

Ignoramos et ignorabimus (1872)

Emil du Bois-Reymond (1818-96)

“Limits of our knowledge of nature”, transl. J. Fitzgerald, *Popular Science Monthly* 5 (1874), pp. 17-32; German original: “Über die Grenzen des Naturerkennens”. In 1880, he delivered another speech on “The seven world-problems”, which presents the phrase *ignoramus et ignorabimus*, from the Latin, meaning “we do not know and will not know”, which he attributed to the ultimate nature of matter and force, to the origin of motion, and to the origin of simple sensations (the mind/body problem).

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Emil Heinrich du Bois-Reymond, around 1870 in Berlin (photo: Haase; obtained from Wikipedia)

[18] [...] If we were to suppose all changes in the physical world resolved into atomic motions, produced by constant central forces, then we should know the universe scientifically. The condition of the world at any given moment would then appear to be the direct result of its condition in the preceding moment, and the direct cause of its condition in the subsequent moment. Law and chance would be only different names for mechanical necessity. Nay, we may conceive of a degree of natural science wherein the whole process of the universe might be represented by one mathematical formula, by one infinite system of simultaneous differential equations, which should give the location, the direction of movement, and the velocity, of each atom in the universe at each instant. “A mind”, says Laplace, “which at a given instant should know all the forces acting in Nature, as also the respective situation of the beings of which it consists, provided its powers were sufficiently vast to analyze all these data, could embrace in one formula the movements of the largest bodies in the universe, and those of the smallest atom; nothing would be uncertain for such a mind, and the future, like the past, would be present to its eyes. The human intellect offers, in the perfection to which it has brought astronomy, a faint idea of what such a mind would be.”

[...] [19] For such a mind the hairs of our heads would be numbered, and without his knowledge no sparrow could fall to the ground. Being a seer expert both in the past and the future, for him, as D’Alembert, in the Introduction to the Encyclopædia [1751], expressed it, giving utterance to the germ of Laplace’s thought, “the universe would be one single fact and one great truth”.

In Leibniz, too, we find Laplace’s thought, and even better developed in some measure than in Laplace himself, inasmuch as Leibniz conceives of this mind as being endowed with senses and with technical powers of corresponding perfection. Bayle brought against the doctrine of Pre-Established Harmony the objection that it supposes the human body to be like a vessel that makes for its harbor by means of its own forces; Leibniz [1697] replied that this is not so impossible as Bayle holds it to be. “There is no doubt”, says he, “that a man might construct a machine that could for some time move about in a city, and turn accurately at certain street-corners. An incomparably more perfect, though still finite mind, might foresee and obviate an incomparably greater number of obstacles. So true is this, that if the world is, as some suppose, only a compound of a finite number of atoms, which move in accordance with the laws of mechanics, it is certain that a finite mind might be elevated sufficiently to comprehend and to foresee with mathematical certitude whatsoever is to occur therein within a given

time. And thus this mind could not only construct a ship capable of making a given port by itself, provided the proper force and direction were supplied, but it could even construct a body capable of imitating the actions of man.”

It need not be said that the human mind will ever remain very remote from this degree of acquaintance with Nature. To show how far we are from even the beginnings of such knowledge, we need but make one observation. Before our differential equations could be brought into the universal formula, all natural facts would have to be reduced to the motions of a substantially undifferentiated and consequently propertyless substratum of what appears to us as heterogeneous matter: in other words, all quality would have to be explained by the arrangement and the motion of this substratum.

This is entirely in accord with what we know of the senses. It is universally conceded that the sense-organs and the sense-nerves carry to their appropriate cerebral regions, or, as Johannes Müller calls them, “sense-substances” (*Sinnsubstantzen*), a motion that is in all cases ultimately identical. As in the experiment suggested by Bidder and successfully made by Vulpian on the nerves of taste, and those of the muscles of the tongue, the sensory and motor nerves, on being cut across, so heal together that excitation of the one class of fibres is transmitted by the cicatrix to the other class; in like manner, were the experiment possible, fibres from different sets of nerves would blend perfectly together. With the nerves of vision and of hearing severed, and then crossed with each other, we should with the eye hear the lightning-flash as a thunder-clap, and with the ear we should see the thunder as a series of luminous impressions. [20] Sense-perception, therefore, as such, has its rise in the “sense-substances”. It is these substances that translate the identical excitation of all the nerves into sense-perceptions, each set, according to its own nature, acting as carriers of Johannes Müller’s “specific energies”, and so giving quality. The Mosaic dictum, “There was light”, is physiologically false. Light first was when the first red eye-point of an infusorial animal for the first time distinguished light from darkness. In the absence of the sense-substance of sight and hearing, this bright, glowing, resonant world around us would be dark and voiceless.

