light. I can be "earth" (so to speak). Or, like an ice skater pulling in for a twirl, I can be "moon inside sun." When I am moon inside sun, it is as if I am inside myself. No longer the flower, I am the seed and the fruit. The image is no longer whole. Instead of wholeness, there is now a homunculus against a background.

In the vein of Plato, I am likening matter and energy to "shadows" of light. Matter and energy are one degree of remove from light, but two degrees of remove from each other. They are flip sides, mirror images. If we create matter to the left of time, we simultaneously create energy to time's right.

I will be treating light as the Platonic state; light is green as green. There is neither foreground nor background. Matter is like putting a green dot on a green background—it needs to expand to achieve light's density. Energy is like putting a yellow dot on a green background—it needs to condense to achieve light's density.

In other words, that which is denser than light will expand. That which is more diffuse than light will condense. But who decides where we draw the line?

A shadow is *real*, it's just something that is being rendered. Simulated, you might say. This paper will argue that it is only when light is being simulated, i.e. rendered, that it has speed. In its "true" (Platonic) form, outside of time, light is massless so it knows no distance, therefore can have no speed (see "spooky action" Aspect, 1986). It is being ensouled in matter that gives light speed. The denser the matter, the faster the speed.

In a holographic universe, the part will mimic the whole. Every cell is a miniature observer. But how can an observer perceive that he is too fast if his background has become simultaneously too hot? Earth as earth has the proper density and proper speed. Moon against sun is "too fast against too hot." Venus against Jupiter. Mercury against Saturn.

To our left (the rocky planets), we see light that is denser than light; to our right (the gas giants) we see light that is more diffuse. Was David Bohm, the great champion of wholeness, correct? Are these twin halves of the same coin—the blue half and the red half of our "3D glasses"?

I was four years old when my father, Fischer Black, published his formula for pricing derivatives in 1973. My father's work was to try to tease the truth from the dross. "The effects of noise on the world, and our views of the world, are profound," he said. He believed noise is what makes our observations imperfect. But—imperfect in what way?

In these models, imperfections arise when our perspective deviates from that of light. We need to see the image *as itself*. Not paired shadows of the image—something smaller against something larger. Not the stationary train. And not all of the points of the track at once. Something between the two. The speeding train itself.

Matter is like a small curve looking at a wider curve—it sees expansion. Energy is like a wide curve looking at a smaller curve—it sees contraction. But the truth lies hidden between the two. Matter is like the seed within the fruit. Energy is like the fruit within the seed. Light is like the flower.

The holographic principle was first proposed by Nobel laureate Gerard 't Hooft in 1993, developed by Leonard Susskind in 1995, and has been championed by Stephen Hawking, Juan Maldacena, and many others ('t Hooft, 2000). In 2017, a UK, Canadian, and Italian study provided substantial evidence (Afshordi et al., 2107) that the universe is, indeed, holographic.

We treat what we perceive as frank light—light as itself. I believe it is more akin to light's derivatives. In order to be seen as itself, perhaps light requires the proper background. When the background is too cold, light has to be too fast. When the background is too hot, light has to be too slow.

To our left, we see the rocky planets—cold light against a hot background. To our right, we see the gas giants—hot light against a cold background. But there is something between the two that we don't see.

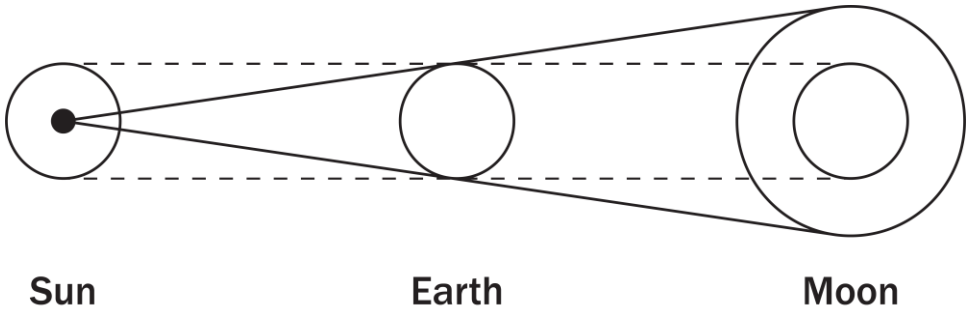

Figure 3 Envisioning time as a width of pipe. Image: John Lunt

There's a brilliant video by Veritasium (19 million views for a reason) that explains very elegantly and succinctly why the speed of light is a round-trip measurement. It's called "Why no one has measured the speed of light."

If light's speed is measured as a round trip, how is the light of day getting to us? Does it go to the moon behind us, then shine forward (expand) as the sun? Does it go to the sun in front of us, then shine backward (condense) as the moon? If Plato were alive today, he might ask us a gasp-worthy question: Is what we call "sun" light that has traveled to the moon and back?

Picture a width of pipe and call it time. When the pipe is more narrow than time (is being squeezed), light "shines forward"—sun; also the fourth state of matter experiment (Kolesnikov, 2016). When the pipe is wider than time (is being stretched), light "shines backward"—moon. When the pipe is just right, light is light. But would we know light qua light (light as light), should we see it? *Could* we see it? Sometimes I wonder if our brains render light as itself—the genuine article, rather than a shadow against a background—as a black hole.

This model—which owes a great debt to cognitive scientists such as Donald Hoffman, Beau Lotto, and Anil Seth—is not about object as object. It's about the expression of light's limits. This is not about black hole qua black hole. It's about a width of light that is "parallel" to our own.

"The black hole at the center of our galaxy, Sagittarius A, has the largest angular size in the sky, followed by M87. M87's black hole is 1000 times bigger, but roughly 1000 times farther away."* —Feryal Özel, Harvard University Black Hole Initiative

This is not a materialist model, where the world is comprised of particles. This is an energetic model, where the world is comprised of forces.

In a holographic universe, should the context against which we make our measurements be that of a vacuum? Wouldn't the background in a holographic

universe be … the speed of light? Perhaps the speed of light is a hidden variable, hidden the way it is hidden when the stage spins left while the actor upon it paces right.

The field (the stage) can be naturally, innately inertial. Or it can be a "net" inertia that I am helping to create.

My body wants to maintain homeostasis (balance). When I sense the expanding force (manganese?), I condense. When I sense the condensing force, the magnetic force (iron?), I expand.

But could it be possible to get "turned around"?

What if, when I perceive the expanding force, instead of condensing, I were to expand (Parkinson's?). What if, when I perceive the magnetic force, instead of expanding, I were to condense (ALS)? In these models, as we will see in a minute, the same limit—the speed of light—can mean different things. *C* has four different varieties of observer: matter, energy, dark matter, and dark energy.

Alternately, could it be possible to "get stuck"—to be effectively locked out of linear time? If my perspective is limited to that of matter, no amount of acceleration is going to get me over the line. It is as if I am trapped behind the speed of light lens from below (ME/CFS i.e. Chronic Fatigue Syndrome?). Or, if my perspective is limited to that of energy, no amount of deceleration is going to get me where I need to go. It is as if I am trapped above the speed of light lens (Autism?). In ME/CFS—this may also play a role in Alzheimer's—time is faster than I am. In Autism, I am faster than time.

Ideally, we want to be in line with time. In tune, so to speak. We want our light and the light of the world to have the same density and speed.

Are we designed to harmonize with the speed of light? Is there light at the center of every skull? I am interested in the small crystal in the brain called the pineal gland, and the idea that it has an optimum density and degree of dilation. If I squeeze my pineal gland too much, I am too small and the world is too large. If I dilate my pineal gland too much, I am too large and the world is too small. If light and I are the same width, the same density, neither acceleration nor deceleration is required.

When I fly backward in time (east coast to west coast, like diving to the bottom of the ocean), I contract and the world expands. When I fly forward in time (west coast to east coast, like hiking to the top of a mountain), I expand and the world contracts.

We don't want the pineal gland to be too cold and under too much pressure. And we don't want the pineal gland to be too hot and under too little pressure. If it is too cold and under too much pressure, I am restricted to seeing with the eyes of matter. If it is too hot and under too little pressure, I am restricted to seeing with the eyes of energy. Ideally, I need to be able to toggle between the two.

There seems to be an issue with the size and flexibility of the blood cells.

If I squeeze my pineal gland too much, the image I create will be too large, and the new RBCs I make will be too large. Once my RBCs are too large, they fit quite snugly within the blood vessel—therefore I have to keep my blood pressure too low. If I squeeze, I deform them. Conversely, if I squeeze my pineal gland too little, the image I create will be too small, and the new RBCs I make will be too small. Once my RBCs are too small, I have to keep my blood pressure too high—I have to squeeze a lot, in order to feel them. I need peripheral resistance; I need to feel the cells within the vessels to have control, to modulate my cardiovascular system.

In other words, once the pressure on my pineal gland is too high, the pressure in my vascular system has to be kept too low—and then I can get trapped like that. Once the pressure on my pineal gland is too low, the pressure in my vascular system has to be kept too high—and then I can get stuck like that.

Once my blood is the "wrong" size—once its scale and the scale of my body are not in line—I can make a whole new set, but it will take me 120 days. According to the Max Planck Center for Physics and Medicine and FAU, the Friedrich-Alexander-Universität Erlangen-Nürnberg (Kubánková et al., 2021), long-term changes to blood cells are triggered by Covid-19 infection. They "were able to prove for the first time that a Covid-19 infection causes significant changes in the size and stiffness of red and white blood cells, sometimes lasting several months. These findings may help to explain why some patients still suffer symptoms long after first contracting the virus (long Covid)."

If my red blood cells are not the right size, it restricts my ability to move around in time. When they are too large, it inhibits my vasoconstriction. When they are too small, it inhibits my vasodilation. If my blood cells are too small, and I vasodilate anyway, I can lose the connection and lose consciousness.

The perception of acidity (e.g. a micro dose of LSD) seems to grant permission for a greater degree of vasoconstriction. The perception of alkalinity seems to grant permission for a greater degree of vasodilation. I have also been able to achieve a greater degree of vasodilation with small doses of niacin. Niacin (niacinamide) on the skin has helped me to prevent skin cancer recurrence.

How do I navigate time? These are my impressions.

To determine what time it is, my pineal gland reads the density of the light in my environment. If it is wider than I am, I expand, by pulling sodium inside the cell. If it is denser than I am, I contract, by pushing potassium outside the cell.

But every cell in my body is intelligent, and every cell reads the density of light for itself. If a cell or a cluster of cells within a local region contracts by a

full degree of light's speed, they pull back from the boundary and create a fresh "layer" of time—a new speed of light lens.

This fresh lens represents light's limits, but at a smaller scale, which increases my constraints.

From matter's perspective, when I accelerate (vitamin K1, potassium grants permission), if I cross the speed of light lens, I split. From energy's perspective, when I decelerate (vitamin K2, sodium grants permission), if I cross the speed of light lens, I fuse.

Since moving out of a moldy house in 2014, I have had issues with fatigue, orthostatic intolerance, and viral re-activation. Why?

Perhaps being in the presence of mold (matter decaying backward) shifted my brain's understanding of time. In these models, time runs both forward and backward. It runs forward until it reaches a boundary—the speed of light—then it flips.

My Krebs cycle, for instance, does not simply run in one direction, to generate energy. It can also run in the opposite direction, to generate matter. When my Krebs cycle runs in reverse, I endogenously (internally) manufacture oxalate, a crystal found in plants capable of photosynthesis. Oxalate is known to induce breast cancer (Castellaro et al., 2015).

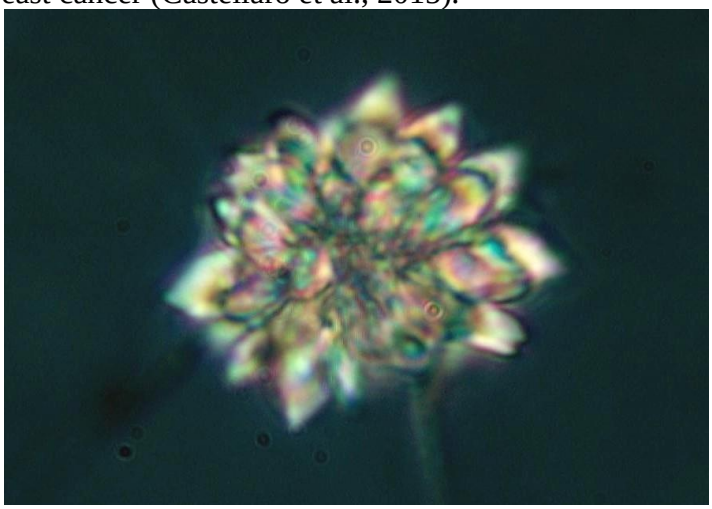

Figure 4 Oxalate crystal: dense light? Image: Facebook, Trying Low Oxalates

The following is from Nick Lane in *Quanta*: "A Biochemist's View of Life's Origin Reframes Cancer and Aging."

"About 10 years ago, the cancer community was amazed by the discovery that in some cancers, mutations can lead to parts of the Krebs cycle running backward. It came as quite a shock because the Krebs cycle is usually taught as only spinning forward to generate energy. But it turns out that while a cancer cell does need energy, what it really needs even more is carbon-based building blocks for growth. So the whole field of oncology began to see this

reversal of the Krebs cycle as a kind of metabolic rewiring that helps cancer cells grow."

I believe this metabolic "flip" should be central to how we view our health and the cosmos itself. When observing the universe—and our bodies—we should remember that the same image can look different when perceived from different directions (Lotto, 2017). We do not see reality as it is (Hoffman, 2019).

Do we have any evidence to suggest this kind of "flip" actually exists?

We do. An analysis of our Cosmic Microwave Background data by physicist Craig J. Copi reveals large-angle anomalies (Copi, 2010). These hot and cold regions appear to flip along the ecliptic (at the eclipse). Here is an image of the data.

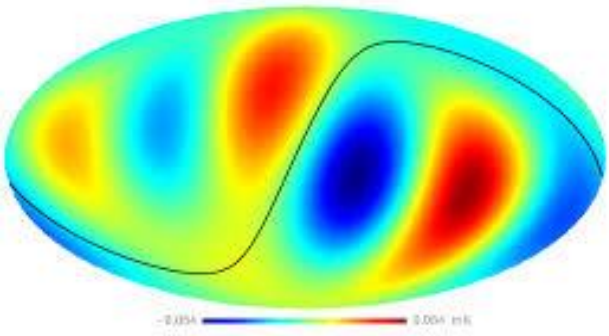

Figure 5 Large-angle anomalies in our Cosmic Microwave Background. Image: Craig J. Copi

And here is what physicist Lawrence M. Krauss has to say about this image:

"But when you look at CMB map, you also see that the structure that is observed, is in fact, in a weird way, correlated with the plane of the earth around the sun. Is this Copernicus coming back to haunt us? That's crazy. We're looking out at the whole universe. There's no way there should be a correlation of structure with our motion of the earth around the sun—the plane of the earth around the sun—the ecliptic. That would say we are truly the center of the universe. The new results are either telling us that all of science is wrong and we're the center of the universe, or maybe the data is (s)imply incorrect, or maybe it's telling us there's something weird about the microwave background results and that maybe, maybe there's something wrong with our theories on the larger scales."

Picture a sphere with a point at its center. Now bisect the sphere somewhere with a flat, 2D plane—let's say, at the 37th parallel.

Who is the designated observer in this model? I believe it's the 2D plane. I am likening the point to matter, the sphere to energy, and the plane to light. When Venus is the point, Jupiter is the sphere. When Mercury is the point, Saturn is the sphere.

When my perspective is that of the point, I am too dense in time. I need to expand, but I can't. When I perceive the 2D plane, it functions as the sphere for me. I can't expand beyond it. When I see with the eyes of matter, my pH range is not a true 0-14. I have to fit 0-14 in the space of 0-7.

When my perspective is that of the sphere, I am too diffuse in time. I need to condense, but I can't. When I perceive the 2D plane, it functions as the point for me. I can't condense beyond it. When I see with the eyes of energy, my pH range is not a true 14-0. I have to fit 14-0 in the space of 14-7.

In each of these cases, I have, in effect, lost my ability to move around in time.

What is time?

I am arguing that a universe is a closed system—a singularity—and time is a force that opposes the Big Bang. When the Big Bang expands, time contracts. When the Big Bang contracts, time expands. My brain seems to be always trying to perceive the forces—the energy differential between self and world—in its environment.

Here is how time seems to operate, in me.

To one side of the baseline, time is slower (dopamine). To the other side, time is faster (serotonin).

I can slow time down, using dopamine, up to a point. But if I start to have too much dopamine, I will compensate, by hyper-methylating.

I can speed time up, using serotonin, up to a point. But if I start to have too much serotonin, I will compensate, by hypo-methylating.

This creates problems. For one thing, the feeling of hypo-methylating can mimic the feeling of dopamine. Is time slow—or am *I* slow? Similarly, the feeling of hyper-methylating can mimic the feeling of serotonin. Is time fast—or am *I* fast?

We have assumed that time is like a river whose speed we are strapped to. What if it's more like a current in which we can swim backward or forward—or tread in place? Altering the pH of my brain (e.g. a micro dose of LSD) seems to affect how long I am able to spend in each discrete moment of time. The more acidic, the longer—up to a point.

In other words, if we think of time as being comprised of discrete units—the way an image is pixelated, the way a movie is comprised of frames—my speed need not match time's speed. But if it veers too far afield, I run into problems.

I believe it's possible to be in a state of simultaneous dopamine toxicity and hyper-methylation, and that this may be part of what we're seeing in both

Parkinson's disease and *encephalitis lethargica*—the illness popularized by Oliver Sacks's memoir, *Awakenings*. When time is too slow, light has to be too fast. Ultimately, discrete moments of time whir past me so swiftly, I am blind to them. They are like the bars the panther passes in Rilke's poem.

