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FREEDOM GIVING BIRTH TO ORDER: PHILOSOPHICAL REFLECTIONS ON PEIRCE'S EVOLUTIONARY COSMOLOGY AND ITS CONTEMPORARY RESURRECTIONS[1]

Zeyad Sameh El Nabolsy

Abstract: This paper seeks to show that Charles Sanders Peirce's interest in an evolutionary account of the laws of nature is motivated both by his desire to extend the scope of the application of the Principle of Sufficient Reason (PSR) and by his attempt to explain the success of our deployment of the PSR, which presupposes the existence of determinate causal structures. One can situate Peirce's concern with the explanation of the laws of nature in relation to the influences of *Naturphilosophie* on Peirce. I then show that some strands of contemporary physics can be understood as resurrections of Peirce's evolutionary cosmology. I show that we can understand Lee Smolin's theory of "cosmological natural selection" as a version of Peirce's evolutionary cosmology that is characterized by greater refinement and determinacy. However I argue that, contrary to Smolin's claim, an evolutionary account of the laws of nature need not require the abandonment of the relativity of simultaneity as established by the special theory of relativity. I also argue that Lee Smolin and Roberto Unger's characterization of the "original state" in their account of evolutionary cosmology raises philosophical problems of individuation that are best approached from the perspective of Chinese process metaphysics. Finally I turn to the wider consequences of evolutionary cosmology in relation to how we traditionally "rank" fields of knowledge that deal with atemporal structures as "more rigorous" than fields that deal with historical phenomena.

The first part of this paper will discuss Peirce's evolutionary cosmology, which is centered around the thesis that the laws of nature evolve, and his motivations for it. The second part of this paper will discuss the contemporary resurrection, by

1 I wish to acknowledge the helpful suggestions which were made by Richard T.W. Arthur in relation to this manuscript.

Lee Smolin and Roberto Unger, of Peirce's thesis. The discussion will revolve around the philosophical implications of this thesis, especially with regard to the need to rethink the nature of causation in order to make sense of this thesis, and the need to recognize (and perhaps abandon) the metaphorical nature of the way that we talk about laws as being "obeyed" by systems, or as "governing" systems. I will be focusing on three aspects of this evolutionary (and revolutionary) approach to the laws of nature. First, the idea (advanced explicitly by Smolin and Unger) that causal relations and processes are primary and that laws, understood as representations of a special case of causation taking the form of repetition and having a determinate structure, are derivative. I will argue that this approach, which purports to provide an account of causation in terms of powers and dispositions, runs into difficulties about the identity of the entities whose causal powers are taken to behave in a non-lawlike manner. I will then attempt to show how these difficulties can be mitigated by drawing on discourses of identity and individuation from early Chinese metaphysics. Second, I will engage with Smolin's claim that an evolutionary cosmology requires a *preferred global time* (Smolin 2013, 164). I will argue that the relativity of simultaneity does not preclude the existence of a determinate order of succession between causally related events, and hence, if a *preferred global time* is being introduced in order to guarantee the existence of a determinate order of succession between causally related universes (i.e., a *parent universe* and its progeny) then it is superfluous (assuming that we can independently establish that the universes in question are causally related). Third, I will argue that emphasizing the primacy of becoming over being has wider implications for the axiology of the sciences, i.e., the way in which we traditionally rank different sciences with physics at the top, then chemistry, then biology, then the human sciences on successively lower rungs. I think that the view that the more a certain field of knowledge deals with atemporal structures the more scientific it is, is quite prevalent. One can find it in structural movements in anthropology (attempts to dehistoricize its subject matter, as if the fact that the structures that it deals with are subject to change is something that tells against its scientific status), as well as in attempts to render Marxism scientific by Louis Althusser by emphasizing structure over history.[2] I

2 Here is Carl E. Schorske's characterization of this development: "somewhere about the 1950s, the break with history acquired the force of a generalized paradigm shift in academic culture. One discipline after the other in the human sciences cut its ties to history.....while the social sciences gravitated toward scientific abstraction (mathematical economics, quantification and behaviourism in sociology and politics and so on),

will argue (in agreement with Smolin and Unger) that this view is both harmful and unjustified.[3]

