**Life and Non-Life: The Irreducible Bidirectionality of Science**

Physics puts us in a position tempting us to try to explain living processes by means of non-living processes. Although all the fruits of such an endeavor are fascinating and important, so much is left out, with the elephant in the room among those most devoted to this pursuit being that things are only subject to physical explanation to the extent that they are locatable in space, whereas our thoughts are not locatable in space. Sure, the brain is a physical organ existing in space and loaded with physical events correlated with mental activity. But they are not identical to that activity. Mental events are not brain events. Correlation is not an identity relation.

When studying the correlations between mental activity and brain/body activity, we tend to lose sight of the onus we have to explain the innerness of the experience, not just the correlate physical events. Whatever neuronal or electrical activity that can be detected when I think of something is not my thought of that thing, but just something that comes along with the thought. We have good reason to infer that it is instrumental or perhaps even necessary to my having the concomitant thought, but it is not that thought.

Consider the thought of triangle: the triangle is not in anyone’s brain to be experienced, either from the outside or from within. Suppose, *per absurdum*, that the microscopic study of a part of the brain thought to be chiefly involved with geometric imagination revealed within a cell’s tissue the etched-out image of a tiny triangle. Would this give me any reason to claim that etching itself to be the person’s idea of triangle? Of course not! In the first place, one’s idea of a triangle is much more than an image; in the second place, the idea of triangle is not just of one single token, but of a type. Possibly that little etching could be instrumental in allowing or making it easier for me to think of triangles, but it itself could not be identical to one’s thought of a triangle.

Nor can we consider the thought of triangle to be identical to an interacting network of neuronal activities, for that is just brain activity of which we are only conscious, if at all, as pain or bodily feelings, not as a thought in our minds.

It is just as much the case, on the other hand, that when we are focused on the thoughts themselves, we tend to ignore if not be ignorant of their physical correlates. Does my brain feel a certain way when I am doing calculations? I suppose so, but any attention to the feeling ruins the thought.

This is just one case in point of a peculiar divide in science that does not receive enough attention from us: that between physical science and organismic science. What is peculiar about the two is that they coexist going largely in opposite explanatory directions. Physical science takes elementary particles as its ultimate explanatory basis and goes largely upward from them: from quarks to nucleons; from nucleons and electrons to atoms; from atoms to molecules; etc. Organismic science, on the other hand, is based on organisms moves largely downward from them. I keep saying “largely…” because there is no point at which physical science, approaching living processes, say, in the study of biochemistry, simply stops, but rather keeps going upwards as far is it can, continuing whatever strands of mechanistic explanation that it can far up into the organism, while organismic science does the same in the opposite direction, moving from living processes to non-living processes within organismic control.

So, it is not that organismic science and physical science mind their own turfs, but rather, they intermesh, without conflict, always going in opposite directions, one studying life and its influence on non-life, the other studying non-life and its influence on life. Each forms a fine-grained scaffolding to support the development and continued growth of the other with neither able to coopt that scaffolding into its own explanatory strands.

For example, organismic scientists know full well that organisms ultimately are composed by elementary particles, but despite that would never count those particles as body parts, any more than an iron atom within the cog of a watch would count as a watch part. Likewise, chemists study the pH content of human blood knowing full well that it is controlled by organismic processes. They can study those processes as much as they want, but their study will never

reduce the subject matter to simple chemistry. In the final analysis, blood pH is what it is because it is in the interests of the organism for it to be so, the full understanding of which requires a lot more than what chemistry or physical science alone has to offer.

As nice as all of this sounds, we are not all agreed on the nature of the coordination between physical science and organismic science. Some still cling to dreams or expectations of an emergent fully deterministic mechanistic science in which organismic science is finally subjugated to physical science in a chain that roughly reduces the phenomenon of moral agency to psychology, psychology to biology, biology to chemistry, and chemistry to physics. Accordingly, biology’s apparently autonomous aspect: its differences with physical science in method, evidence gathering, theory formation, and experimentation - would be accounted for as *compendia loquendi* of physical science.