I believe it's possible to be in a state of simultaneous serotonin toxicity and hypo-methylation, and that this may be part of what we're seeing in Lou Gehrig's disease (ALS). When time is too fast, light has to be too slow.

In fact, I believe these patterns of titration—of compensation—extend far beyond human disease to the cosmos itself.

In the gas giants, light is spinning so slowly, it's burning up. In the rocky planets, light is spinning so quickly, it's precipitating out of solution. Only *at* the speed of light is there "simple" (two-dimensional) homeostasis.

I'd like to propose an alternate model to that of the vacuum. What we observe is taking place inside time. A unit of time has a fundamental length—27,729 days, which is about the length of a human life, and approximately 70 x 360 plus 7 x 360 days. This "width" of time defines a margin inside which, light is light. Above and below it, light is no longer light, but matter and energy, respectively.

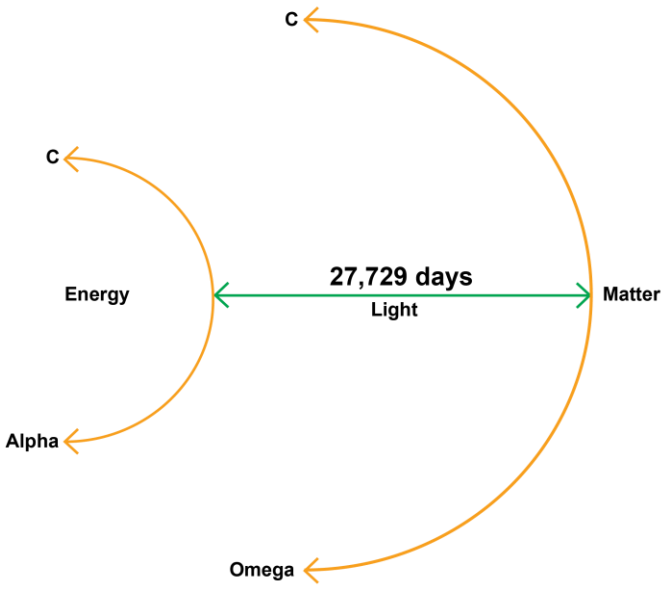

Figure 6 Linear time as bounded by two speeds of light. Image: Ray Vella

Between *c* and *c*, the equation is naturally balanced. Beneath the lower *c*—which I'm calling Alpha—if I perceive the exploding force, I will apply the condensing force, by moving potassium ions outside the cell. But here's the problem: if I am condensing, the world will appear to explode. It is possible to get caught in a loop.

Above the higher *c*—which I'm calling Omega—if I perceive the condensing force, I will apply the exploding force, by moving sodium ions inside the cell. But here's the problem: if I am exploding, the world will appear to condense. Again it is possible to loop.

It's a metabolic cul-de-sac, a feedback trap. And its root cause, I believe, is relativity. Perception.

I am pushing Ca+ calcium ions back and forth across the cell membrane. But when time is too long, I have to push them too quickly. In this model, time is "long" (relatively speaking) when I am tall, or on top of a mountain. It is "short" when I am deep-sea diving or at the bottom of the ocean.

In other words, time relates to scale—and both relate to disease.

My brain must accurately locate me inside time. At the speed of light—between Alpha and Omega—I have maximum freedom. Above or below the speed of light, my hands are tied. The past is already written; it cannot split. The future is not written yet; it cannot divide.

If my brain locates me in the past (above pH7), I become metabolically trapped. I can no longer move forward in time; I am restricted to creating only chiral images. With chiral (splitting) images, the moments fly away from me too quickly (ME/CFS, Chronic Fatigue Syndrome?).

If my brain locates me in the future (below pH7), I become metabolically trapped. I can no longer branch backward in time; I am restricted to creating only achiral images. With achiral (repeating) images, the moments linger too long (Autism?).

I have a fundamental unit of time to work with—27,729 days. If I spend all my energy going in a circle (space), I have none left to go up and down (time). If I spend all my energy going up and down (time), I have none left to go in a circle (space).

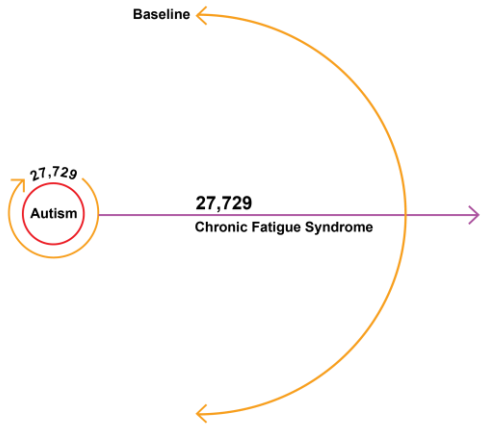

Figure 7 Do our health disorders relate to space and time? Image: Ray Vella

In this model, every arrow of time is enclosed by two speed of light boundaries—two black holes. We are inside the past and outside the future. Behind us is a speed-of-light boundary we cannot escape—because it is already written. In front of us is a speed-of-light boundary we cannot enter—because it is not written yet. I'm interested in physicist Nikodem Poplawski's theory that our universe is the interior of a black hole inside another universe (Poplawski, 2012). In fact, I wonder if we could be inside a black hole inside a black hole inside a black hole—etc.—where "black hole" is the 2D boundary known as the speed of light. Moving outward from brane to brane, scale increases. Moving inward from brane to brane, scale decreases.

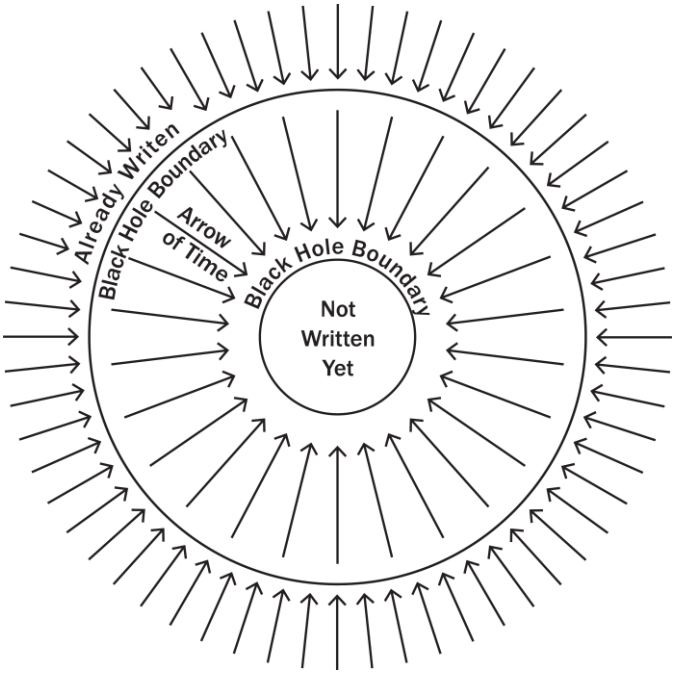

Figure 8 The multiverse as framed by two black holes. Image: John Lunt

It's all well and good to theorize that scale may play a role in disease. But do we have any *evidence* to support this theory?

As a matter of fact, here's something interesting.

The Atacama skeleton, who is human, is from a region of the world known as the South Atlantic Anomaly, where our magnetic field is altered. Earth's inner Van Allen radiation belt comes so close to the surface that it dips to an altitude of two hundred kilometers. Atacama looks alien to us. Perhaps we are not viewing her through the right lens.

Figure 9 Atacama skeleton. Photograph: Dr Emery Smith

What if Atacama's light is "too dense" in the same way the moon's light is "too dense"? Perhaps we are seeing her in the wrong context. Atacama's medium, her environment, was very high energy.

If the world is light—holographic universe—how is my image being rendered? From matter's side—from the left of time? Or from energy's side—from time's right?

What if, when I am spinning left-->right and the basal cells on my shoulder are spinning right-->left, I have cancer. When I am spinning left-->right and the *H. pylori* in my gut are spinning right-->left, I have an *H. pylori* "infection," and perhaps an ulcer. When I am spinning left-->right and the DNA in my womb is spinning right-->left, I am pregnant. But the infant will likely need some vitamin K1 at birth, to help her change perspectives and change direction.

Maybe the speed of light functions like a lens. When observed from beneath the lens, light appears to be branching into many worlds. When observed from above the lens, light appears to be condensing into one world. But, in a sense, these are mirror images. Reciprocal illusions. Noise. At the lens—the "real" world—light is light.

What happens if I insert a new lens—a fresh perspective, new consciousness, a stem cell—into an old environment? If I put new wine into old wineskins, I run the risk of re-setting the metronome. A new lens creates a new 2D plane from which light can condense and then expand—or expand and then condense. It creates a "fresh green," if you will, from which can be derived fresh "blue yellow blue" or "yellow blue yellow." New light is capable of operating at a different time signature—a different scale.

Imagine light as like a fabric comprised of blue and yellow fibers. There are different ways "green" can be rendered. When the fabric is "flat," and the fibers are dispersed homogenously, we see green. If we pull all the blue fibers to the foreground, the background becomes yellow. The image is still green, but to see it as green, we would have to be outside the background and inside the foreground. If we stretch all the blue fibers to the periphery, the foreground becomes yellow. The image is still green, but to see it as green, we would have to be outside the background and inside the foreground. These are different ways of rendering the same image; all that changes is the foregrounding.

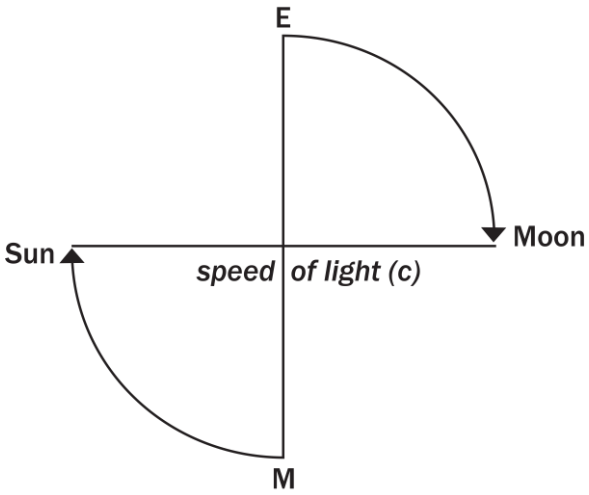

Figure 10 Matter burning and energy precipitating toward the speed of light.

A lens can focus or scatter light—or both, at the same time. When the image becomes too dense, on one side of the lens, it becomes too expanded, on the other.

With cancer, I am deranged on both sides of time—both sides of the speed of light lens. To one side, I am too salty, too bitter. To the other, I am not salty enough. Instead of the flower, I become the fruit and the seed.

My light is splitting too quickly—and not quickly enough. To one side of time, it's so cold, it's burning up. To the other side, it's so hot, it's precipitating out of solution. Instead of "earth," I have become … moon against sun. Venus against Jupiter. Mercury against Saturn. The image is no longer flat; now there is foregrounding.

Only at the speed of light are we able to see light as itself—the train as the train. Beneath Alpha, we are viewing light as its passenger. Above Omega, we are viewing light as its track.

As I write this, the United States is experiencing extreme weather. Record-breaking cold. Epic snow and rain. Last week, a 7.8 magnitude earthquake struck Turkey and Syria. I wonder if we have crossed a line and have entered a period of contraction.

But, surely, if the earth—the entire universe—were contracting, we would perceive it, wouldn't we?

Not necessarily. Not if what we perceive exists against a backdrop—as would be the case if reality were holographic. Would we perceive contraction if the background were expanding to a commensurate degree? Would we perceive expansion if the background were contracting? I recently read a wonderful piece by Jim Pivarski at Fermilab. "Is the universe getting bigger or am I getting smaller?"

Perhaps what we perceive is a composite image of which we see only half. We see only one side of the speed of light lens at a time. In "sun," we see only the fire of acceleration—not the dark matter behind it. In "moon" we see only the precipitate of deceleration—not the dark energy that surrounds it.

E = mc^2—mass-energy equivalence—suggests that either matter or energy can play the role of matter or energy.

What if the speed of light is an invisible boundary—a limit, a lens, a curved line or "dome," like the dome of Genesis—between matter and energy? Matter will expand toward the lens (day, sun). Energy will condense toward the lens (night, moon).

But matter cannot cross the speed of light lens. Only dark energy (energy that is denser than matter) can do that. And energy cannot cross the speed of light lens. Only dark matter (matter that is more diffuse than energy) can do that.

If dark matter is able to dip below the lens, and dark energy is able to eclipse the lens, perhaps the resulting configuration would look something like this:

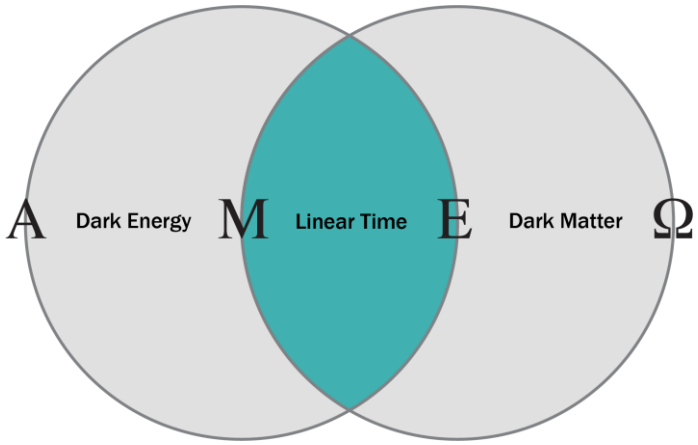

Figure 11 Time as vesica piscis. Image: John Lunt

But here's the tricky bit. The green region of overlap between two speeds of light, the vesica piscis—which, in this model, represents linear time—will read differently to different varieties of observer. For matter, the speed of light is the ceiling. For energy, it is the floor. For dark energy, it is something to eclipse. For dark matter, it is something to dip below.

Might this variance in how the speed of light can be interpreted have bearing on our illnesses?

3. Conclusion

When my father was dying of squamous cell carcinoma (a tumor at the base of the tongue) at age 57 in 1995—one hundred years after the death of Louis Pasteur—something I had never seen before appeared behind the great man's eyes. A question. *What is this life?*

What if this life is a story, fresh and ancient, always present and yet ever new? A story that is endless—eternal—that starts with the beautiful phrase: בְּרֵאשִׁית *In the beginning*. A story in which we all get to participate, and no part is greater or less than the others. In fact, all the parts are played by the same consciousness. The same "I." The same love.

We have not come into being in order to hate and destroy. We have come into being in order to thank and praise and love. I feel happiest, and most alive, when instead of judging or condemning others, I try to imagine what it feels like to be them.

What is this life? Sometimes it feels like a movie I'm watching, in real time, from the inside—a movie entitled "What It Was Like to Be Alethea Black." And I'm watching it through her eyes, but I'm not really Alethea.

Fischer Black
President of the American Finance Association
1985

Figure 12 Fischer Black

So what is the solution? I don't know. I'm sorry; I wish I did. I'm hoping that others who understand the human body far better than I might read this, and allow it to shift the conversation a little. Perhaps what we observe on the surface is only part of the story; there are hidden variables we are not seeing: the height and depth of time. Time may be like an iceberg, where we see only

the interface where it intersects with the surface of the water. In a sense, we see only a single MRI slice.

Everyone is different. I am still not 100% recovered. For me, I feel best when I avoid activities that increase intracellular sodium (dark energy): physical exertion, adrenal overload, frightening situations, scary movies. Intracellular sodium causes me to expand, and it feels as if I am already too expanded—too pixelated.

After living in a moldy house, one of the lingering problems I had was orthostatic intolerance—when your body can't adapt quickly enough to changes in blood pressure. When I tried micro dose psilocybin for cluster headaches (it worked), I noticed it also helped with my orthostatic issues. I could feel that I suddenly had access to a greater degree of vasoconstriction, and found that I could stand near elevator banks without feeling I was going to pass out. I could drink flat water without feeling vertigo and dizziness. I could be in sunlight without acute photosensitivity. I could read (could tolerate artificial light) after sundown. Around this same time, I saw a patent application for LSD to treat Alzheimer's, and began to ponder life's big questions in a deeper way, as well as the promise of psychedelic medicine.

Please bear in mind that one of the underlying principles of this model is that no one needs to be "fixed." Inside every child and every person is an extraordinary gift. We are all perfect, just as we are.

4. Bonus Track: The Speed of Light and *Pi*

God said: Let there be light. Might this truly be a holographic universe, as predicted by Leonard Susskind, Stephen Hawking, Juan Maldacena, Gerard 't Hooft, Michael Talbot, and many others? I don't know. But if it is, a better understanding of light's behavior will surely benefit our attempts to decode our diseases.

Perhaps, to an observer wider than it is, light will expand. To an observer denser than it is, light will condense. To an observer who is the same width… . But if it does nothing, would it be visible? We have witnessed light behave in mystifyingly inconsistent ways depending on the presence of an observer in the double-slit experiment.

I promised you a paper not about matter inside space but about light inside time. What does that even mean?

The issue is one of perception. From the vantage point of the stationary train, our eyes see the track. From the vantage point of the track, our eyes see the stationary train. But the truth is speeding between the two. We are used to seeing eggs or chickens. We need to see the chickenegg.

Time is a chickenegg. It is both one and many. "Now" (the present) is neither past nor future; it is the middle point—Wednesday. Many Wednesdays look back to a single Monday. But many Fridays look back to a single Wednesday. The same point looks singular when viewed from the future but myriad when viewed from the past.

The perspectives of past and future are both noise. The "truth" (now as now) is the dotted line hidden between the two.