And voiceless and dark in itself, i.e., propertyless, as the universe is on subjective decomposition of the phenomena of sense, so is it also from the mechanical stand-point, gained by objective contemplation. Here, in place of sound and light, we have only the vibrations of a primitive, undifferentiated matter, which here has become ponderable, and there imponderable.

But, however well-grounded these views may be in general, nothing, as we may say, has been done toward carrying them out in detail. The philosopher’s stone that should transmute into one another the as yet unanalyzed elements, and produce them from a higher element, if not from primeval matter itself, must be discovered before the first conjecture as to the development of apparently heterogeneous, from actually homogeneous matter, becomes possible. [...]

[24] But now there comes in, at some point in the development of life upon the earth which we cannot ascertain – the ascertainment of which does not concern us here – something new and extraordinary; something incomprehensible, again, as was the case with the essence of matter and force. The thread of intelligence, which stretches back into negatively-infinite time, is broken, and our natural science comes to a chasm across which is no bridge, over which no pinion can carry us: we are here at the other limit of our understanding.

This other incomprehensible is consciousness. I will now, conclusively as I believe, prove that not only is consciousness unexplainable by its material conditions in

the present status of science, which everyone will readily admit, but that, even in the nature of things, it never can be explained by these conditions. The contrary opinion, that we must not give up all hope of getting at consciousness from its material conditions, and that in the course of hundreds or thousands of years the mind of man, having invaded now unthought-of realms of knowledge, might succeed where we fail – this is the other error which I propose to combat here.

I use the term “consciousness” designedly, the question here being only as to the fact of an intellectual phenomenon, of any kind whatsoever, even of the lowest grade. There is no need to think of Watt, engrossed with his parallelogram, nor of Shakespeare, Raffaele, or Mozart, engaged in producing their grand creations, in order to have an instance of a mental fact unexplainable by its material conditions. Just as the most powerful and best developed muscular performance of man or animal is in fact no more obscure than the simple-contraction of a single muscle – as the single secretory cell involves the whole problem of secretion – so the most exalted mental activity [25] is no more incomprehensible in its material conditions than is the first grade of consciousness, i.e., sensation. With the first awakening of pleasure or pain, experienced on earth by some creature of the simplest structure, appeared that impassable gulf, and then the world became doubly incomprehensible.

[Presents the three classical views on the relation between mind and body, illustrated by the analogy of the two clocks] [...]

[26] Astronomical knowledge of a material system I call such a knowledge of all its parts, their respective positions and their motions, that their position and motion, at any given time, past or future, may be calculated with the same certainty as we calculate the position and motion of the heavenly bodies, by means of previous absolute accuracy of observation and perfection of theory. To get the differential equation whose integration will give the desired results, we need only have, as it were, three positions of the parts of the system; i.e., we must know the position of the parts of the system at three successive instants, separated by two differentials of time. From the difference of the courses run in the equal and infinitesimal periods of time between the three we deduce the forces acting upon the system and within it.

In our incapacity to comprehend matter and force, astronomical knowledge of a material system is the completest knowledge we can expect to acquire of it. With this our instinct of causality is wont to be satisfied, and this is the kind of knowledge that would be possessed even by the Mind imagined by Laplace, [27] if it made due use of its universal formula.