The drive that keeps this tendency alive – a drive from which even Einstein struggled to extricate himself, and eventually did, at least in practice, in his eventual acceptance of quantum theory, which in its acceptance of stochastic events breaks with determinist science – is dissatisfaction with the notion that scientific explanation is bidirectional in principle. This duality strikes some as irrational or even circular. Should not explanation go in one direction only, breaking down the complex into the simple by causal reasoning? Since organisms appear to be the most complex things, shouldn’t their explanation be by breakdown into simpler non-organismic things, ultimately down to elementary particles? Perhaps patience will finally show us how living processes are just emergent features of non-living ones, if we only remain loyal to science.

My answer to those who may think this way is that it is they who are at odds with how science is now being done. The vision of bidirectional scientific explanation is not something I am proposing; it is something we are already doing, and have been for some time, without much fanfare. Physical science follows a mechanistic *ideal*, not an unbroken mechanistic *principle*, while organismic science as well follows all the strands of organismic influence as far as it can, in some places past life into non-life Quietly, life science has penetrated down to the molecular world to find what many call the building blocks of life in amino acids from, which are constructed proteins following the patterns encoded in DNA, another molecule. None of these molecules are alive; yet they have everything to do with life. On their own, outside of living processes, they don’t do anything. You can’t make new proteins without DNA, you can’t make new DNA without proteins, and organisms are required to synthesize most amino acids. So, we can’t say these basic molecules of live came first, then life was built from them.

In short, life exists upon a scaffolding of non-life. Yet whereas it is not generated by that scaffolding, it plays quite a role in generating much of it. Any attempt, therefore, to subjugate life science to physical science will fail, just as badly as the other way around. We are irreducibly stuck with both as co-primary. This used to bother me, but now I am bothered by the fact that it did. There is nothing wrong with bidirectional explanation as long as it does not collide in the middle – which it never does – nor turn back into a vicious circle, which it doesn’t. Perhaps we are spooked by the fear that it might do either.

My peace of mind regarding this point was reaffirmed recently with the arrival of a nut grinder I had ordered – a manual model with a crank, with removable container cups top and bottom and the grinding module in the middle. I bought the grinder to grind nuts down to prepare them for making various kinds of nut butter

Try as I might, I just couldn’t figure which compartment was the top one and which the bottom. The cranking mechanism itself didn’t seem to “care”; it worked in both directions. Gravity gave the edge to the downward movement of nut fragments, but you could get some to go upward if you filled the lower container enough.

This device is designed to be used multiple times on the same batch of nuts until the desired milling of the nuts is achieved. If you overuse it, you arrive at a point of diminishing returns and get little extra benefit from there on. Nut butter makers don’t do as well if you throw whole nuts straight into them. Starting the process with well-ground nuts makes the job much easier.

I am embarrassed to say how long it took me to figure out the optimal use of the grinder. My big mistake came at the beginning when I was agonizing over which container I should count as the input side and which the output side. Since the machine was so symmetrical, I practically had to make the decision arbitrarily and tried to keep track, putting the nuts I was grinding only in that container to begin the process. Then when all had been ground and fallen into the output container, I would remove the nuts from there and return it to the original input container and repeat. This was a messy process because there was so much transferring to do between one container and another.

After doing this for a while, I realized that all those transferrals were a waste of time. All I had to do after grinding in one direction was flip the device hour-glass style and begin grinding again.

I gave myself a smug pat on the back until I realized a little later, once again, my own small-mindedness. By filling only one chamber rather than two, I was ending up with a smaller batch of ground nuts at the end than I would have had I begun the process by filling both chambers. A quantity of whole nuts takes up much more room that those same nuts ground. By filling both chambers at the beginning – not jam-packed, but just leaving enough room for grounds to fall either way - I was able to grind more nuts in a shorter amount of time and with less mess.

The lesson learned from this was that analytical processes do not have to be unidirectional and often can be multidirectional without conflict. This is surely the case with science, which has always been done this way in spite of a tendency to promote unidirectional mechanistic explanation as an ideal. Just like grinding nuts, we can break things down more effectively by accepting both life as well as matter as basic to science and studying the interdependences between them instead of trying to explain one in terms of the other in the manner of materialists and idealists. Just as well ground nuts make for better nut butters and grinding in both directions makes the work easier, so, too, a robustly and unapologetically bidirectional science makes for an easier and more fine-grained analysis, leading to more fruitful developments in technology, metaphysics, and even theology.