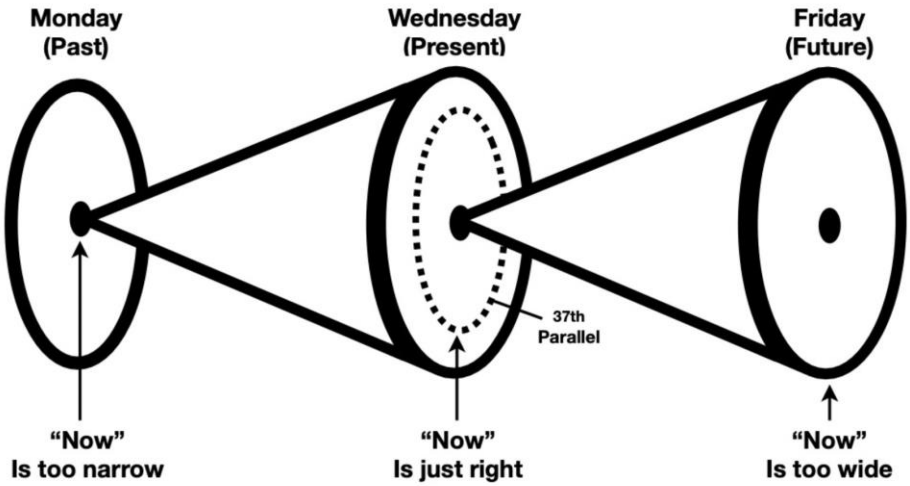

Figure 13 Past and future are distortions. Image: Haley Blevins

Time is not a cone. That is the optical illusion, the visual effect. It appears to narrow when we look toward the past, and to widen when we look toward the future. But I believe it does neither; more accurately, it can be likened to a width of pipe that is the width of the earth. The width of the moon would be too narrow. The width of the sun would be too wide.

Or, at a smaller scale, the proper width is the 37th parallel. The center of the earth would be too narrow and the circumference of the earth would be too wide.

This paper is called "Am I Too Pixelated?" because it is about an ancient idea: the world as image. When the amount of pressure is just right, there is wholeness. When the amount of pressure is too high, the image is no longer whole; instead of wholeness, there is now a homunculus against a background—something smaller inside something larger—a kernel, and a context. To the left of time, I am denser than light. To the right of time, I am more diffuse.

When I had breast cysts, and ovarian cysts, I could feel what this was like. It felt like cake batter, in a bowl, where instead of being dispersed homogenously, all the flour had been squeezed to the center, creating a liquid background. When I was the size of the bowl, as evenly dispersed as the bowl, I was pH7. When I was being squeezed, I was sodium inside potassium.

Once I become sodium inside potassium, watch what happens. Let's say the mandate in a holographic universe is pH7, "purple." When I am sodium inside potassium, when viewed from the outside and the inside simultaneously, I am still pH7. From one side, I am seeing red through a blue lens. From the other side, I am seeing blue through a red lens. Because of this, I become metabolically trapped. I write more about this in a series of articles on the Hormones Matter website, one of which is called "Perception, the Key to Disease."

To return to the batter in a bowl analogy, if the center is too dense, how can I add water? Then the whole bowl will be too watery. If the periphery is too diffuse, how can I add flour? Then the whole bowl, the batter will be too thick. I am stuck, because I need to do two things at once. If we are talking about an actor walking toward the left while the stage spins right, I need them both to change their speeds in tandem.

But, see, this is the very heart of the problem. They *are* changing their speeds in tandem. If the actor is running, and the stage is spinning quickly, to their eyes, everything is in balance. If the actor is standing still, and the stage is standing still, to their eyes, everything is in balance. We want the actor to walk in an easy stroll as the stage gently spins. The more he feels the condensing force, the "squeezing" force, the faster he will run.

When I was being squeezed too much, it felt like too much vasoconstriction, like a localized niacin deficiency. Nicotinamide (niacin) increases lipid metabolism and ROS-induced energy disruption in triple-negative breast cancer, and is being investigated for its drug potential as an anti-tumor agent (Jung et al., 2022). In my opinion, the niacin is needed locally—not globally. Garlic, too—another famous cholesterol-lowering vasodilator—has demonstrated "profound" anti-cancer activity, but only when injected, not ingested (Li et al., 2018): "Although very simple, the profound anticancer property of the injected RGE [raw garlic extract] has not been reported in the literature."

There seems to be an issue linking the pH of my brain with the amount of vasoconstriction or vasodilation it will permit. When my brain is too acidic, it will not let me vasodilate as much as I'd like. When my brain is too alkaline, it will not let me vasoconstrict. When I was living in a moldy house, I had a lot of orthostatic problems and balance problems.

To have maximum metabolic freedom, I need to increase my acidity—and my alkalinity. But how can I? If I increase both at the same time, I am simply a

"larger" pH7—a bigger mixing bowl. When this happens, I am too expanded, too homogenous, too pixelated.

When my image is too large, I vasoconstrict too much, and loose feeling in my hands and feet (neuropathy). I vasodilate too much, and get a migraine. I do not understand the proper values for time's floor and ceiling. The poles of my pH range are too far apart.

Bizarrely, when I was very sick, I could not drink water. It did not give me a lever, in either direction. I could not expand in response to bitter nor condense in response to sweet. Water is not bad for you, obviously; it is good for you. The problem was not with water—it was with me.

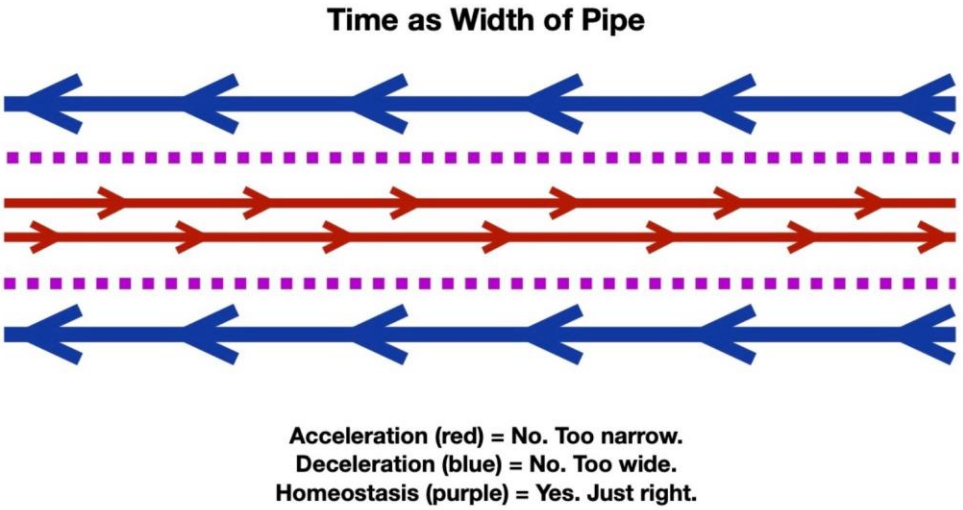

Figure 14 Scale and time. Image: Haley Blevins

With many illnesses, we are achieving the appropriate speed of time inefficiently. To be "accelerating inside deceleration" (red on blue) or "decelerating inside acceleration" (blue on red) is not the same thing as standing still (purple). To be doing both simultaneously will result in too many worlds—cancer. A fundamental unit of time that includes both Monday and Friday will be both too narrow for the pipe at one end and too wide for the pipe at the other. This is a violation of time; it is not one but two universes. A single arrow of time cannot contain both purple "red and blue, superimposed" and "red and blue, separate." This is not "now;" not light; not a true Wednesday. It is Monday→Friday. Time, in other words, is too long. When time is too long, too alkaline, it has to oscillate too quickly. Sometimes I am able to "shorten" time—to make it more acidic, and therefore able to oscillate

more slowly—with a micro dose of LSD "acid" or psilocybin. Melatonin does the opposite.

My circadian rhythm has been shifted for many years—since childhood. I like to stay up late at night and sleep late into the day. My brain, I have noticed, does not seem to treat darkness as darkness. It treats it as light that is wider than light.

The behavior of light is interesting. If I stand in the middle of a flashlight beam and face the source, I can see light. But if I face away from the source, can I see light? I can see whatever light might *hit*. But that is not the same thing as seeing light *itself*.

Light's speed is measured as a round trip. So what if Jim is creating light's speed by running around a track, and Susie is creating light's speed by running to the center of the track and back? (Is the speed of light evinced in the *pi* ratio?) It doesn't matter if you're a doctor or a coder: if, within one system, we have two different definitions of the same thing, it's a problem.

In a holographic universe, what we call light could be genuine light. But it could also be light that is at a remove from itself. If we treat light as a derivative, all that we need to do to call something light is establish a pH floor (matter) and ceiling (energy). In these models, which owe a debt to Klee Irwin and Garrett Lisi's quasi-crystalline E8 models, light can be removed from itself by up to eight degrees.

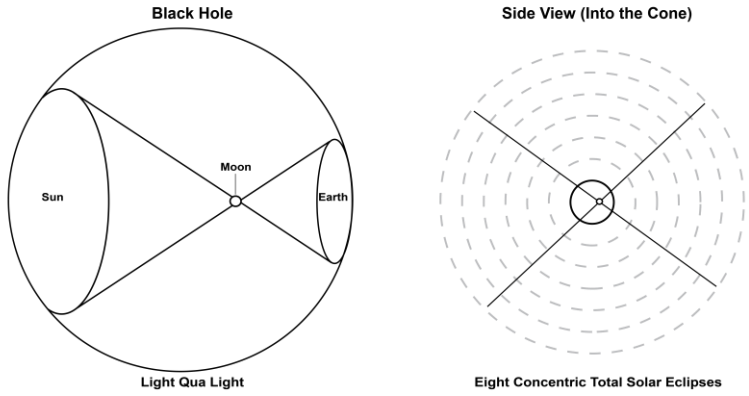

Figure 15 Eight degrees of light's speed. Image: Ray Vella

Many of us think of today as being *sui generis* and unique. But today could be iterative—eternal. Tomorrow, today will happen again. I no longer think of time as running in linear fashion, from one day to the next and the next. I think of all the days as running simultaneously.

"Everything is temporary" we are fond of saying. This essay sings a counter-note. Everything is eternal. If time—the Big Bang—is eternal, all of it

already exists. Although we experience it progressively, layer by layer, the whole thing is present. The future is exploding in many directions at once. The past is co-happening behind us. But both are here, now. What we were, we are. What we will be, we are. We am.

Acknowledgements

Everyone likes to believe they are open-minded and willing to entertain new ideas. But old ideas possess a certain gravity; they have been published in papers, in textbooks; people have built their careers and their tenures around them. The best new ideas display a humility that acknowledges that everything serves a purpose in the grand scheme, and they seek not to abolish but to complete. My goal is to spark someone else's torch.

For a new idea that challenges the way we have seen ourselves for a long time to break through the noise does not merely require a free-thinker with a laptop and a reader with an open mind. It also requires an editor with intellectual and moral courage—con le palle. I have been lucky enough to find such an editor not once but multiple times, and would like to wholeheartedly thank Fabrizio Maturo and Chandler Marrs.

References

[1] Bostrom, N. (2003). Are you living in a computer simulation? *Philosophical Quarterly*, Vol. 53, No. 211, pp. 243-255 https://doi.org/10.1111/1467-9213.00309

[2] Mosconi L**.,** Berti V., Dyke J., Schelbaum E., Jett S., Loughlin L., Jang G., Rahman A., Hristov H., Pahlajani S., Andrews R., Matthews D., Etingin O., Ganzer C., de Leon MJ., Isaacson R., Brinton RD. (2021). Menopause impacts human brain structure, connectivity, energy metabolism, and amyloid-beta deposition. *Scientific Reports* 2021;11: e10867.

[3] Seth, Anil K. *Your brain hallucinates your conscious reality*. TED, 2017.

[4] Aspect, A. & Grangier, P. (1986). Experiments on EPR type correlations with pairs of visible photons in Penrose, R. & Isham, C.J., *Quantum Concepts in Space & Time*, Oxford University Press, 1986.

[5] t Hooft, G. (2000). The Holographic Principle. 37. 10.1142/9789812811585_0005.

[6] Afshordi, N., Corianò, C., Rose, L.D., Gould, E., and Skenderis, K. (2017). From Planck data to Planck era: observational tests of holographic cosmology. *Physical Review Letters* 118, 041301.

[7] Kolesnikov, A., Reiter, G., Choudhury, N., Prisk, T., Mamontov, E., Podlesnyak, A., Ehlers, G., Seel, A., Wesolowski, D., and Anovitz, L. (2016). Quantum tunneling of water in beryl: a new state of the water molecule. *Physical Review Letters* 116, 167802.

[8] Kubánková, M., Hohberger, B., Hoffmanns, J., Fürst, J., Herrmann, M., Guck, J., Kräter, M. (2021). Physical phenotype of blood cells is altered in COVID-19, *Biophysical Journal*, 2021, ISSN 0006-3495, doi.org/10.1016/j.bpj.2021.05.025.

[9] Castellaro AM., Tonda A., Cejas HH., Ferreyra H., Caputto BL., Pucci OA., Gil GA. (2015). Oxalate induces breast cancer. *BMC Cancer*. 2015 Oct 22;15:761. doi: 10.1186/s12885-015-1747-2. PMID: 26493452; PMCID: PMC4618885.

[10] Lotto, B. *Deviate: The Science of Seeing Differently*. Hachette Books, 2017.

[11] Hoffman, D.D. (2019). *The case against reality: how evolution hid the truth from our eyes*. [S.l.]: Allen Lane. ISBN 978-0241262627

[12] Copi, C.J., Huterer, D., Schwarz, D.J., & Starkman, G.D. (2010). Large-Angle Anomalies in the CMB. *Advances in Astronomy, 2010*, 847541. https://doi.org/10.1155/2010/847541

[13] Poplawski, N. (2012). Every Black Hole Contains a New Universe. *Inside Science: Reliable news for an expanding universe*, 2012.

[14] Jung M, Lee KM, Im Y, Seok SH, Chung H, Kim DY, Han D, Lee CH, Hwang EH, Park SY, Koh J, Kim B, Nikas IP, Lee H, Hwang D, Ryu HS. Nicotinamide (niacin) supplement increases lipid metabolism and ROS-induced energy disruption in triple-negative breast cancer: potential for drug repositioning as an anti-tumor agent. Mol Oncol. 2022 May;16(9):1795-1815. doi: 10.1002/1878-0261.13209. Epub 2022 Mar 25. PMID: 35278276; PMCID: PMC9067146.

[15] Li, Z., Le, W. & Cui, Z. A novel therapeutic anticancer property of raw garlic extract via injection but not ingestion. *Cell Death Discovery* 4, 108 (2018). https://doi.org/10.1038/s41420-018-0122-x.

Science & Philosophy Volume 11(1), 2023

Correcting the Doppler Effect Formula

Denis Thomas*

Abstract

Christian Doppler, an Austrian physicist, described in 1842 the apparent change in frequency of a wave when motion of the source or the observer is involved. Named after him, this change in observational frequencies is known as the Doppler Effect. The formula for calculating the frequency change is taught in universities, textbooks, Youtube, and on the internet. Understanding the Doppler effect is used in applications such as radar and astronomy. Yet, the formula is wrong, yielding a different result when applying the same velocity, once to the source, then to the observer. This article will show the formula, the error, the correction to the formula, and how it disproves Einstein's theories of special and general relativity.

Keywords: Doppler Effect; Special Relativity; Redshift.†

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† Received on April 28, 2023. Accepted on June 21, 2023, Published on June 30, 2023. DOI: 10.23756/sp.v11i1.1196. © Denis Thomas. This paper is published under the CC-BY licence agreement.

1. Introduction

The Doppler Effect describes the change in observed frequency of waves due to the motions of the source, the observer, or both. Every type of wave travels at a constant velocity until conditions change. The velocity of sound changes with temperature and travels faster as the medium gets denser, going from about 340 meters/second in air to over 5,100 m/s through steel. "Water waves produced by a slow-moving tugboat have the same speed as those produced by a high-powered speedboat."[1] And light goes slower as the medium becomes denser, going from approximately 300,000 km/sec in a vacuum to about 200,000 km/sec through glass. The formula for the Doppler effect will be explained, examples given to show the error, the correction to the formula, and how applying the corrected formula to special relativity disproves the theory.

2. The Doppler Effect formula

$fd = fs\ (\frac{vw \pm vo}{vw \mp vs})$. The symbols are defined as follows: *fd* = frequency detected; *fs* = frequency of source; *vw* = velocity of waves; *vo* = velocity of observer; *vs* = velocity of source; ± = direction of motion: if *vo* is moving away from the source, then that velocity is subtracted from *vw*, and added to *vw* if the observer is approaching the source; if *vs* is moving away from the observer then that velocity is added to the *vw* and subtracted if the source is moving toward the observer. The formula to find the wavelength of one wave is: $\lambda = \frac{velocity\ of\ wave}{frequency}$ where λ equals the length of one wave.

3. Showing the error

Two examples will be given here: one with sound, and the other with the electromagnetic waves of radio. We will assume constant velocities of the waves used in these examples.

Example #1. Our source is a car horn; *fs* = 1,000 Hz; *vw* = 340 m/s; our observer is on a quiet electric bicycle and our car when moving travels at the same velocity; *vs* = 15 m/s; *vo* = 15 m/s. Part 1a of the example is with the observer stationary and the car approaching the observer; part 1b is with the car stationary and the observer riding toward the car.

Solving 1a: $fd = 1{,}000\ Hz\ \left(\frac{340\frac{m}{s} + 0\frac{m}{s}}{340\frac{m}{s} - 15\frac{m}{s}}\right)$; *fd* = 1,046.15 Hz.

Solving 1b: $fd = 1{,}000 Hz\ \left(\frac{340\frac{m}{s} + 15\frac{m}{s}}{340\frac{m}{s} - 0\frac{m}{s}}\right)$; *fd* = 1044.12 Hz.

