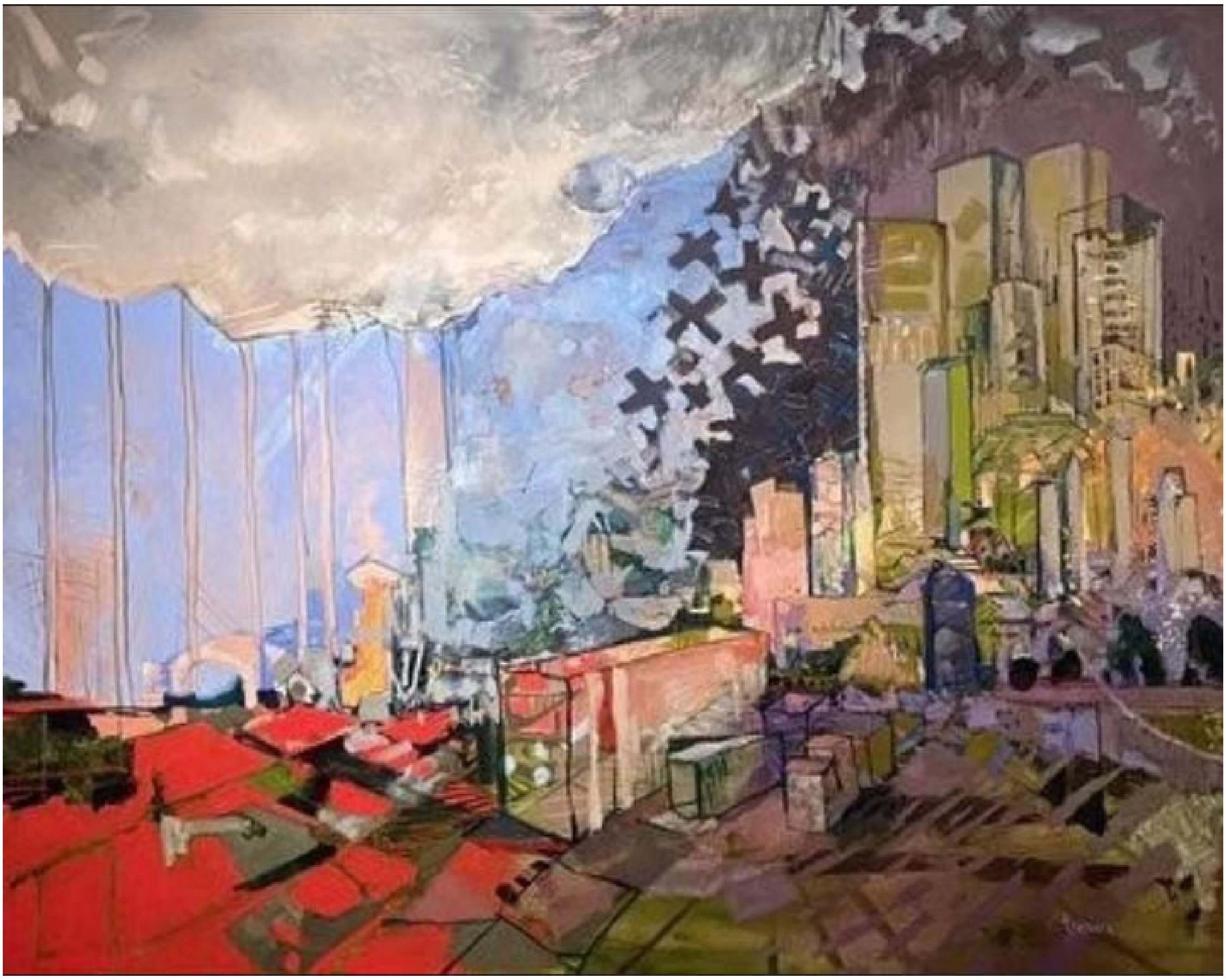
More on Causality

by Lev Tsitrin (November 2024)