Now, suppose we had such astronomical knowledge as this, with regard to a muscle, a gland, an electrical organ, or a luminiferous organ in the state of excitation; of a ciliary cell, a plant, an ovum in contact with the sperm, or of a fruit at some stage of its development. In that case we should possess the fullest possible knowledge of these material systems, and our instinct of causality would be so far satisfied that we should desire nothing more, save to know what matter and force themselves are. Muscular contraction, secretion by the gland, the shock of the electrical, and the shining of the luminiferous organ; ciliary action, growth and chemical action of the cell in the plant; impregnation and development of the egg—all these phenomena, now hopelessly obscure, would be as evident for us as the movements of the planets. On the contrary, if we make a like supposition of astronomical knowledge, with regard to the brain of man, or even the soul-organ of the lowest animal, whose mental activity may be restricted to the sensation of pleasure and pain, then, so far as all the material phenomena are concerned, our knowledge would be as perfect, and our instinct of causality as satisfied, as in the case of muscular contraction or secretion, provided we had astronomical

knowledge of muscles or glands. The involuntary actions of the centers, and those not necessarily connected with sensation – reflex action, simultaneous action, respiratory movements, growth and decay of the brain and spinal cord – would be completely understood. Further, those phenomena which are always, and hence necessarily, simultaneous with mental phenomena, would also be perfectly understood. And it certainly were a great triumph of human knowledge if we were able to say that, on occasion of a given mental phenomenon, a certain definite motion of definite atoms would occur in certain definite ganglia and nerves. It would be profoundly interesting if we could thus, with the mind's eye, note the play of the brain-mechanism, in working out a problem in arithmetic, after the manner of a calculating-machine; or, even if we could say what play of the carbon, hydrogen, nitrogen, oxygen, phosphorus, and other atoms, corresponds to the pleasure we experience on hearing musical sounds; what whirl of such atoms answers to the climax of sensual enjoyment; and what molecular storm to the raging pain we feel when the trigeminus nerve is misused. The intellectual enjoyment afforded by Fechner's preliminary studies in psychophysics, and by Donders's measurements of the duration of simpler mental operations, gives reason to expect that such direct insight into the material conditions of mental phenomena would be highly instructive.

Still, as regards mental operations themselves, it is clear that, even with astronomical knowledge of the mind-organ, they would be as unintelligible as they are now. Were we possessed of such knowledge, they would still remain perfectly unintelligible. [28] Astronomical knowledge of the brain – the highest grade of knowledge we can expect ever to have – discloses to us nothing but matter in motion. But we cannot, by means of any imaginable movement of material particles, bridge over the chasm between the conscious and the unconscious.

Motion can only produce motion, or be converted back into potential energy. Potential energy can only produce motion, maintain static equilibrium, or exert pressure or traction. The sum of energy, however, remains the same. Beyond this law nothing can go in the physical world, nor can anything fall short of it; the mechanical cause passes completely into the mechanical effect. Hence the mental phenomena, which in the brain appear in company with material phenomena, are, so far as our understanding is concerned, void of sufficient basis. They lie beyond the law of causality, and hence are unintelligible, like a mobile perpetuum. But they are also unintelligible on other grounds.

True, on superficial observation, it looks as though certain mental operations and conditions might be intelligible to us, from a knowledge of the material phenomena of the brain. Among such mental phenomena I might reckon memory, association of ideas, habit, specific talents, etc. It needs but little reflection to show that this is an error. We should only be acquainted with certain inner conditions of the soul's life, which are of about equal import with the external conditions created by sense-impressions; but we should know nothing about the origin of mental life in virtue of these conditions.

What conceivable connection subsists between definite movements of definite atoms in my brain, on the one hand, and on the other hand such (for me) primordial, indefinable, undeniable facts as these: "I feel pain, or pleasure; I experience a sweet taste, or smell a rose, or hear an organ, or see something red", and the immediately-consequent certainty, "Therefore I exist"? It is absolutely and forever inconceivable that a number of carbon, hydrogen, nitrogen, oxygen, etc., atoms should not be indifferent as to their own position and motion, past, present, or future. It is utterly inconceivable how consciousness should result from their joint action. If their respective positions and their motion were not indifferent to them, they would have to be regarded as each possessed

of a consciousness of its own, and as so many monads. But this would not explain consciousness in general, nor would it in the least assist us in understanding the unitary consciousness of the individual.