Example #2: Our source is a radio transmitter broadcasting at 10 MHz; *vw* = 300,000,000 m/s; our source is on a fast spacecraft, while our observer is on another

spacecraft; when each are moving their velocity is 0.8*c*, or 240,000,000 m/s. Part 2a of this example is with the observer stationary and the craft with the transmitter approaching the observer, and vice versa for part 2b. Parts 2c & 2d of the problem is where the observer and source are moving away from each other. When dealing with velocities such as with example #2, we can substitute *vw* = *c* instead of the approximate velocity of *c*, which is 300,000,000 m/s. Then, we would also represent the velocities of *vs* & *vo* as a fraction of *c*. Although not necessary since you would be dealing with smaller numbers, the condensing of the formula could also be done with the sound waves, such that *vs* & *vo* would be a fraction of the velocity of the sound wave.

Physics texts claim that the formula for calculating the Doppler effect is different for electromagnetic waves "due to the effect of relativity" and is expressed as: "$fd = fs\left(\frac{\sqrt{1-\frac{vrel}{c}}}{\sqrt{1+\frac{vrel}{c}}}\right)$"[2] and most do not distinguish the motion between the source and observer, substituting *vrel* for relative velocity. By replacing the light clock, which is the foundation of special relativity, with an example which uses radio transmitters, and receivers with counters which serve as the observer's clock, it will be shown that special and general relativity are false theories. That example will be provided in the conclusion of this paper. Thus, the relativistic form of the equation is incorrect. These formulas, however, will be illustrated in the solutions marked Parts E & F, while the standard equation will illustrated in Parts A - D .

Both, the longhand and the shorthand examples of the problem are illustrated for example parts A – D, and only the shorthand example for later examples.

Solving for part A - the source is approaching the stationary observer:

$fd = 10MHz\left(\frac{300{,}000{,}000\frac{m}{s}+0\frac{m}{s}}{300{,}000{,}000\frac{m}{s}-240{,}000{,}000\frac{m}{s}}\right)$; or $fd = 10MHz\left(\frac{1c+0c}{1c-0.8c}\right)$; *fd = 50MHz.*

Solving part B - the observer is approaching the stationary source:

$fd = 10MHz\left(\frac{300{,}000{,}000\frac{m}{s}+240{,}000{,}000\frac{m}{s}}{300{,}000{,}000\frac{m}{s}+0\frac{m}{s}}\right)$; or $fd = 10MHz\left(\frac{1c+0.8c}{1c+0c}\right)$; *fd = 18Mhz.*

Solving part C - the source is moving away from the stationary observer:

$fd = 10MHz\left(\frac{300{,}000{,}000\frac{m}{s}+0\frac{m}{s}}{300{,}000{,}000\frac{m}{s}+240{,}000{,}000\frac{m}{s}}\right)$; or $fd = 10MHz(\frac{1\,c+0c}{1\,c+0.8\,c})$; *fd = 5.555MHz.*

Solving part D - the observer moving away from the stationary source: $fd = 10MHz\left(\frac{300{,}000{,}000\,\frac{m}{s} - 240{,}000{,}000\,\frac{m}{s}}{300{,}000{,}000\,\frac{m}{s} + 0\,\frac{m}{s}}\right)$; or $fd = 10MHz(\frac{1c - 0.8c}{1c + 0c})$; fd = *2MHz*.

Solving part E using relativistic formula - the source and observer are approaching:

$$fd = 10\ MHz\left(\frac{\sqrt{1-\frac{-0.8}{c}}}{\sqrt{1+\frac{-0.8}{c}}}\right) = \ 30\ MHz$$

Solving part F using relativistic formula – the source and observer are moving apart:

$$fd = \ 10\ MHz\left(\frac{\sqrt{1-\frac{0.8}{c}}}{\sqrt{1+\frac{0.8}{c}}}\right) = 3.333\ MHz$$

Whether it was the source moving or the observer moving, the distance between the two was changing at the same rate, and therefore the waves should appear to be compressed when approaching, or expanded when moving apart, at the same rate. While the difference at lower velocities and frequencies, such as in example #1, is slight, and the answers given in some texts and online use the ≈ symbol for approximately, once we apply the formula to light speed equations as in example #2, the error in the Doppler equation becomes substantial.

As we look for the correct answer for example #2, we search for solutions. Our wavelength of *fs* is: $\lambda = \frac{vw}{fs} = \frac{300{,}000{,}000\ m/s}{10{,}000{,}000\ Hz}$; λ = 30 m. Our velocities of the observer and source closed the gap at 240,000,000 m/s when approaching each other. This meant that the electromagnetic waves had the appearance of moving at 540,000,000 m/s. When moving apart the waves appeared to have velocity of only 60,000,000 m/s. Approaching: $30m = \frac{540{,}000{,}000\ m/s}{fd}$; *fd = 18 Mhz*; receding: $30m = \frac{60{,}000{,}000\frac{m}{s}}{fd}$; *fd* = 2 *MHz*. We should also realize that if we doubled our velocity of waves, the observed frequency would only be 20 *MHz*, and therefore parts a and c yielded an incorrect answer.

Relativity is wrong and there is no way to correct the errors in the relativistic versions of the Doppler effect formula. It was illustrated in parts E & F of the example only for the purpose of showing that it yielded an incorrect answer.

The instant implication of the error of the Doppler Effect formula being wrong is that every astronomer/ astrophysicist who has by means of redshift used the formula to calculate the velocity at which a star is moving away or a galaxy is expanding has reached an incorrect conclusion. Redshift is a measurement of the shift in the frequency detected of light from a star or galaxy based upon the assumption that the shift in frequency is caused by motion. It is an assumption

because lower temperature, higher pressure, or a combination of the two can also cause a shift in the frequency of light.

4. Correcting the Doppler Effect Formula

Simply by moving the velocity of the source to the numerator and changing our ± use on the source such that as it approaches we add and as it recedes we subtract, we arrive at a correct solution: $fd = fs(\frac{vw \pm vs \pm vo}{vw})$. This can be reduced to $fd = fs\ (1 \pm vrel\ )$. Applying this to Example #2:

Part A: the source is approaching the stationary observer: $fd = 10MHz\left(\frac{300{,}000{,}000\frac{m}{s} + 240{,}000{,}000\frac{m}{s} + 0\frac{m}{s}}{300{,}000{,}000\frac{m}{s}}\right)$; $fd = 10MHz\left(\frac{1c + 0.8c + 0c}{1c}\right)$; *fd = 18 MHz*;

part B: the observer is approaching the stationary source: $fd = 10MHz\left(\frac{300{,}000{,}000\frac{m}{s} + 0\frac{m}{s} + 240{,}000{,}000\frac{m}{s}}{300{,}000{,}000\frac{m}{s}}\right)$; $fd = 10MHz\left(\frac{1c + 0c + 0.8c}{1c}\right)$; *fd = 18 MHz*;

part C: the source is moving away from the stationary observer: $fd = 10\ MHz(\frac{1c - 0.8c + 0c}{1c})$; *fd = 2 MHz*;

part D: the observer moving away from the stationary source: $fd = 10MHz(\frac{1c + 0c - 0.8c}{1c})$; *fd = 2 MHz.*

5. The Light Clock

The light clock is a thought experiment, fundamental to the teaching of special relativity which is comprised of two parallel, horizontal mirrors with a pulse of light bouncing between the mirrors. There are numerous errors made with the teaching of the light clock: 1. Representing light as not to act "independent of the state of motion of the emitting body"; 2. The observational delay when viewing the pulse of light; 3. The imaginative thought that you could see the individual pulse of light; 4. The angle of observation illustrated in college physics textbooks prohibits the moving observer from being in inertial motion with respect to the stationary observer; 5. The scale to which the illustration is drawn (light travels approximately 300,000 km/second, yet the observers are shown next to the clock as the pulse bounces between the mirrors); 6. A clock is merely an instrument attempting to measure time, just as a barometer is an instrument which attempts to measure atmospheric pressure: each instrument is subject to instrument error and neither time nor atmospheric pressure is determined by the instrument; and 7. The misunderstanding of what time is. Yes, an accurate clock can be used to calculate velocities such as race cars, and distances such as with timed radio signals. But time is a system of information exchange, how that God and men communicate events

in relation to the rotation of Earth: how long it took God to create the Earth and the universe, how long Jesus was in the tomb, what you plan to do next month, and how fast something travels, including the velocity of light, all relate to the rotation of Earth. It is not the clock that determines the time, but the rotation of Earth.

While the light clock would cease to work once in motion, most people are apparently unaware of this fact. Calculations are made by the stationary observer, Bob, of the moving, Alice, observer's light clock using the Lorentz transformation equations, which are based upon Pythagorean's theorem. For a more detailed description of a few of these errors, look up and read my published paper, *It is Impossible to Teach Special Relativity Without Deceiving the Student.*[3]

6. Conclusion

Simply by replacing the light clock by each observer with two receivers which are equipped with pulse counters and a radio transmitter beside each observer, we have a thought experiment which is irrefutable in disproving special and general relativity. The transmitters emit a modulated pulse every second, similar to that of the U.S. Naval Observatory's WWV transmitter, which navigators monitor for their time signal. One of the receivers monitors the transmitter beside the observer and its counter represents the true time. The other receiver monitors the transmitted signal emitted from the other observer's transmitter. The receivers have autotune capability which is required because as Alice goes into motion, the Doppler effect will alter the observed frequency from the other observer's transmitter. All four counters/clocks are synchronized prior to Alice going into motion. Regardless of direction or velocity which Alice travels, the two receivers monitoring the other person's transmitted signal will stay in sync, but will not agree with the "true time" counters of the receivers monitoring the transmitter adjacent to it until Alice returns to her original starting point. Time dilation is impossible.

If you still think special relativity is true, work the math using the corrected Doppler equation until you see your error. Nothing false can be proven true by experiments or tests. Therefore, as special and general relativity are proven false, so also are all the claims made in support of these theories. Apply God's advice: "prove all things, hold fast that which is good", and you should have little difficulty in finding the errors of the claims or tests made in support of Einstein's theories of relativity. I addressed a few of the more popular deceptive claims in a recently published paper I had written.[4]

Acknowledgements

I thank God for giving me the understanding to see the error in this 180 year-old formula, and the solution to the formula.

References

[1] Physics, James Walker, ©2002, page 948

[2] College Physics, Nicholas Giordano, ©2010, page 785

[3] It is Impossible to Teach Special Relativity Without Deceiving the Student, Science and Philosophy Journal, Volume 10, Issue 2, ©2022, http://dx.doi.org/10.23756/sp.v10i2.1036

[4] Ibid.

Science & Philosophy Volume 11(1), 2023

Sociological Explorations of Food: Interconnections, Aesthetics, and Rituals in Culinary Practices

Umberto Pagano*

Abstract

This article explores the sociological dimensions of food, emphasizing its social significance, aesthetic qualities, and ritualistic aspects. It investigates how food creates social bonds, influences power dynamics, and shapes hierarchies. It examines the sensory qualities and cultural contexts that generate culinary experiences, including the concept of "food as art". Additionally, it highlights the symbolic and transformative nature of food rituals, exploring their impact on ethical and aesthetic sensibilities. Overall, this article offers a sociological perspective on the multifaceted nature of food, providing insights into its role in shaping social relationships, cultural identities, and human societies. Through the interconnections, aesthetics, and rituals of culinary practices, it delves into the complex dynamics, cultural meanings, and lived experiences associated with *foodways*.

Keywords: Social relations, Cultural meanings, Foodways, Philosophy of food.[1]

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[1] Received on May 15. Accepted on June 21, 2023. Published on June 30, 2023.
doi:10.23756/sp.v11i1.1218. ©U. Pagano. This paper is published under the CC-BY licence.

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1. Introduction: food and identity

The assertion that "man is what he eats and eats what he is" carries both materialistic and symbolic implications that intertwine in the complex tapestry of human identity. While the materialistic perspective, influenced by Feuerbach, emphasizes the physiological and nutritive aspects of food as the foundation of human existence, it is essential to recognize the broader cultural and symbolic dimensions that shape our relationship with food.

Feuerbach's materialistic view, rooted in the notion of nourishment as the basis of human functions, represents a deterministic understanding of the interplay between food and identity. According to Feuerbach, "*foods become blood, blood becomes brain and heart, substance of thought and feelings. The foundation of human culture and emotions lies in human nourishment*" (Feuerbach, 1850, 50). However, it is crucial to acknowledge that this perspective fails to account for the cultural construction of taste, dietary practices, and the dynamic nature of food symbolism.

The connection between food and identity extends beyond the physiological realm, encompassing religious and cultural practices, which often crystallize in dietary regulations, aiming to maintain purity and prevent contamination. The act of consuming certain foods is associated with notions of abomination or sanctity. Feuerbach himself queries, «*Isn't someone who eats something repulsive and disgusting truly an object of disgust and repulsion for us?*» (Feuerbach, 1862, 77). Nevertheless, it is important to recognize that the repulsion towards certain foods is not inherent to the foods themselves but culturally generated, functioning as markers of identity and ideological differences.

Cultural factors play a significant role in shaping our perception of taste and disgust. What may be considered repulsive in one culture could be considered a delicacy in another. This demonstrates that taste and disgust are predominantly social constructs rather than purely sensory experiences. Our repulsion towards certain foods is often influenced by cultural conditioning, mental schemas, and preconceived notions. This interplay between physiology and cultural construction of taste is complex and dynamic, with influences working in tandem or even contradiction. The relationship between nature and culture in shaping our food preferences is very far from unidirectional or deterministic.

Nevertheless, the symbolic dimension of food should not be overlooked. Food choices and dietary practices are deeply intertwined with personal and collective identities. They serve as markers of cultural heritage, social status, and group affiliations. In this sense, what we choose to eat or not to eat becomes an expression of our identity. However, it is important to recognize that food choices are not solely determined by identity but can also be

influenced by factors such as personal taste, health concerns, or ethical considerations.

To delve deeper into the complex interplay between food and identity, scholars have examined various dimensions of food culture and symbolism. Pierre Bourdieu's concept of "cultural capital" highlights how food choices and preferences are markers of social distinction and class identity (Bourdieu, 1979). Mary Douglas, in her seminal work "*Purity and Danger*", explores the symbolic significance of food practices and the construction of boundaries between the clean and the unclean (Douglas, 1966). Claude Lévi-Strauss investigates the structural aspects of food symbolism and its role in the formation of cultural meaning (Lévi-Strauss, 1964). These scholars provide valuable insights into the intricate connections between food, culture, and identity.

Basically, while the materialistic perspective emphasizes the physiological foundations of human existence, it is essential to recognize the broader cultural and symbolic dimensions that shape our relationship with food. Food choices, dietary practices, and cultural meanings associated with food play a central role in constructing personal and collective identities. The interplay between taste, cultural constructs, and individual identity is a complex and dynamic process that cannot be reduced to a simple cause-and-effect relationship.

Exploring the multifaceted nature of food and identity requires an interdisciplinary approach that draws from fields such as anthropology, sociology, cultural studies, and gastronomy. By examining the social, historical, and cultural contexts in which food practices and preferences emerge, we gain a deeper understanding of how food shapes and reflects individual and collective identities.

In addition to the aforementioned concepts, the notion of "foodways" provides valuable insights into the cultural and historical dimensions of food practices[2]. While Carole Counihan's research on gender, food, and identity sheds light on how food choices and preparation contribute to the construction of gender roles (Counihan, 1999). And further notable contributions can be found in the works of scholars such as Arjun Appadurai, who explores the

[2] Social scientists specializing in the study of food practices often utilize the term "foodways" to explore the cultural, social, and symbolic dimensions surrounding food consumption. It encompasses an examination of why certain foods are chosen or avoided within a given culture, as well as the processes of food acquisition, preparation, and the cultural significance attributed to these practices. As such, foodways transcends the realms of basic sustenance, recipes, and taste, delving into the intricate layers and profound implications of how and why we consume food. According to Harris, Lyon and McLaughlin (2005, VIII–IX): «*…everything about eating including what we consume, how we acquire it, who prepares it and who's at the table – is a form of communication rich with meaning. Our attitudes, practices and rituals around food are a window onto our most basic beliefs about the world and ourselves*».

global flows of food and the impact of globalization on local culinary practices (Appadurai, 1988).

By incorporating these and other relevant scholarly perspectives, we can enrich our understanding of the intricate relationship between food and identity. Such an approach allows us to move beyond a reductionist materialistic view and embrace the complexity and richness of food as a cultural and symbolic phenomenon.

2. The representational dimension of food

The identity between being and eating can be understood at a materialistic and physiological level, but it is not sufficient to comprehend the relationship between food and individual and collective social existence. In this sense, the most valuable contribution to understanding this relationship comes from being what one does not eat – a cultural construction, a result of selecting possibilities, and a consequence of individual or collective choice (with its implications of freedom or constraint). This can be understood in two ways.

On one hand, it refers to contextual prescriptions and prohibitions. In this sense, what one does not eat, should not eat, or chooses not to eat qualitatively characterizes both the individual and the group, just as much as what one does eat. On the other hand, this issue can be interpreted more broadly. It means that human existence must remain inscribed, without seductive reductionism, «*within the omnivorous logic of the whole alimentary system*» (Riva, 2015, 50). In this sense, the expression "man is what he eats" attains its full meaning in freedom.

In other words, transcending the narrow scope of organic exchange theory, human beings are defined not only in biochemical terms but predominantly in symbolic terms. It is also evident that the representational dimension is not limited to the food itself as an object but extends to the processes of its preparation and consumption, regardless of the specific objective or symbolic characteristics of a particular food. Often, the symbolic and ritual aspects of food preparation and consumption are more potent than the communicative function of the food itself. In such cases, the symbolic determinants, historically or originally linked to the substance of the food itself, predominantly manifest through the technique as representation, as a theatrical performance.