Swimming in the Sky (Cliff Tresner)

My previously-posted musings on the debate over causality of radioactive decay did not put a stop to my thinking about it. Somehow, the subject's fascination endured, acausality being such a strange notion. Wikipedia thusly summarized it: "Radioactive decay is a random process at the level of single atoms. According to quantum theory, it is impossible to predict when a particular atom will decay, regardless of how long the atom has existed." The decay is an "aggregate process" for which "the single-event probability of realization is very small but … the number of time-slices is so large that there is nevertheless a reasonable rate of events." The only potential "cause" mentioned as relevant is aging—mentioned only to be dismissed due to "key assumption that a nucleus of a radionuclide has no "memory" or way of translating its history into its present behavior. A nucleus does not "age" with the passage of time. Thus, the probability of its breaking down does not increase with time but stays constant, no matter how long the nucleus has existed. …This is in marked contrast to complex objects that do show aging, such as automobiles and humans. These aging systems do have a chance of breakdown per unit of time that increases from the moment they begin their existence." Or, to summarize Wikipedia's summary, radioactive decay is a cumulative product of chance occurrences.

I find this more interesting for what it does not say, than for what it says. For one, what does this have to do with causality? A "cause" is the sum of forces applied to an object. "Randomness" relates to our reaction when we fail to anticipate the result of their impact—or are even unaware of the forces themselves. "Cause" is about physics. "Randomness" is about psychology. The former refers to an object, the latter, to observers of that object.

Consider a coin toss. Its result is proverbially random—but that result does have a definite cause. In fact, we call the result of a coin toss "random" only because we have no ability to calculate, in the time it takes for a coin to land, the sum of the forces and factors that are acting on it—the impulse our thumb gives it when sending it up into the air, the number of resulting rotations, the effect of its rebound. If we could factor all this while the coin was airborne, there would be nothing "random" about the result, and the very word "coin-toss" would lose its meaning. The same is true of all other ways by which we produce a "random" results—rolling the dice, shuffling the cards, picking the lottery balls. The results are “random” simply because we can’t compute the sum of compounded forces by which we produce those results, i.e. the “cause.” If we could, there would be no such thing as “randomness” at all—as Andy Thomas observed in his comment on my original musings. “Randomness” results from a cloak of invisibility (or rather, of our inability) thrown over causes. “Randomness,” to use Andy Thomas’ apt word, is simply a result of “obfuscation.” In a way, “randomness” is a human convention like meridians, parallels, time—but unlike those pointers to precision, “randomness” indicates the lack thereof.

(Oddly, this plays a rather amusing trick on Einstein’s famous dictum in his rebuttal to Bohr, “God does not play dice.” Since God is all-knowing and thus instantly factors in all forces compounded to form any “cause,” unlike us he would know the result way before dice stop rolling (or even leave the air—or for that matter, leave the palm of His hand). Hence, the notion of “God playing dice” (unlike the notion of us humans playing dice) is meaningless. God does not play dice for an entirely different reason than that suggested by Einstein; to Him dice is useless as producer of a “random” result. (Please note that I would never be so presumptuous as to dare criticize Einstein’s physics—but when it comes to his theology (or for that matter, his logic)—why not?))

Returning to radioactive decay, a nucleus acts rather like a juggler who keeps several balls in the air at the same time. Built right into the juggler’s act is the distinct possibility of his dropping a ball (and for all the uncertainties surrounding radioactive decay, a similar possibility of losing a particle must be built right into the nucleus—else, there would be no radioactive decay at all!) Since dropping a ball is not something the audience normally expects (we expect to be amazed and awed by a perfectly virtuoso performance), every time a ball is dropped—as occasionally happens to even a most experienced juggler, it is treated as a “random,” surprising event. Yet, for all its “randomness,” it is no more acausal than the result of a coin toss or of rolling the dice. The juggler may have momentarily lost focus, or the palm of his hand got too sweaty, or he felt a sudden itch or an urge to sneeze. For the members of audience however, this moment is “impossible to predict”—exactly like what Wikipedia tells us of decay of individual atoms.