That it is and ever will remain utterly impossible to understand higher mental operations from the mechanics of the cerebral atoms (supposing them to be known), needs not to be proved. Yet, as has been already remarked, we need not consider the higher forms of mental activity, in order to add weight to our argument. But its force is intensified by contrasting the absolute ignorance [29] wherein astronomical knowledge of the brain leaves us with regard to the origin of the lowest mental phenomena, and the complete solution of the highest problems of the physical world which we get from such knowledge. A brain that should, from one cause or another, be unconscious – for instance, one that should sleep without dreaming – would, had we astronomical knowledge of it, hold no secret; and, if we possessed astronomical knowledge of the rest of the body also, then the whole human machine, with its respiration, its heart-beats, its exchanges of materials, its heat, etc. – in short, everything short of the essence of matter and force, would be fully deciphered. The dreamless sleeper is comprehensible to us, like the universe previous to consciousness. But, as, on the first awakening of consciousness, the world became doubly incomprehensible, so too is it with the sleeper, at the first appearance of a faint image in dreaming.

The irreconcilable conflict of the mechanical view of the universe with freedom of will, and hence indirectly with ethics, is no doubt a matter of high importance. The ingenuity of thinkers in all times has been exhausted in trying to reconcile them, and this question will afford exercise to the mind of man forever. To say nothing of the fact that free-will may be denied, whereas pleasure and pain are unquestionable; desire, which gives the impetus to exertion, and hence gives occasion to act, or not to act, is necessarily preceded by sense-impressions. Hence it is to the problem of sensation, and not, as I have once said, to that of free-will, that analytical mechanics leads. [...]

[31] Imagine all the atoms whereof Cæsar was made up at a given moment, say as he stood at the Rubicon, to be by mechanical power brought together, each in its own place, and possessed of its own velocity in its proper direction. In our view Cæsar would then be restored mentally as well as bodily. This artificial Cæsar would at the first instant have the same sensations, ambitions, imaginings, as his prototype on the Rubicon, and the same memories, the same inherited and acquired faculties, etc. Suppose several artificial figures of the same model to be simultaneously formed out of a like number of other carbon, hydrogen, etc., atoms. What would at the first moment be the difference between the new Cæsar and his duplicate, beyond the differences in the places where they were formed? But the mind imagined by Leibniz, after fashioning the new Cæsar and his many *Sosiæ*, could never understand how the atoms he himself had disposed in order, and set into action with proper velocity, could give mental activity.

Take Carl Vogt's bold expression, which in 1850 introduced a sort of mental tournament: "All those capacities which we call mental activities are only functions of the brain; or, to use a rather homely expression, thought is to the brain what the bile is to the liver, or the urine to the kidneys". The unscientific world was shocked at the simile, considering it to be an indignity to compare thought with the secretion of the kidneys. Physiology knows no such aesthetic, discriminations of rank. In the view of physiology the kidney secretion is a scientific object of just the same dignity as the investigation of the eye, or the heart, or any so-called "nobler" organ. Nor is Vogt's expression worthy of blame on the ground that it represents mental activity as being the result of material conditions in the brain. Its faultiness lies in this, that it leaves the

impression on the mind that the soul's activity is in its own nature as intelligible from the structure of the brain, as is the secretion from the structure of a gland.

Wherever the material conditions of mental activity in the shape of a nervous system are lacking, as is the case with plants, the scientist cannot admit the existence of soul-life; and here he but seldom finds his views controverted. But what answer is to be given to him if he were to require, as the condition of his believing in a soul of the universe, that there should be shown to him somewhere in the world, bedded in neuroglia, and nourished with warm arterial blood under due pressure, a system of ganglia and nerves corresponding in extent to the mental power of such a soul?

Finally, the question arises whether the two limits of our knowledge of Nature are not perhaps identical, i.e., whether, supposing we understood the nature of matter and force, we should not also understand how the substance that underlies them could, under certain conditions, feel, desire, and think. Certainly this is the simplest hypothesis, and, according to well-known principles of scientific research, until it is disproved it must be preferred to that other hypothesis, which, as we have said, makes the universe doubly incomprehensible. But such is the nature of things that we cannot attain clearness of view with regard to this point, and it is idle to dwell upon it.

With regard to the enigma of the physical world the investigator of Nature has long been wont to utter his "Ignoramus" [we do not know] with manly resignation. As he looks back on the victorious career over which he has passed, he is upheld by the quiet consciousness that wherein he now is ignorant, he may at least under certain conditions be enlightened, and that he yet will know. But as regards the enigma of what matter and force are, and how they are to be conceived, he must resign himself once for all to the far more difficult confession:

"Ignorabimus!" [we will not know]