Human practice is the result of two interrelated dimensions: doing and representing, technique and language, material culture and systems of representation, practices and discourses (De Benedittis, 2013, 11). While the distinction between these two realms has a logical coherence, it struggles to translate into a definite empirical articulation. On one hand, doing is a form of

representing (and representation is impossible without doing). Technique not only presupposes language but is language itself (and conversely, language always has an indispensable technical dimension). Technique is discourse, and discourse is (and has) technique.

Acknowledging that there are specifically communicative phenomena related to food, completely dematerialized and purely signifying, preceding, following, parallel... essentially autonomous from its material production, what needs to be emphasized is that, regardless of these phenomena, there exists a specific representational and meaningful dimension in the technique of food preparation. Sometimes, this meaning exists even apart from the food product itself, having significance for itself.

There are striking cases in which the technique of food preparation and consumption becomes a symbolic representation of great intensity and precedence over the symbolism of the food being ingested. Consider the Japanese tea ceremony, which encompasses codified rituals in every aspect of its enactment: from the architectural features of the spaces where it takes place to the decorative elements within those spaces, from the utensils used to the sequence of gestures, positions, and timing to be observed. Everything converges towards a situation in which the central act of consumption is not the act of drinking the tea but participating in the aesthetic experience constituted by the application/representation of the technique of its preparation within a specific environment, accompanied by a set of behaviours related to ingestion. These behaviours are "related" but not functional since it is evident that, in this case, there is no means-end relationship between the technique of preparation/consumption and the intake of the food. There is a reversal in which the preparation itself becomes the end.

Particularly, Japanese culture is permeated with the concept of emptiness. The tea ceremony is a shining example of a practice that embodies this idea. In the Buddhist view of the world, every being has an empty essence, meaning that the essence of each being is not exclusively its own because it can only exist in relation to the essence of other beings. Essentially, "empty essence" means "essence of emptiness," signifying that every being is characterized by a lack of autonomy, by a void of the absolute. Emptiness is the condition of existence for any being, in the sense that everything is based on a regime characterized by relationality and transitoriness. Even emptiness itself does not escape this state of things, as it does not have *absolute* reality or self-consistency (many Buddhist texts speak of the "*emptiness of emptiness*").

Apart from the emblematic case of the tea ceremony, there are numerous examples that highlight the significance of the preparation process itself, emphasizing the importance of dedicating time, care, and attention to the "ritual" and techniques of preparation that transcend technical

rationality/functionality and transfigure into practices of self-care, care for others, and care for things.

In Italy, homemade pasta is regarded as a cherished art and tradition. Kneading the flour and water, rolling out the dough, and cutting the pasta require time, patience, and skill. This practice accentuates the care and attention to the process, where the act of preparing pasta becomes a form of meditation and a connection with the food itself.

In Argentina, the traditional barbecue known as "asado" surpasses mere meat cooking. Argentinians devote time and attention to fire preparation, selecting the cuts of meat, and taking care of the cooking process. Asado becomes a social and ritualistic experience where the act of cooking and sharing food becomes a celebration of Argentine culture and culinary artistry.

In Morocco, the preparation of *couscous* is an art that demands time and attention. Semolina is steamed and meticulously worked to separate the grains, achieving a light and fluffy texture. *Couscous* is then seasoned with various ingredients such as meat, vegetables, and spices, creating a dish rich in flavor and tradition. The preparation of couscous in Morocco signifies the importance of dedicating time and care to the creation of a meal and preserving culinary traditions passed down through generations.

In the Maori culture of New Zealand, the *hāngi* ceremony involves a traditional method of earth oven cooking. Food is prepared in a large underground oven heated with hot stones, resulting in slow and aromatic cooking. This process necessitates time, planning, and the collaboration of the entire group, creating a culinary experience that goes far beyond the mere act of cooking. *Hāngi* represents a deep connection to the land, tradition, and the significance of sharing food as a moment of celebration and unity in Maori culture.

Arthur Schopenhauer, at the beginning of what he considered his fundamental work, stated, «*The world is my representation*» (Schopenhauer, 1819). By "my representation" he does not assert the world's exhaustion in the subject's reality but primarily refers to "my cognition". However, every properly human cognition of the world is always also a representation of a world or, rather, from a world (in the sense of provenance, generation). Every cognition derives, though not deterministically, from a cultural universe. The world does not impose itself on the subject as givenness; it is the result of cultural mediation (Berger & Luckmann, 1969).

"*Man is what he eats*" is not limited to the narrow confines of organic exchange theory, nor is it merely a biochemical phenomenon. Rather, it encompasses a profound symbolic dimension. Furthermore, it is evident that the representational dimension is not restricted to the food object itself but extends to the techniques of its preparation and consumption, sometimes even

independent of the food's objective characteristics. Often, the symbolic and ritual aspects of food preparation and consumption hold more significational power than the communicative function of the food itself. Thus, their representation and meaning intersect with the act of choosing what to eat or not to eat.

While the notion of choice introduces the dimension of freedom, it also navigates treacherous terrain, intertwining with the broader question of the *real freedom* of the subject in a mass-individualized society. The Frankfurt School[3], Gunther Anders (1956) and, more recently, Zygmunt Bauman (2001) have eloquently explored this topic. Pierre Bourdieu (1979) has argued that individual tastes are often illusory outcomes of genuine subject choices and frequently underlie subtle mechanisms of constraint and non-choice shaped by social context and position. Tastes reproduce culture, and individuals incorporate them (often literally, in terms of transforming their own bodies). They are powerful mechanisms for manifesting and reinforcing ethical and aesthetic values and power dynamics.

Acts of categorization and representations are fundamental elements of the social construction of attitudes and behaviours related to food. They are essential for the perpetration of symbolic violence, which functions to sustain collective existence in many ways. The choice of one's food is also a mode of self-assertion for the individual because the choice of what to eat or not to eat is an identity-based decision, a choice of what to be and/or what not to be. In the current era of progressive de-subjectification and a crisis of presence[4], exercising the choice of what to eat/be is an attempt to reclaim meaning. However, this endeavour is significantly influenced by market-driven conditioning, which often disguises itself as free choice.

The issue of food identity explodes today not only as a purely identity-related matter but also encompasses critical dimensions such as sustainability (both individual and collective), distributive justice, social equity, public health, and ethics.

The subject yearns for choice, yet this choice is inherently illusory and complex. It is not easy to determine the extent to which choice is genuine and whether there are still gaps, margins, and interstices of "authentic" will and freedom. The subject is inevitably suspended, torn, perhaps, between the choice of being and the experience of being acted upon, between self-assertion and nullification. And food, with its essential physiological nature and rich symbolism, is inevitably suspended, torn, perhaps, between will and representation.

«*The word is my representation*», as Schopenhauer proclaimed, points to the fact that every human cognition is always mediated by culture. The

[3] Notably, reference should be made to: Adorno & Horkheimer (1947) and Marcuse (1955).
[4] On this theme also see Pagano (2011, 99-104).

representation of the world is not a simple reflection of objective reality, but rather a complex interplay between the individual and the cultural framework in which they are situated.

The "man is what he eats" extends far beyond the realm of mere biological processes. It encompasses a profound symbolic dimension, where the representation and meaning of food play a significant role. The representational dimension extends to the techniques of food preparation and consumption, often holding more power and significance than the food itself. The act of choosing what to eat or not to eat becomes an act of self-assertion and a means of constructing individual and collective identities. However, the concept of choice and freedom in relation to food is fraught with complexities, as it intersects with broader questions of societal influence and constraints.

By critically examining the interplay between food, culture, and identity, we can gain a deeper understanding of the multifaceted nature of human existence and the intricate relationship between individuals and their food choices. This expanded perspective allows us to recognize the power dynamics, social structures, and cultural influences that shape our relationship with food. As Barthes (1961) eloquently posited, food is not merely about sustenance, but a system of communication, a body of images, a protocol of usages, situations, and behaviours.

Foodways are deeply enmeshed with a community's identity, acting as a mirror that reflects its history, traditions, societal stratification, and spiritual leanings. The broader societal forces – power, economics, politics, and beyond – become discernible through the lens of foodways.

These foodways serve as a rich tapestry of communication, narrating tales about ourselves and our communities, codifying and transmitting cultural norms, values, and identities. The offering of specific foods during distinct occasions, the modus operandi of food preparation, its presentation, and the rituals enveloping its consumption can all communicate crucial cultural narratives.

However, it is of paramount importance to underscore the dynamic and evolving nature of these foodways. Influenced by globalization, migration, and technological advancement, foodways are in a state of constant flux. As societies intermingle, foodways coalesce, adapt, and transform, leading to the genesis of *hybrid identities*, a phenomenon discussed extensively by Appadurai (1996, 2013)[5]. This underscores the fluidity of cultural identity and food's pivotal role in its ongoing negotiation and redefinition.

[5] *Hybrid identities*, according to Appadurai, arise from the fusion and interaction of cultural elements sourced from diverse origins. These elements may encompass language, religion, cuisine, fashion, traditions, values, and behavioural patterns. Hybrid identities can serve as a means for individuals to negotiate and navigate the various cultural influences encountered in our globalized world. Appadurai challenges traditional conceptions of identity as fixed and

Concurrently, the choice of food metamorphoses into a political act – a form of resistance or compliance to societal norms and expectations. The choice to adopt a vegan or vegetarian lifestyle, for instance, could be interpreted as a defiance against dominant foodways that prioritize meat consumption, as Singer (1975) points out in his seminal work. Alternatively, the choice to consume traditional foods can serve as a bastion of cultural preservation and resistance against homogenizing global influences.

It is also incumbent upon us to reflect upon the systemic inequities that pervade our food systems. Access to food is far from universal, and is influenced by myriad factors such as socioeconomic status, race, and geography. The construct of "*food deserts*"[6] is a stark manifestation of how systemic injustices can shape food choices and health outcomes, an issue highlighted by Beaulac, Kristjansson and Cummins (2009).

In conclusion, the dissection of food, culture, and identity extends far beyond personal gastronomic predilections. It is an exploration of power, tradition, resistance, identity negotiation, and societal structures. It is a reflection of our individual and collective identities, and how we interact with the world that surrounds us. By examining our relationship with food, we can unpick the intricate web of cultural, social, and political dynamics that shape our existence.

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homogeneous entities, emphasizing the significance of recognizing and appreciating the complexity of both individual and collective identities. Hybrid identities can be regarded as a creative response to the challenges and opportunities of globalization, providing a pathway to embrace and reinterpret diverse cultural influences in order to construct novel forms of identity that reflect contemporary experiences and contexts.

[6] The concept of "*food deserts*" is a topic of significant concern in the fields of public health, urban planning, and social justice. The term "food desert" is used to describe areas where access to affordable, nutritious food is limited, particularly for individuals without vehicles. These areas are often characterized by a prevalence of fast-food outlets and convenience stores, with fewer supermarkets or grocery stores providing fresh produce. In their systematic review titled "*A Systematic Review of Food Deserts, 1966-2007*", Beaulac-Kristjansson-Cummins (2009) explore the evidence related to *food deserts*. They conducted an in-depth examination of studies from developed countries to assess the existence of *a food-desertification* process and its potential impact on the residents of these areas. Their review suggests that *food deserts* do exist, especially in urban areas. These *food deserts* tend to be inhabited by lower-income residents, and this contributes to health disparities in these communities. For instance, people living in *food deserts* may have a lower quality diet or suffer from higher rates of obesity and other diet-related conditions, such as diabetes and heart disease. The authors highlight the complexities of the issue. They note that while proximity to food retailers is an important factor, it is not the only one. Factors such as food prices, individual income, personal food preferences, and knowledge about nutrition also play crucial roles in determining dietary choices and health outcomes.

3. Eating as an Experience of Being-Singular and Being-Shared: Representation and Plurality

The interconnectedness does not arise solely from the mere amalgamation of individual elements, but rather serves as the foundation for their existence. The constituent elements are not innately given entities, but instead represent ephemeral manifestations subject to perpetual transformation within the fabric of interconnectedness itself. While it is commonly assumed that the individual elements serve as the wellspring of interconnection, establishing the bonds among them, the veracity lies in the fact that interconnectedness pre-exists the very elements entwined within it, akin to an imperceptible tapestry permeating the fabric of the universe.

Interconnectedness does not emerge as a fortuitous aggregation of discrete elements, but rather stands as an antecedent reality that imbues shape and significance to the entire spectrum of existence. It is as if an intrinsic order, an underlying network of relationships, engenders the emergence of the elements themselves. Consequently, the elements are not isolated entities, but rather mutable and transient expressions of the interconnectedness that sustains them.

Such a perspective beckons us to transcend the superficiality of appearances and comprehend that the essence of reality resides in the interplay of relationships and interdependence. Each phenomenon, every living being, and all events represent inseparable nodes intricately intertwined within an expansive web of connections that predated their very emergence.

When we come to grasp that interconnectedness is inherent to our existence, a profound sense of humility and reverence toward the surrounding world envelops us. We are called upon to recognize that our actions and choices reverberate throughout the very tapestry of interconnection, influencing every other element to which we are linked.

In this context, the individual cannot subsist in isolation, but rather serves as a vital node within a complex network of relationships. Every action, thought, and emotion propagates through the interconnectivity, engendering effects that extend far beyond the confines of the individual.

Acknowledging that interconnectedness predates the interconnected elements impels us to contemplate the entire system and adopt a broader perspective that encompasses the grand tapestry. It prompts us to conceive in terms of interdependence rather than separation, and to consider the ramifications of our actions upon the global fabric of interconnection.

In these terms, emptiness pertains to existence in its temporal dimension, thus, the past, present, and future are not “autonomous” but mutually co-produced: all events are not “confined” within a particular temporal dimension but rather nodes within an endless spatiotemporal fabric. The notion of the

"emptiness of permanence" does not simply indicate a condition of transience nor does it precisely equate to Heraclitus' notion of "everything flows". Instead, paradoxically, it consists of the eternity of events and beings, not in the sense of their eternal duration (in a more external and sensory way), but in the sense that they can only be dispersed through an infinite network of spatiotemporal interconnections, where the reality of each element lies not in its "passage" but in its "diffusion" across the past, present, and future, before, during, and after its occurrence.

In the Japanese worldview, the notions of ephemerality and infinity coexist harmoniously, not just as theoretical constructs, but as the essence of experiential reality. Zen encourages experiencing the void in practical, day-to-day contexts rather than through metaphysical contemplation. The traditional tea ceremony stands as a poignant embodiment of this experiential engagement with the void. The emphasis is on the processes of creation and consumption, rather than on the end product, where the technique embodies symbolism and representation more than the resulting artifact.

The *sukiya* (tea room) is an epitome of void, both materially and conceptually, where equilibrium is achieved through the principle of *less is more*[7]. It is minimalist in its decor, furnished only with items necessary for the ceremony. The aesthetic of the room, with its *tatami* mats, unadorned walls, and the lone decoration in the *tokonoma* alcove, is not just a sight to behold but a model for existential aspirations. It seeks to guide the participant's mind towards the void, from which the tea ceremony emanates and within which it unfolds. The near-silence that swathes the ritual is punctuated by the sound of water boiling in the iron kettle. The auditory experience, much like the visual one, is a delicate balance between sound and silence, with an inclination towards the latter.

The faint sound of the boiling water, often overlooked in the cacophony of daily life, takes centre stage in the solemn ambiance of the tea ceremony. As Pasqualotto explicates (2004, p. 83), the soft sounds emanating from the kettle amidst the silence mirror the subtle shifts in a tranquil mind, or inversely, these quiet stirrings in consciousness can be seen as spiritual echoes of the kettle's sounds. A harmony is thus established between the ambient rhythm and the participants' inner time.

The ceremony is then imbued with the slow, deliberate gestures of the tea master and their apprentice. The apprentice's actions, deliberately slower than the master's, signify more than just inexperience. Their movements are still bound by the internal-external dialectic, a pragmatic interplay between thought and action. The master, on the other hand, through a deeper immersion into the void, becomes one with their actions. They embody the gesture, as natural and

[7] Note how "*sukyia*" is the Western transliteration of Japanese ideograms "数奇屋", which translate to "*abode of emptiness*".

unobserved as snowfall or a river's flow. The technique transcends its original form in the void, and it's within these movements that the preparation process's independent semantics reside.

The preparation gestures are not purely functional but evolve into something greater, possessing their own inner purpose. They break away from their functional origins to stand as an end in themselves. This metamorphosis also carries ethical implications, as the perfection of the gestures serves as a model for everyday life. Thus, the tea ceremony, resonating with Zen meditative practices, aims to discipline its participants, influencing other aspects of their lives.

The notion of emptiness is intricately woven into every facet of the tea ceremony, extending to the attributes of the ceramic vessels utilized for tea consumption. These bowls are intentionally designed with surface inconsistencies, indentations, and minute fissures, creating a panorama of "disruptive discontinuity". This representation of the void is not only visually apparent but can also be discerned through the touch of one's fingertips and lips. Additionally, the tea bowls and the instruments used in the tea preparation process bear the mark of time, embodying the concept of *sabi* (寂)[8].

The tea ceremony is a profound illustration of the symbolic superiority of the process over the product, of technique as a means of representation. Nevertheless, the landscape of Japanese culinary practices offers numerous instances of this concept. It is a familiar scene in Japanese eateries for the chef to cook in the patrons' presence, utilizing a portion of the counter where the meals are consumed as a makeshift kitchen. The acts of preparation and consumption occur concurrently, cohabitating and intertwining in time and space. Paralleling the tea ceremony, the culinary techniques become a form of aesthetic sustenance that precedes, coincides with, and complements the physical nourishment. Here again, these movements exceed their utilitarian purposes and assume an independent representational capability. The inaccessible alchemical mystery of the Western culinary workshop is supplanted by a public, magical-ritualistic performance by the chef-priest, which transcends the demonstration of their culinary precision and purity. Instead, the act takes on inherent meaning, akin to modern performance art forms.