Now, let us imagine an “aggregate” juggling performance—a show in which a gazillion jugglers do their act all at once. Just as with atoms, on the “level of single juggler” dropping a ball is a “random process” with a result that, to paraphrase Wikipedia, it is “impossible to predict when a particular juggler will drop the ball.” Nonetheless, dropping a ball is strictly a causal process—despite being labelled “random” since an observer would find it impossible to predict which juggler will drop a ball at what time. Just as with radioactive decay, only the cumulative, statistical results will have meaning.

As to Wikipedia’s dismissive mention of cars and humans, it also leaves something important unsaid: namely that aging is, sadly, not the only reason of their demise. Road accidents cause it too, destroying cars and killing humans way before their time. Such events—that are fortunately relatively rare—are seen as “random” by those impacted, but as causal by those who investigate them, and accumulate them into statistics. (Perhaps, a particle escaping a nucleus is also an “accident,” a causal though a “random” event?)

Now, all this holds true for the “macro” world with which we are familiar. Bohr’s argument in the Einstein-Bohr debate seems to be that subatomic world is drastically different: that there, “randomness” is not a mere reflection of the limits of our cognition but, so to speak, the actual “cause” of processes, thus rendering those processes acausal—a distinction that Einstein dismisses. Einstein’s position can be summarized as “we perceive subatomic events as random because we do not fully know their causes” while Bohr’s argument is, “we cannot discover causes for subatomic processes because there are no causes to discover.” Thus, Bohr equates our inability to know causes of processes with the absence of such causes—which, whatever the relation to the actual physical reality, is a textbook example of a logical fallacy called “does not follow.”

This makes the Einstein-Bohr debate an exact carbon copy of a perennial debate between atheists and theists, a debate which ultimately boils down to interpreting the reason for God’s silence: do we not hear from Him in a reliably direct way because He chooses not to speak to us—or because there is no God out there to speak to us? The latter, atheistic position is an instance of the very same “does not follow” fallacy, given that there always remains a distinct possibility of God existing and breaking His silence by reliably revealing Himself. In other words, it can never be proven that God does not exist, but only that He does—which would happen if He chooses to do so, of course. Just as, in the final analysis, God’s existence can be proven while his non-existence cannot, Bohr, it seems to me, can never be proven to be right, while Einstein can be, because there is always a possibility—or at least a hope—that an experiment can be devised that finds the exact mechanism of radioactive decay (and clearly, some kind of mechanism exists!)—even if predicting which particular atom decays at which particular moment will continue to be no more possible than predicting whether a given coin toss results in heads or tails, or predicting which juggler among many will be next to drop a ball. Thus, the Einstein-Bohr debate over causality seems to me signally fruitless—and therefore, moot. Modeling the ways by which a particle can escape the nucleus would have been a far better use of time, it seems to me.

On June 14, 1927, a German diplomat, aesthete and a man-about-town by the name of Count Kessler made an entry in his diary that recorded a dinner conversation in which one of the guests, literary critic Alfred Kerr, indulged in witticisms on the subject of God, and Kessler interrupted him by saying that Einstein, who was also present, was—in Kessler's characterization—very religious, and would find this kind of talk hurtful. Kerr was undeterred: "What? It isn't possible! I must ask him right away. Professor! I hear you are supposed to be deeply religious?" Einstein's reply was, "Yes, you can call it that. Try and penetrate with our limited means the secrets of nature and you will find that, behind all the discernible concatenations, there remains something subtle, intangible and inexplicable. Veneration for this force beyond anything that we can comprehend is my religion. To that extent I am, in point of fact, religious."

Clearly, Bohr harbored no such piety; but even to Einstein, there was a limit to it. To him, for all its mystery acausality was a bridge too far—and to be perfectly honest, and taking strictly the logical point of view, it seems so to me, too.

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