It is particularly evident in Japanese culture that the significance related to representation, in terms of action rather than the food object itself, is not

[8] This Japanese term encapsulates the notion of temporal imprints on objects, the vestiges of existence, a sedimentation of memory that stirs emotions through its evocation of melancholic beauty and the inescapability of time passage. Imperfections, fractures, chipped edges, and wear signs (within acceptable bounds) add value to the object as they bear witness to its life journey and point to the ephemeral nature of reality, the pervasive emptiness that permeates every entity and moment.

confined to the practices of food preparation but also extends to the tools and gestures involved in the consumption of food, starting with the use of chopsticks. Clearly, there is a convergence and complementarity between such practice and the way food is prepared. As Roland Barthes noted in his masterful work on Japan – *L'empire des signes* (1970) – Japanese dishes are already cut into small pieces during preparation to be easily grasped by chopsticks, but the reverse is also true: chopsticks exist because the food is cut into tiny pieces. The same logic and form underlie both the food (the material) and the behaviours (and tools) of its manipulation: harmony. Japanese cuisine is divided, devoid of centrality, constantly decentralized in a harmonious chaos devoid of solidity, lacking a permanent centre to reach and conquer. The absence of centrality is twofold: it concerns the division of matter itself (the absence of a physical centre in the dish) as well as a "hierarchy" void (the absence of a "main course"). In contrast to Westerners, for whom eating implies an ordering rationality (first course, second course, side dish, etc.), the Japanese have a fluid relationship with the different dishes of a meal, often served simultaneously. The table tray becomes a palette for creating, little by little, what one eats, «*drawing here a handful of beans, there a scoop of rice, there a touch of seasoning, and there again a sip of soup, following a free alternation in the manner of a (Japanese) graph*» (Barthes, 1970, 16). On the table, the food is never anything more than a collection of fragments, in which none appears privileged by an order of ingestion; eating does not mean adhering to a menu (a sequence of dishes) but rather selecting colours, one after another, with the gentle touch of chopsticks, guided by a sort of inspiration.

This decentralized matter that is food is never violated or torn by the chopsticks; it is lifted, moved, with a precision and gentle firmness reminiscent of maternal care, testifying to an absolute respect for that which we nourish ourselves with.

Eating is much more than mere incorporation. While it is evident that humans do not live to eat, it is equally clear that eating is not solely about sustenance. Eating extends beyond the chemistry of nutrition and the aesthetics of taste; it involves an excess that catalyses the transition from necessity to desire (*Cf.* Lévinas, 1961, 130), with a force unknown in other human experiences, except perhaps in the erotic realm, where the dimension of necessity is infinitely less potent than in the realm of food. «*Eating is not incorporation but rather opening the body to that which is ingested (…) There is never incorporation, only exits, twists, cavities or spillages, crossings, compensations. Susceptibility to 'being into' is a metaphysical chimera*» (Nancy, 2009, 100).

Food consumption (a complex phenomenon of which food itself is only a part) as representation also means that there is never an "I" who eats; it is

always a plurality, a plurality not as a sum of bodies, knowledge, individual worlds, and destinies, but as a "primary regime" where everything – especially the food – symbolizes something (*Cf.* Nancy, 2011, 73), where everything is condemned to signify something, to *represent*.

Eating transcends the "I" and the "other," existing within the dimension of proper human and social being, that of being singular-plural. The rationality of food holds a privileged perspective on this panorama of social being, but it is evident that the discourse that has unfolded thus far has led us into a broader and foundational domain. As Franco Riva has written, «*Eating is directed outward, always among others and with others. This is why eating is, from the very beginning, speaking and thinking... it is always, immediately, among us, in proximity, me and you, us and others. Traces of the outside, precisely. Eating is not the experience of an 'I' that exists prior and for itself, with the world and others at its unquestionable disposal. Traces, because even on the mouth, which remains a mouth, food, animal, there appears the beginning of a response, of a responsibility that begins to live at the very moment when it seems to be only about survival*» (Riva, 2015, 194), existing in the same moment when it seems to be solely about existence. «*Eating is not the experience of an 'I' that exists prior and for itself*» – true, indeed – but also, especially after Heidegger, obvious. Yet, potentially misleading. The point is that no experience can be the experience of an "I" that exists prior to or separately from others, no matter how much it may isolate itself physically. Jean-Luc Nancy, in a text that, unfortunately, has not received adequate attention from sociological circles (especially in Italy), has explained that the singular being does not pre-exist its singular plurality (Nancy, 1996, 55). «*To be singular-plural means: the essence of being is, and is solely, a co-essence; but a co-essence, or the being-with – the being-with-many – also designates the essence of the co- or, more precisely, the co- (the cum) itself in the position or guise of essence... One could even say that if being is being-with, in being-with, 'with' constitutes being, and is not added to being*» (*Ibid.*, 56).

This "with" is something other than being physically together in a place; it is not something we share but rather something we are. More precisely, we are not "with" but rather "we with": we exist because and inasmuch as we are with. Hence, only the plural should be used to indicate being, no longer "is" and no longer "I am": «*being can only be said as 'we are': 'the truth of ego sum is a nos sumus*» (*Ibid.*, 59). «*In me, there is more than myself... We live in the surpassing, but not in the sense of going beyond ourselves. We are surpassing, movement-toward*» (Riva, 2015, 281).

We are more than what we are or are not at any given time. We are condemned to be more than what we may wish to be or not be. Here, "more" does not signify addition but, positively or negatively, in its entirety, a difference.

The act of eating encompasses far-reaching implications that extend beyond the individual or the mere consumption of food. It operates within the realm of human and social existence, where the interplay between the singular and the plural takes centre stage. The *rationality of food* provides a unique perspective on the social fabric, revealing the intricate relationships between ourselves, others, and the world. Eating embodies an act of being-with, transcending the boundaries of individuality and embracing the collective experience. It is a complex interweaving of sustenance, desire, and the profound significance of shared nourishment.

4. Discussion and conclusions

Building upon the conceptual framework delineated thus far, the act of eating invites a deeper exploration as an existential phenomenon (Fischler, 1988). As we partake in the ritual of dining, our engagement extends beyond the immediate sustenance before us, encompassing the tapestry of histories, narratives, and lives embedded within each morsel. The sustenance we consume stands as an eloquent testament to a constellation of human endeavour, the fecundity of nature, and the inexorable march of time. Each act of consumption, in essence, represents a form of communion—a shared experience that intertwines us with the world in a profoundly intimate manner (Counihan and Van Esterik, 1997).

Moreover, eating transcends mere passivity; it emerges as a dynamic interchange between the consumer and the consumed (Beardsworth and Keil, 1997). This exchange bears the marks of a dialogue, a reciprocal sculpting whereby both eater and eaten indelibly imprint upon one another. Our identities are moulded by the food we ingest, even as we simultaneously sculpt the food through our individual predilections, culinary practices, and cultural and personal associations. Consequently, in the act of eating, we are co-participants in an ongoing process of creation, ceaselessly negotiating and redefining our identities, relationships, and realities.

The interplay between the singular and the plural extends its tendrils into every facet of our existence, far beyond the act of eating. As we are ‘we with’ within the context of eating, so too are we ‘we with’ within our relationships, our communities, and our engagements with the natural world. This heightened awareness of our inherent interconnectedness, of our shared ontology, serves to catalyse a more profound sense of empathy, responsibility, and stewardship.

In this context, the act of eating can be construed as a microcosm of the human condition: an intricate interplay of necessity and desire, individuality and community, being and becoming. It operates as a mirror, reflecting the

tapestry of our shared humanity, a potent reminder of our collective enmeshment in the intricate fabric of life, perpetually weaving and being woven into existence. Embracing this understanding, we can approach each meal, and indeed each moment, with an enhanced sense of reverence, gratitude, and interconnectedness.

References

[1] Adorno, T.W., Horkheimer M. (1947). *Dialektik der Aufklärung*, Amsterdam: Querido Verlag.

[2] Anders, G. (1956). *Die Antiquiertheit des Menschen. Über die Seele im Zeitalter der zweiten industriellen Revolution*. München: Verlag C. H. Beck.

[3] Appadurai, A. (1988). How to Make a National Cuisine: Cookbooks in Contemporary India. *Comparative Studies in Society and History*, 30(1), 3-24.

[4] Appadurai, A. (1996). *Modernity at Large: Cultural Dimensions of Globalization*, Minneapolis: University of Minnesota Press.

[5] Appadurai, A. (2013), *The Future as Cultural Fact: Essays on the Global Condition*, London-New York: Verso.

[6] Barthes R. (1970), *L'empire des signes*, Skira, Genève; Ital. trans. *L'impero dei segni*, Torino: Einaudi, 1984.

[7] Barthes, R. (1961). Pour une psycho-sociologie de l'alimentation contemporaine. A*nnales. Economies, sociétés, civilisations*, 16(5), 977-986.

[8] Bauman, Z. (2001). *The Individualized Society*, Cambridge: Polity Press.

[9] Beardsworth, A., Keil, T. (1997). *Sociology on the menu: An invitation to the study of food and society*, London: Routledge.

[10] Beaulac, J., Kristjansson, E., Cummins, S. (2009). A Systematic Review of Food Deserts, 1966-2007. *Preventing Chronic Disease*, 6(3), A105.

[11] Berger, P., Luckmann, T. (1969). *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*, Garden City, NY: Anchor Books.

[12] Bourdieu, P. (1979). *La Distinction: Critique sociale du jugement*. Paris: Les Éditions de Minuit.

[13] Counihan, C. (1999). *The Anthropology of Food and Body: Gender, Meaning, and Power*, London: Routledge.

[14] Counihan, C., Van Esterik, P. (Eds.). (1997). *Food and culture: A reader*, New York: Routledge.

[15] De Benedittis M. (2013), *Sociologia della cultura*, Roma-Bari: Laterza.

[16] Douglas, M. (1966). *Purity and Danger: An Analysis of Concepts of Pollution and Taboo*, London: Routledge & Kegan Paul.

[17] Feuerbach L. (1850), *Die Naturwissenschaft und die Revolution*, in «Blätter für literarische Unterhaltung», Nr. 268, S. 1069-1071; Nr. 269, pp. 1073-1074; Nr. 270, pp. 1077-1079; Nr. 271, pp. 1081-1983, Brockhaus, Leipzig; Ital. trans. *La scienza naturale e la rivoluzione*, in Tomasoni F. (ed. by), *L'uomo è ciò che mangia*, pp. 25-52, Brescia: Morcelliana, 2015.

[18] Feuerbach L. (1862), *Das Geheimnis des Opfers oder der Mensch ist, was er ißt*, in *Sämmtliche Werke*, X, pp. 1-35, Wigand, Leipzig, 1866; Ital. trans. *Il segreto del sacrificio ovvero l'uomo è ciò che mangia*, in Tomasoni F. (ed. by), *L'uomo è ciò che mangia*, pp. 53-88, Brescia: Morcelliana, 2015.

[19] Fischler, C. (1988). Food, self and identity. *Social Science Information*, 27(2), 275-292.

[20] Harris, P. Lyon, D., McLaughlin, S. (2005). *The Meaning of Food*. Guilford: The Globe Pequot Press.

[21] Lévinas E.(1961), *Totalité et Infini. Essai sur l'extériorité*, La Haye, Nijhoff; Ital. trans. *Totalità e Infinito. Saggio sull'esteriorità*, Milano: Jaca Book, 1980 (reprint 2006).

[22] Lévi-Strauss, C. (1964). *The Raw and the Cooked: Introduction to a Science of Mythology (Vol. 1)*, New York: Harper & Row.

[23] Marcuse, H. (1955). *Eros und Kultur: Philosophische Kritik am industriellen Zeitalter*, Frankfurt am Main: Verlag der Frankfurter Hefte.

[24] Nancy J.L. (1996), *Être singulier pluriel*, Galilée, Paris; Ital. trans. *Essere singolare plurale*, Torino: Einaudi, 2001.

[25] Nancy J.L. (2009), *Indizi sul corpo*, Torino: Ananke.

[26] Nancy J.L. (2011), *Corpo Nudo*, in Calabrò D., *L'ora meridiana. Il pensiero inoperoso di Jean-Luc Nancy tra ontologia, estetica e politica*, Milano: Mimesis, 2012.

[27] Pagano U. (2011), *L'uomo senza tempo. Riflessioni sociologiche sulla temporalità nell'epoca dell'accelerazione*, Milano: FrancoAngeli.

[28] Pasqualotto G. (2004), *Estetica del vuoto. Arte e meditazione nelle culture d'Oriente*, Marsilio, Venezia.

[29] Riva, C. (2015). *Consumo e identità: una prospettiva antropologica*. Trento: Erickson.

[30] Schopenhauer A. (1819), *Die Wels als Wille und Vorstellung*, Brockhaus, Leipzig; Ital. trans. *Il mondo come volontà e rappresentazione*, Vol. 1, Perugia: Bartelli & Verando, 1913 (new revised edition, Milano: Mursia, 1969).

[31] Singer, P. (1975). *Animal Liberation*, New York: Avon Books.

Science & Philosophy Volume 11(1), 2023

Scientific-Philosophical Base of Darwin's and Wallace's Theory of Evolution

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Abstract

If Darwin's and Wallace's theory of evolution is reduced to "eat and be eaten" misunderstanding and rejection arise. From a didactic point of view, a scientific and philosophical examination of the theory is necessary. It can create understanding and acceptance. Epistemologically, the theory of evolution describes a cognition and innovation process that corresponds to scientific working methods. The philosophical analysis shows that ethical behaviour emerges in evolution. The basic concept of this article is the assumption of the unity of spirit and matter (monism) and the parallelism of ethics and mechanics (Elome concept). There is no principal contradiction between the theory of evolution and religious ideas but to the magical-mythical worldview. An understanding of the scientific method is a prerequisite for a deeper understanding of the evolutionary process. It is not about a branch of biology, but about a worldview.

Keywords: philosophy science; ethic evolution; ethic social sciences; biology life definition; evolution pedagogy didactic.[†]

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[†] Received on May 23, 2023. Accepted on June 23, 2022. Published on June 30, 2023. DOI: 10.23756/sp.v11i1.1228. ISSN 2282-7757; eISSN 2282-7765. ©F. Klaus. This paper is published under the CC-BY licence agreement.

1. Introduction

The theory of evolution occupies a central place in biology didactics, because many characteristics of living beings can only be understood from an evolutionary perspective. The theory is important for biology, medicine and society. Manny interesting examples of evolutionary development can be found in the literature. The texts are mostly intended for professionals. Almost all biologists accept Darwin's theory of evolution. But there is a lot of uncertainty among the general public. Presumably many reduce Darwin's theory of evolution to "eat and be eaten". This creates misunderstanding and rejection.

One reason is the lack of connection between evolution and scientific working methods. This connection creates a deeper understanding.

One reason is the lack of integration of biology into philosophy. This connection not only increases understanding, but the inclusion of ethics can also create emotional acceptance.

One cause is rejection based on religious beliefs. Politeness and sincerity are a basis for conversation.

Building on this didactic foundation, many aspects of biology can be discussed: spirit and matter, perception and consciousness, viruses and information or the origin of biological life, arise of matter and the natural laws.

This study shows necessary and sufficient philosophical, scientific and educational approaches to create a connection. This connection is also important because of the impact it has in society. Possible solutions are shown here.

2. Scientific and philosophical base

Darwin's and Wallace's theory of evolution is based on simple logical-mathematical considerations. The correctness of the considerations can be proved mathematically (statistically). Simple evolutionary processes can be generated experimentally. Observations of nature confirm the concept. The driving force behind evolution is the "*struggle for existence*" (Darwin / Wallace, 1859 / 1889). But every animal and plant die, what survives? A philosophical analysis is required to answer this question.

2.1 Preliminary considerations

Darwin's and Wallace's theory of evolution can be divided into three steps: mutation, selection, reproduction. During mutation, the genetic material changes and variations arise, during selection some of the organisms die, while those that survive can reproduce.

The scientific way of working can also be divided into three steps: creating a model, testing the model, and publish the model. After publication, other scientists modify the model or design new ones.

"The theory of evolution describes a cognition and innovation process that corresponds to scientific working methods. ... Evolution brings about something comparable to science: models (knowledge) and technology (innovations). The resulting objects have spiritual and material properties." (Fröhlich, 2017)

Many observations show that living beings support each other and show ethical behaviour. Their survival often depends on their mutual cooperation. Ethical behaviour is produced evolutionarily in symbioses.

2.2 Didactic considerations about science

A key goal of science education is to teach scientific methods. Knowledge of model properties helps to classify scientific relationships and to better understand the products of evolution such as the physical and mental properties of living beings.

Models are based on mental constructs that should help the user to set goals and solve tasks. Complex operations are simplified, taking into account the essential properties. There is no identity between model and object, just a core identity. The essential relationships to the object depend on the tasks that this model has to fulfil.

The quality of models is based on self-restraint. Philosophical models have to be logical, good ones have to be logical in themselves. Science is part of philosophy. Science imposes additional limitations on itself. (See table 1.)

Designation	**Description**	**Principle**
Russell's Chicken	Models should explain connections. (Russell's chicken does not understand the context.)	Principle of reason
Occam's razor	Models should be based on as few assumptions as possible, but take into account the essentials. (Occam's razor cuts off superfluous assumptions.)	The principle of simplicity, also known as the economy principle of science.
Copernican Principle	The same laws of nature apply to everyone, including the observer.	Principle of equality (before the law)
Scientific	Only verifiable statements are scientific.	Principle of truthfulness
Checked	Models should be exterminated in practice in many ways.	Principle of validation (experience, repeatability)

Table 1: Quality criteria for philosophy and science (Fröhlich, 2017)

Limitations can expand possibilities. This is how safety rules restrict actions. Road traffic, chemical plants and much more do not work without the restriction of safety rules. *"Systems theory"* (cf. Bertalanffy, 2009) is also based on self-restraint. It helps to better understand biological processes. An ant colony consists of ants, which in turn consist of cells, which in turn consist of atoms, which in turn consist of elementary particles. Systems have the ability to self-organize. This creates higher levels with new properties and laws. According to the systems theory, the laws valid at each level are observed. For this, the laws of the lower rules are restricted at the higher levels. A lowest level without laws is possible, where everything is allowed and chaos prevails.

2.3 Elome: Unity of spirit and matter - parallelism of ethics and mechanics

According to Heraclitus of Ephesus (600-540 BC), natural laws arise in an evolutionary process. The starting point is change. Forces wrestle with each other. If they are of different strengths, the stronger force destroys everything it can influence and thus loses its effect. What remains are opposing, equally strong forces. In the resulting equilibrium, the forces are mutually supportive. Heraclitus called this stable balance harmony, Aristotle (384-322 BC) called it matter, and today's definition is symbiosis.

The oscillations and waves of physics have the properties described. The properties of natural laws and matter point to an evolutionary origin. There is only one requirement for this: It is possible. The universe does not arise from non-existence, but from possibility. The starting point is the principle of freedom: it is possible for valid laws of nature to form.

Valid laws have a material effect. Every material property and every material process based on valid laws. The other way around: natural laws are valid through their material effect and thus through their material properties. Spirit and matter form an inseparable unit: *Monism / Information theory.* (cf. Haeckel, 1899 / cf. Shannon, 1948)

Evolutionary stability requires compliance with the laws of mechanics and ethical rules. Ethics and mechanics develop in parallel in the process of evolution. They influence each other but are not linked to each other by natural laws. Ethics, logic and mechanics form the basis of our world: *Elome concept.* (cf. Fröhlich, 2017)

The theory of evolution is about survival. People, animals, plants are dying. What is passed on? Spiritual concepts that are materially implemented passed on.

2.4 Scientific considerations: evolution and innovation

Darwin's and Wallace's theory of evolution is based on simple observations. Trees produce many thousands of seeds (reproduction). Due to genetic changes (mutations) the seeds have different properties, called variations. Only a few seeds grow into trees (selection). The scientific way of working can be divided into steps that correspond to the theory of evolution. (Table 2)

Biology	**Science**	**Philosophy**
Mutation	Creation of a model	Principle of freedom
Selection	Testing of the model	Principle of truthfulness.
Reproduction	Publish the model	Principle of love

Table 2: Evolution as scientific cognition and innovation process.

Darwin's and Wallace's theory of evolution describes a scientific cognition and innovation process. This is an artistically creative process. A scientific cognition and innovation process produces models and functional models. Map and navigation system are models, self-driving car is functional model. Since living beings have developed in an evolutionary process of cognition and innovation, they have the properties of functional models. Their organs also have these properties. A wolf has the properties of a functional model in relation to its environment, the biotope. His hearing is a functional model of the acoustic environment. The functional models of a living being help to ensure survival.

Models like Maxwell's equations are written in a human language called mathematics. Models have linguistic properties. The laws of nature could have evolved. According to this, matter has the properties of functional models, physical interactions the properties of languages.

2.5 Philosophical considerations: monistic and dualistic concepts

The theory of evolution has triggered a discussion on how to explain our world. Which concept is suitable for this, the scientific or the magical-mythical?

People have long pondered why thoughts and words have an effect. To explain this, the concept of magic was developed. It is based on the dualism of spirit and matter. Mental processes (thoughts, dreams, states of intoxication, spirits) therefore have a direct effect on matter. For example, if the magic word for ´fire´ is pronounced, it should burn without any further cause. The assumption can be tested. The assumption was not confirmed.

Statements predicting an observable effect are scientific. Statements in which the effect takes place in transcendence cannot be tested and are therefore unscientific. E.g. ´Good deeds will be rewarded in the hereafter´.

Independent of the experimental results, dualistic models are not very suitable for explaining the world. They divide the world into two unconnected parts and do not allow understanding. To explain events a continuous, logical chain of explanation is required in science, but not in dualistic magic. In magic, the gap in explanation is often obscured by seemingly scientific explanations or references to secret truths.

Information theory is the main scientific counter-theory to magic. It is based on the unity of spirit and matter. In the monistic "*information theory*" (Shannon, 1948), words

are functional models of the action. One says: ´Make a fire´, another lights a match. How does this work? Information always has a material basis, but can change its basis. E.g. written texts are read out and listened. Every time the base is changed, an energy conversion takes place. Language is like a stone unleashing an avalanche. Small amounts of energy can release large amounts.

The information theory has been confirmed in many individual cases. This monistic theory has a high quality. Information theory is suitable for explaining the effect of genes and the evolutionary processes. The magic concept has been falsified many times in individual cases. As a dualistic model, it is of low quality.

Some of the traditional religious beliefs contain magical components. These beliefs usually have much greater problems with ethics then with science. For biology as a social science, social implications are particularly important. Magical-mythical ideas are widespread, even in the industrialized countries. So-called healing spells, which are also supposed to work over long distances, are accepted and considered ethically good by many people. But: If you believe healing spells work over long distances, you conclude that damage spells can also work over long distances. That creates fear. Fear creates witch-hunts. Healing spells are ethically very problematic.

"Belief in witchcraft is widespread. A 2005 poll of Canadians and people from the United Kingdom found that 13 percent believed in witches. For Americans, that number was even higher: 21 percent. ... Organizations like the United Nations and Stepping Stones Nigeria have found that the number of witch trials around the world is increasing. They are almost always violent, and sometimes they are deadly." (Schons, 2011)

Belief in magic is often accompanied with rejection of science. Science is based on the principle of truthfulness. In other words, scientists strive to find out the truth. The rule applies to scientific work: Differences of opinion are settled with arguments. Fraud is named as such. Unfortunately, this is often violated in the debate about the theory of evolution.

Socrates already found out that we humans are not able to recognize the truth: *"I know that I know nothing."* (To Socrates, 463-399 BC). Epistemologically, it is disputed whether there is ´truth´. That is why scientific theories and models are not declared to be the truth. Good theories and models are useful and only apply until more useful ones replace them. (Popper, 1933)

In a *"paradigm shift"* (Kuhn, 1962), fundamental concepts are replaced by new ones. The change from the magical-mythical worldview to the scientific worldview of information theory is a paradigm shift. Since both worldviews do not harmonize, everyone has to make a decision for themselves.

The theory of heredity replaces the concept of the transmigration of souls to explain the relationships of the family and the theory of evolution, the doctrine of creation. The natural sciences are not fundamentally in conflict with religion, but do not agree with some religious views. Differing views are common in science. However, there is a

contrast between the effort to be truthful and ideology. Philosophical and religious dogmas that must not be questioned are not compatible with the principle of science.

What is the difference between belief and superstition? When a person's beliefs fit together, they are genuine beliefs. Ideas that contradict basic beliefs are superstitions. Many ancients believed the stars were gods and concluded that stars could influence their lives. Today there are people who believe in horoscopes even though they know that planets are rocks. What was a belief in ancient times may be a superstition today. Even today, some ideas of natives are real beliefs; the same ideas in industrialized countries are superstitions. Superstition goes hand in hand with self-deception and doublethink. It is pedagogically important to uncover these inner contradictions, as they are often psychologically distressing. Self-honesty is an important pedagogical goal.

2.6 Didactic considerations: evolution and education

Representative surveys show whether Darwin's and Wallace's theory of evolution is understood and accepted. Here are the survey results from two highly developed industrialized countries:

„The poll found that 25% of Britons believe Charles Darwin's theory of evolution is ´definitely true´, with another quarter saying it is ´probably true´. Half of the 2,060 people questioned were either strongly opposed to the theory or confused about it.“ (Butt, 2009)

„According to a new Pew Research Center analysis, six-in-ten Americans (60%) say that ´humans and other living things have evolved over time´, while a third (33%) reject the idea of evolution, saying that ´humans and other living things have existed in their present form since the beginning of time´.” (Pew Research Center, 2013)

What needs to be done? First: Good instruction of (biology-) teachers. It's not just about specialist knowledge, but also about enthusiasm for the subject and the scientific method. This is particularly important in areas where attempts are being made to discourage the study of evolution.

Then: Allocate sufficient teaching time for an appropriate engagement with the theory of evolution. Interdisciplinary lessons in biology, chemistry, physics and philosophy should school the topic of science: What is science? How do scientists work? What do scientists create? What is the relationship between ethics and science? What is information? How does information work? The biological topics can build on this. A pedagogical approach to divergent worldviews is a matter of course.

The following paragraph shows how combining philosophy and biology can create a deeper understanding. Studying viruses, students learn a lot about evolution. As a specialist and social science, biology offers many opportunities to generate interest. Microbiology, medicine, psychology and sociology can be combined.

2.7 Teaching practice: viruses as information carriers

Information can be stored in different ways. In cell nuclei, plasmid rings and viruses [gene], in infectious proteins as prions [protein], in computers and computer viruses [bit] and in brains or books ["*meme*"]. (Dawkins, 1976) Biological viruses, computer viruses, thought viruses have common properties.

Viruses infect humans, animals, plants, bacteria and archaea. There are even viruses that infect viruses. "*Smallpox is estimated to have killed up to 300 million people in the 20th century*." (Wikipedia, 2023)

Viruses are often described as highly aggressive. But viruses are not aggressive attackers, they are passive - passive as a book: Books reflect light and viruses are involved in chemical reactions. The cell produces the necessary proteins to dock onto the virus, open it, transport the viral DNA into the cell nucleus, translate it and carry out the virus's instructions. The cell also provides the required energy. Humans, animals, plants, bacteria, archaea invest a lot of energy and time in activating viruses and they go to great lengths to fight viruses. What is the reason for this? In a figurative sense, it is hope that the virus contains valuable information and the fear that it will make you sick or kill you. For this reason, the viruses are tested several times before they are recorded. (See table3)

	Biological viruses	**Computer viruses**	**Thought viruses**
Description	Chemical molecules: RNA, DNA.	Programs that are spread from computer to computer.	Human language.
Spread	Spread by contact, blood, saliva, feces, air.	Distribution via floppy disks, CD, USB stick, mobile phone reception, e-mail, internet.	Dissemination through talks, lectures, books, newspapers, radio, films, internet.
Infection	E.g., contact with infected people.	E.g., opening an infected email.	E.g., listening to a conversation.
Possible valuable	If the effort equals the benefit, it is very important. Viruses may be essential to life.	Helpful program as a Word processor or a mailing app, important mails and interesting pictures.	Helpful knowledge, interesting information's, the chance to become rich and powerful.
Possible dangers	Illness, death, external control (e.g. rabies).	Data loss, data theft, external control, destruction of the controlled machines.	Hatred, violence, suicide, murder, war, external control (e.g. some sects).
Test	Body and cell have immune systems. The RNA is also checked add can be destroyed.	Anti-malware virus scanner.	Inform, reflect.
Example	Smallpox kills.	Zero-locker encrypts all files.	Anti-Semitism discriminates and kills.
Prevention	Hygiene, vaccination, strengthening the immune system. Responsibility for your own health.	Caution, anti-malware, backup, encrypt data, required apps only. Responsible for your own data security.	Education, human rights, democracy, social security. mental hygiene. Responsible for your own thoughts.
Treatment	Care, medication, isolation.	Disconnect from the network if infected, delete viruses.	Stand up against the spread of criminal ideologies.

Table 3: Virus properties

Can books kill? Yes! For example, a love novel from Goethe temporarily triggered a wave of suicide with unfortunate lovers. But that didn't last. There is a race virus against anti-virus. If a virus is recognized as harmful, it is rendered harmless. To spread

further, viruses have to change. Biological viruses and polymorphic computer viruses can change themselves. Propaganda and thought systems are also subject to mutation. Ideas come in many variations, some catch on and spread. Viruses can become more harmless but also more dangerous through mutations. If a cell is infected at the same time by a virus that spreads rapidly and another virus that is dangerous, both viruses can mix and create a dangerous, rapidly spreading virus. This also applies to thought viruses (memes).

Information about the sender helps to assess the value of a message. Virus shells disguise themselves as body cells, e-mail transmitters are faked, and not every scientific statement comes from a scientist. Groups of people who are particularly trusted, such as scientists and teachers, have a special responsibility.

2.8 Philosophical considerations: evolution and ethics

Humans have responsibilities. Does ethical action also exist in other areas of biology, such as between cells? Such questions carry the danger of humanization. Cells cannot consciously choose ethical behaviour. But cells can exhibit behaviour that we would call ethical in humans. In ethics it is the act that counts.

Cooperation for mutual benefit increases the partners' chances of survival. In social creatures, helping is one of the most important behaviours. For very important behaviours, overgeneralisation makes sense from an evolutionary perspective. Social creatures often provide help without expecting anything in return. For example, animals adopt alien, even non-specific animal children. Something new has emerged. Selfishness has turned into mutual help and even selflessness.

In symbioses, the evolutionary process promotes ethical behaviour. Outside of the symbioses, however, ruthlessness and aggression can be the most successful strategies. Even symbioses are not without conflict. Partners often try to put themselves in a better position to get more benefits out of the relationship. There is a tendency to evolve from symbiote to parasite. This development can be found in symbiotic fungi and plants, but also between spouses. The opposite reverse process also takes place. Parasites have a quest to make themselves indispensable.

The focus of the theory of evolution is mostly on hunter-prey relationships. A brutal struggle for survival takes place between individuals. But there is also another aspect. Over time, the species involved become fitter. For the individual, hunters are parasites, for the species they are symbionts. Symbioses are a suitable topic to speak explicitly about the theory of evolution and to show different sides.

Humans are living being made up of many living beings (cells), which in turn are made up of smaller living structures. Its survival relies on the reliable functioning of many symbioses. Living and surviving requires the observance of ethical rules and philosophical principles such as truthfulness, love, freedom and justice. Like love, symbioses are partisan.

Symbiosis has an ethical basis and is a mandatory requirement for life. Darwin's and Wallace's theory of evolution can explain how symbioses and thus behaviours that meet ethical requirements arise. This is significant for laws and regulations in the fields of animal welfare, medicine, psychology and sociology.

Human society is still under construction. There are many symbioses and social behaviour that goes beyond that. At the same time, aggressive and antisocial behaviour endangers survival. A word of warning: astronomers have not yet discovered any intelligent extra-terrestrial life. The laws of evolution also apply on other planets. It is possible that the extra-terrestrial beings have become extinct each time they have developed science and technology.

2.9 Discussion: world views

Religious beliefs have historically produced compassion, helpfulness, and great achievement, but also horrific wars and crimes. A peaceful coexistence of the different religions is particularly important. The discussion about the theory of evolution clarifies worldviews and their implications.

Evolution theory: The processes of nature obey logical mathematical laws of nature. Creationism: There are texts that come from an omniscient and are absolutely true. Intelligent Design: There is a higher power directing the universe.

The assessment of world views is based on the following principles. (See table 4.)

Religion	**Philosophy**	**Everyday life**
Respect for God*	Truthfulness	Principle of scientificity
Trust and love for God*	Understanding and love	Principle of legality
Religious practice	Ethics / life experience	Life practice
Wisdom		
* Cipher in the sense of "*philosophical faith*". (Jaspers, 2000)		

Table 4: Ethical and religious criteria (Fröhlich, 2017)

Karl Jaspers formulated the concept of philosophical faith. It is accepted that human knowledge is limited. Holy books are books of wisdom. The interpretation as literal truth is not appropriate. It is based on the acceptance of all schools of thought and beliefs. The various conceptions of God are understood as ciphers. There is no humanization of God, no attribution of immeasurably increased human abilities. (cf. Jaspers, 2000)

Creationism claims that human beings gain access to absolute truth through texts. Creationism rejects all divergent views and is in conflict with all scientific disciplines such as physics, chemistry, astronomy, geology or biology. According to the concept of intelligent design, the laws of nature are partially suspended or circumvented. This approach does not contradict any discipline, but the philosophical basis of science.

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The concept of intelligent design is unscientific because it cannot be experimentally verified. Both approaches are based on the concept of magic. The principle of scientificity is based on truthfulness. Respect for God* requires religious truthfulness.

Scientific models and philosophical concepts of God* have no problems with striving for trust and love in God. If human attributes are attributed to God, then he also possesses negative human attributes. In creationism and intelligent design, actions punishable under human law are attributed to God. The ethical problems are already discussed in the Book of Job. The religious problems with the theory of evolution are insignificant in comparison.

Biology, sociology and systems theory describe the characteristics of communities. Mechanisms that stabilize the group but also power mechanisms are at work in communities. Statements of content and social mechanisms are often combined by the community into an interwoven dogma. A typical group-binding dogma is: believe what we believe and you will be rewarded. From an evolutionary point of view, the associated mechanism is to be separated from content-related statements and evaluated differently. This can be helpful in scientifically testing the truthfulness of statements.

The supposed possession of the truth has consequences for the human community, for everyday life and the law. The different interpretations of religious scriptures often led to armed conflicts. The formation of groups is of particular importance for a peaceful and genuine coexistence. Biology and sociology observe how groups differentiate themselves from others.

Common values contribute to group formation. Its borders are permeable, members can come and go. These groups are cooperative and work symbiotically with others. In nature cells in an organism are examples of good cooperation.

In ideologies, lies and crimes encourage demarcation. Convinced supporters defend them and thus reliably distinguish themselves. Outsiders are often degraded, exploited and persecuted. Even members who want peace and reject violence support the system.

In a religion, all people call the god by the same name. Some help people in the name of this god, some kill people in the name of this god. Do they actually believe in the same God? Some help in the name of their god, others help in the name of another god. Do they actually believe different gods?

Worldview shapes behaviour. Is religious practice and practical life oriented towards respect, trust, understanding, love and truthfulness? Faith without truthfulness can easily be misused as an instrument of power, piety seeks balance. The concept of philosophical faith shifts the focus of religion from faith to piety. Piety is a way of life based on ethical and religious values. As in science, it is also possible to work together in religion across borders without giving up one's own convictions. Fanatic, dogmatic faith divides, piety unites across borders. Today the world is growing together, people need to approach each other. Peaceful coexistence is possible.

3. Biological aspects of the theory of evolution

Evolution as a scientific cognition and innovation process produces models and functional models. It is also an artistic-creative process. Our perception also emerges in an artistic-creative process.

3.1 Basics of biology: perception and consciousness

As our perception has evolved, it has model properties. Our perception is not a direct representation, but also not an illusion, not a deception. Emotionally we feel our perception as reality. But it is a fallacy to assume that the world is as we perceive it. The model of physics describes light as electromagnetic waves with different wavelengths; in the model of perception, light has different colours. However, models also have advantages over an image. They help to understand the world and are helpful in mastering life. Furthermore, several models, each of which illustrates other aspects, can be combined with one another. New technical possibilities and insights thus expand knowledge and options for action.

For psychology and information theory, spirit and matter form a unit. René Descartes saw an insurmountable gap between perception and the environment. (cf. Descartes, 1641) This is called the Cartesian prison of our mind. The theory of evolution makes it possible to break out of Cartesian prison. However, it is only a partial outbreak, because scientific statements are not absolute. The theory of evolution shows a connection between perception and the environment, but it is very narrow. With the help of our perception, we receive only little information about our environment. So, in the room you are in right now there are songs, pictures, films that you are not aware of. A television antenna can receive this information.

The coloured flowers of plants give scientists information about the colour perception of insects that pollinate the flowers. Flower colours have evolved and therefore serve a purpose. Obviously, plants communicate with insects. This suggests colour perception in insects.

Our perception, i.e. seeing, hearing, smelling, touching, has model properties. The innate sensations of space, time, matter and temperature are functional models of our environment. The model character can be recognized by the so-called optical illusions. Vision is combined with other sense organs such as the vestibular system and combined with ´experience´ acquired evolutionarily and stored in the processing system of the visual centre. Movements are balanced, edges are sharpened, overlays are separated, objects are recognized. Our visual perception has more information than an image.

Models have the properties of languages. Our perception, i.e. seeing, hearing, smelling, touching, has linguistic properties. Language works when translated into another language. This is accompanied by a change of media.

Language has model properties. Different languages correspond to different models. There is no identity between object and model, but a core identity. A correct translation preserves this core identity. Translation modules must guarantee this. Many vital translation modules have been optimized in the evolutionary process: the narrowing cochlea of the inner ear amplifies sound frequencies locally. There the hair cells are set in motion and nerves are stimulated. - In the speech organ, nerve impulses produce muscle movements that regulate the resonance space in the mouth and shape sound frequencies. In the eye, sensory cells establish a connection between light frequencies and nerve impulses. The impulses of the auditory nerve produce tones in the brain, those of the optic nerve produce colours.

There is a problem: external perceptions are not accessible to us. Solipsism assumes that there is only one perception, your own. Systems theory provides the basis for an alternative model: every system needs an internal perception in order to function. The model is based on the following postulate: fundamental properties are based on fundamental physical processes. Physical interactions have an external and an internal effect at the same time. This inner effect is based on a symbiosis and is the basis for perception. Since perception is based on interactions, it is always about external perception and not self-perception.

Assumption: each brain area, like a person, may have its own perception. Different areas of the brain may be talking to each other. It is possible that we perceive the perception of one area of the brain and the other areas send their messages in different languages to this centre. It is possible that these conversations between the brain areas trigger the differently perceived feelings. Many scientists have a different opinion, they assume that perception is only possible for creatures with a brain.

The evolution process optimizes processes. To solve complex challenges, the internal processing is optimized. This is done by developing functional models and suitable languages in our brain. This assumption can be researched experimentally by communicating with the individual brain areas.

3.2 Teaching practice: from the unicellular organism to the nerve

The way nerves work is strange at first glance. Why are there gaps between them into which they release chemical compounds called messenger substances? This process has its evolutionary roots in the unicellular ancestors. After eating, protozoa excrete urine. Other protozoa can smell the urine. When smelling, a chemical reaction takes place (matter) and information is transmitted (spirit). The urine provides information about the location of a food source. The information triggers a change in behaviour, the other protozoa swim to the food source. Knowledge can be acquired individually or through evolution. Knowledge can be stored in different ways, consciously or as a functional part of an innovation. Protozoa can use this behaviour to attract other protozoa, by excrete the substance in the urine that is smelled.

Chemical changes in this substance have enabled different reactions. We call this group of substances messenger substances or hormones. They serve not only to attract partners, but also to show growing nerves the way to their target. Messenger substances also regulate organ formation. A language based on chemical reactions has emerged. (cf. Ditfurth, 1976)

Darwin's and Wallace's theory of evolution creates an understanding.

3.3 Basics of biology: on the origin of life

There are many different definitions of life. Here is a technical and a scientific-philosophical definition of life: *"Living beings have a boundary, a metabolism, grow and reproduce. They can record, save, change, and send information. They obtain their inner order by responding appropriately to internal and external influences."* (Fröhlich, 2022) Symbioses are a necessary condition for life. In the symbiosis definition, life has an ethical value and provides a basis for legislation. This is important for lawyers, doctors and vets. *"In the words of philosophy: ´Basis of life is the principle of love. Life exists where this principle rules (symbiosis).` In the words of biology: ´Basis and indicator of life is the symbiosis.´"* (Fröhlich, 2022)

How do symbioses, how does ethics arise? Is it possible for chemistry to become biology? The theory of evolution creates family trees. They help to recognize connections and to better understand how the organs of living beings work. Drawn up by scientists they describe possible relationships and not always the actual ones. Possibilities are shown. There are many possible pathways in chemical evolution in the laboratories of nature: hydrothermal vents, cold vents, methane vents, white smokers, black smokers, fumaroles, mud pots, dried up puddles, deserts, salt flats, ore deposits, crystals, ice, clouds, asteroids, meteorites. Different reactions are described that could have resulted in important chemical building blocks such as sugar, fats, amino acids or nucleic acids. The following description gives one possible way.

There are small cavities in rock. It can be observed that slimy deposits form on the walls of the cavities. Chemical reactions take place in them, which catalytically promote each other. (cf. Eigen, 1971) This symbiotic system already has the most important functions of a living being. Through fissures, chemicals (food) enter the cavity (boundary), react (metabolism), and leave (excretion). Some of the resulting catalysts remain in the cavity (growth) or get into neighbouring cavities (reproduce). Catalysts from different sources can mix (sexuality). Changes in catalysts change the speed of chemical reactions (evolution). Chemicals and thus information are absorbed, processed, stored and released. Over time, membranes can form on the wall and in the gaps. This way the inflowing and outflowing substances can be regulated (cell walls). This also creates a requirement for exiting the hole. Catalysts accelerate reactions, end products inhibit them. Catalysts are preserved in chemical reactions. A cycle is formed in which the end product can be used as the starting product in a further cycle. In this hypercycle, the cycles involved regulate each other. (cf. Eigen, 1971) In other words:

They obtain their inner order by responding appropriately to internal and external influences. According to the above definitions, it is a life form. You can find them in cavities. Metabolism is information processing. Hypercycles are information stores. In this life form there is no storage of information in written form. Writing and reading presuppose structures that can carry out instructions. The RNA has formed in its own hypercycle as a chemical. The cell plasma is prior than our genes. Later different hypercycles have joined together to give rise to modern cells. In them, the genetic information is stored as text in the DNA / RNA.

RNA and DNA are written languages that use different types of paper made from sugar compounds. The deoxyribose of DNA creates a more stable paper than the ribose of RNA. The four letters consist of four different nucleic acids. Words consist of three letters. The translation module, called t-RNA, translates words into protein language. The medium DNA, like the medium book, can store information in the long term. Messenger RNA can spread information like a radio broadcast. Proteins serve both as building components and as construction machines.

The cycles described here meet the requirements of the technical definition of life. In the symbiosis definition of life there is no contrast inanimate - alive, but a smooth transition. In protozoa there is a very large number of symbiotic processes. A hypercycle describes the first step from chemistry to biology, but is closer to chemistry. Hypercycles arise constantly in many places in a variety of forms. They obey the rules of evolution. Evolution is masterful in perfecting processes and in combining different components (building block method), but it takes a lot of time.

According to this model, life possibly begins in a variety of rock pores. The starting point is not an individual, but a community. The community could be described as a species or biotope. The biotope forms the first biological form of life. The one cell from which all other cells descend is just a statistical construct. The possibilities for the emergence of biological life are so manifold that many biologists suspect that there are diverse life forms in space.

3.4 Scientific considerations: evolution and nature laws

There are issues in science that are controversial. Like Heraclitus, some scientists assume that the laws of nature and matter arose evolutionarily, while others reject this notion. Natural laws and matter should therefore have typical properties. These products of evolution arise through symbioses. Symbioses store information and create an environment, a history. Symbioses must be maintained. Accordingly, the validity of every natural law in their environment would have to be constantly confirmed. Symbioses create a tiered structure of varying complexity. According to this, matter should have a graded structure. The laws of the higher levels limit the possibilities that are available at any one time. Accordingly, natural laws should limit. Symbioses are only stable in the long run if ethical principles are observed. According to this, the laws of nature should be based on principles.

3.5 Teaching practice: examination of the theory of evolution

Darwin's and Wallace's theory of evolution is based on as few assumptions (Occam's razor), and can explain connections (Russell's Chicken). The only requirement are mathematics and natural laws (Copernican Principle). The statements are verifiable (scientific). The theory is testable and has been tested many times through observation and experimentation (checked). Some topics were discussed intensively:

Animals that can have offspring together belong to a species. The division into species is a human classification that is only valid given the place and time. It does not refer to the ancestors. Experimentally, two different species could be bred from one species, and the separation of the species could be observed in fossilized mussels.

Do new species have worse properties? Both in speciation and in spatial separation into breeds, the number of individuals and the gene pool is becoming smaller. Skills are lost but innovation can spread faster. A major driver of evolution is race formation and interbreeding. The breeds involved contribute their respective abilities to the gene pool. Speciation increases competition, which often leads to specialization.

Many innovations occurred in the Cambrian Explosion 500-600 million years ago. A comparable process can be found in the industrial explosion. A basic innovation triggers a chain of further innovations. Organ formation was probably the basic innovation in the Cambrian explosion. During organ formation, different cell types join together in a symbiosis according to a blueprint.

Is evolution just a matter of chance? Genetic changes have different causes. Point mutations caused by radioactive radiation are random. The exchange of gene sections is controlled by mechanisms. Protozoa have an arsenal of genetic engineering tools at their disposal. They can activate mechanisms depending on the situation. Even unicellular organisms can learn and act adaptively. Not only the mutation, but also the selection is not purely random. This enables the high speed of the evolutionary processes that can currently be observed. In retrospect evolution has a direction. Chance is important, but in the long run principles prevail.

The theory of evolution is based on cause and effect and does not require a goal to be striven for. Mechanisms do not have a goal, but a direction. The mechanism of evolution tends toward cognition and innovation. The mechanism of evolution produces the striving for goals. The seed of a tree obeys cause and effect and becomes a tree according to its genetic blueprint. Living beings can aspire to goals. Cause and effect or striving for a goal has been an important topic of philosophy since Aristotle.

3.6 Basics of biology: important steps in evolution

In evolution, small steps often lead to small improvements, but sometimes to fundamental changes. These are referred to as basic innovations or emergence. Here are five important innovations.

e.g. Matter / Laws of nature: From a purely material point of view, it is very strange that the universe should once have been smaller than a hazelnut. In the concept of the unity of mind and matter in terms of information theory the Big Bang is a legislative process. Laws always have material properties. New matter arises with new laws. Evolution creates dynamic stability. Interactions are the language of the laws of nature.

e.g. Biological life / Language of genes: Biological life arose in two steps. First the cell plasma formed and then the gene language. The construction and operating instructions for cells, organs and the body are stored in the genes.

e.g. Eukaryotes / Complex cells: Protozoa with different abilities often join together. Smaller cells attach to larger ones or live inside the cell (endosymbiosis). Together they can do more. The higher organisms are eukaryotes.

e.g. Organisms / Organ formation: All cells in an organism have the same DNA. When organs are formed, cells acquire different abilities and join together according to a blueprint. Together they can do more and the Cambrian explosion could start.

e.g. Instinct Language / Universal Language / Science: Their universal language, the ability to cooperate and their manual skills are particularly important for people's success.

3.7 Discussion: meaning of life

Science limits itself. It makes no claims about transcendence. It doesn't say whether or not there is a transcendental meaning. But scientific analyses of our world can reveal a lot about goals, values and meaning.

The environment of life is the biotope. Nobody is alone. Many forms of communication have evolved: smells, colours, movements, songs, languages and actions. Many behaviours have evolved, helpful and aggressive. Evolution creates a thirst for research and knowledge, technical excellence and beauty, art and music, colour and sound perception, love and hate.

Living beings perceive. They taste, smell, see and feel. They also perceive their emotions, their thoughts, joy, sadness and pain.

Living beings want to live and experience. They want to find partners and procreate. They strive to prove themselves through achievement and in battle. There are many ways of setting goals and creating meaning: experience, love, fight, research, learn, teach, create, design.

A starting point of evolution is the principle of freedom. Living beings can set themselves goals and strive for them. Every living being can give its life its own meaning. We, the living beings are part of the universe. We give meaning to the universe.

4. Conclusions

Like science, evolution is an artistically creative process. The matter of the universe and all living beings are created through symbioses within the framework of cognition and innovation processes based on the mechanism of science (mechanism of evolution) and in accordance with philosophical principles. This creates a logical-mathematical control system that obeys ethical principles and has material properties. Ethics, logic and mechanics form a unit. Spiritual concepts that are materially implemented are passed on from generation to generation. Living beings, their organs and their perception have the properties of functional models of their biotope. Symbioses sustain life. Mechanisms have a direction but no goal. Living beings can aspire to goals and show unselfish behaviour.

The universe does not arise from non-existence, but from possibility. The starting point is the principle of freedom: it is possible for valid laws of nature to form. Valid laws have a material effect. Every material property and every material process based on valid laws.

Biological life begins with the biotope as the original form of life. Ultimately, all forms of life form a symbiosis in a biotope. Ultimately, all people worldwide form a symbiosis. There is a worldwide ethic among people and a biotope-wide ethic among all living beings. However, this is often subject to the egotism of the individual life forms.

Evolution, like science, creates power. Creatures kill creatures to survive. Mutations are more often harmful than beneficial. Hereditary diseases lead to disability, suffering and death. Affected individuals make sacrifices for the common good of the species. The theory of evolution does not lead to a relativization of the concepts of good and evil, but to an understanding of the connections in a tragic conflict.

It is difficult to imagine that a unicellular organism develops into a lion. But you can observe how a fertilized egg cell becomes a tadpole and then a frog. And you can see how a caterpillar becomes a butterfly. Darwin and Wallace's theory of evolution explains the connections. The discussion about the theory of evolution is not just about a part of biology, but about a world view.

References

[1] Aristotle. Aristotle: containing selections from seven of the most important books of Aristotle, selected and translated by Philip Wheelwright, 1951

[2] L. von Bertalanffy. General System Theory. Biologia Generalis, 1/1949: 114–129, 1949

[3] R. Butt. Half of Britons do not believe in evolution, survey finds; in: The Guardian, 1.2.2009

[4] C. Darwin. The Origin of Species, London, 1859, retrieved by John Murray, 2009

[5] R. Dawkins. The Selfish Gene, Oxford, 1976

[6] R. Descartes. The Method, Meditations and Philosophy of Descartes 1596 - 1650, translated by John Veitch, Washington D.C., London, 1901

[7] H. von Ditfurth. Der Geist fiel nicht vom Himmel, Hamburg, 1976.

[8] M. Eigen. Selforganization of matter and the evolution of biological macromolecules, Naturwissenschaften 58, 465–523, 1971

[9] K. Fröhlich. Anregungen zum Nachdenken über Wissenschaft, Philosophie, Religion und Recht, Raleigh, 2017

[10] K. Fröhlich. Scientific-Philosophical Definition of Life, Science & Philosophy - Journal of Epistemology, Science and Philosophy. Vol. 10.2, 188-205, 2022

[11] H. Genz. Wie die Naturgesetze Wirklichkeit schaffen, München, Wien, 2002.

[12] E. Haeckel. Die Welträtsel. Gemeinverständliche Studien über Monistische Philosophie. 1899, new edition Bonn, 2016.

[13] Heraclitus Ephesus. 520-460 BC, as quoted by Plato in Cratylus. standardebooks.org/ 2023

[14] K. Jaspers. Was ist der Mensch? München, Piper, 2000

[15] T. S. Kuhn. The Structure of Scientific Revolutions, Chicago, 1962

[16] K. Popper. The Two Fundamental Problems of the Theory of Knowledge, 1930–1933, new edition 2008

[17] J. Miller. J. D. Scott, E. C. Okamoto. Public Acceptance of Evolution. Science Vol 313, NO. 578811, Issue 5788, pp. 765-766, Shinji, 2006

[18] G. Orwell. Nineteen Eighty-Four. A novel. London, 1949

[19] Pew Research Center Washington DC. 2013, Public's Views on Human Evolution, December 30, 2013

[20] C. E. Shannon. A mathematical theory of communication. Bell System Technical Journal, 27, pp. 379–423 & 623–656, 1948

[21] M. Schons. Witch Trials in the 21st Century; National Geographic, Washington DC, 2011

[22] A. R. Wallace. Darwinism an exposition of the theory of natural selection. London, New York, 1889.

[23] Wikipedia. Virus; Smallpox, 24.2.2023

Science & Philosophy

Volume n. 11, Issue n. 1, 2023

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Published by APAV (Accademia Piceno-Aprutina dei Velati in Teramo)