C.S. Peirce in his *Design and Chance* (1883-1884) claims that "among the things that demand explanation, then, are the laws of physics; and not this law or that law only but every single law" (Pierce 1989, 547).[4] Hence, for Peirce, the primary motivation for postulating that the laws of physics evolve is that without postulating their evolution, and the existence of determinate selection mechanisms, we would be unable to explain why the laws of physics are as they are and not in any other way. The same mode of reasoning applies to initial conditions. In fact, Peirce and Smolin both seem to think that at the level of cosmology the distinction between initial conditions and physical laws is eroded. The motivation for postulating that the laws of physics evolve is derived from a desire to extend the range of cases to which the principle of sufficient reason (PSR) applies. Lee Smolin in his *Time Reborn* explicitly invokes Leibniz's PSR (Smolin 2013, 117), and C.S. Peirce talks of the "postulate that things shall be explicable" (Peirce 1989, 548). Note that it is important to distinguish the fact of evolution, taken here to simply mean change over a period of time, from its explanation by the postulation of determinate selection mechanisms (e.g., natural selection). The point is that if the evolution of physical laws is postulated in order to explain why our universe is governed by these laws and not others, then we have to be able to explain the outcome of the process of evolution by referring to determinate selection mechanisms.

Peirce himself thought that his contemporaries had not fully exploited the

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the humanities de-contextualized their inquiry and treated their objects wholly internalistically" (Schorske 1990, 416). We should note that in both cases the emphasis on atemporal structures in opposition to temporal (and changing) configurations is apparent. I should also note that while dehistoricization in anthropology is often associated with Claude-Levi Strauss' structuralism, George W. Stocking argues that the dehistoricizing tendency was firmly established in 20th century anthropology after the publication of Malinowski's *Argonauts of the Western Pacific* in 1922 (Stocking 1992, 274). For a critical discussion (from a Marxist perspective) of Althusser's structural version of Marxism I refer the reader to Alfred Schmidt's *History and Structure* (1983).

3 Smolin briefly discusses the implications of his thesis for economics, emphasizing the importance of recognizing the path dependence of processes (Smolin 2013, 258-263). Unger also discusses the wider implications of the thesis that the laws of nature evolve, paying special attention to the social sciences (Unger and Smolin 2015, 67-74).

4 This was Peirce's first attempt at developing his evolutionary cosmology.

explanatory power of evolutionary theories.[5] According to him, their theories "all suppose essentially the same basis of physical law to have been operative in every age of the universe" (Peirce 1989, 548). Peirce thought that in order to explain why the universe has come to be governed by determinate laws we have to suppose that, in the distant past, physical laws were less determinate and perhaps nonexistent (i.e., causal relations were in some sense looser). In *Design and Chance*, Peirce also mentions an interesting idea. Pierce argues that in order to explain the PSR itself (taken as a metaphysical principle, or even as a heuristic whose evident success depends on the world being a certain way, or having a determinate causal structure), we have to postulate that it (i.e., the PSR) emerged (or that the corresponding state of the world emerged) over a long period of time, so that initially the PSR did not hold, and that indeterminacy (in the metaphysical sense) reigned in the universe (Peirce 1989, 548). In short, Peirce suggests that in order to explain how the PSR holds in the world we have to assume that it did not always hold.[6] Perhaps a Leibnizian objection to Peirce's conception of the PSR would take the form of maintaining that the PSR is not a natural law at all, but only a meta-principle, i.e., a principle that governs all normative discourse for reason asking and reason giving animals such as ourselves.[7] I think that a charitable reading of Peirce would read him as demanding that we provide an explanation for the evident success of our explanatory activities. For I take it that Peirce is really claiming that for our explanatory activities to be successful, which by and large they are, the universe that we inhabit must be a certain way. In particular, I take Peirce to be claiming that since much of our explanatory activity takes the form of providing causal accounts, and since the explanatory power of these causal accounts is dependent on the universe having determinate causal structures, the demand to explain the success of the PSR is really a demand to explain the determinate causal structures that characterize our universe in its current stage (i.e., how did the determinate causal structures come to be? and

5 I should note that Peirce makes explicit reference to Darwin, "the epoch of intellectual history at which the world is now arrived finds thought still strongly under the influence imparted to it in 1859 by Darwin's great work" (Peirce 1989, 544).

6 As Peirce puts it, "among the determinate facts which ought thus to be explained is the very fact supposed in this postulate [i.e., the PSR]. This must also be explained, must be among the things which have been somehow brought about. How then can it be absolutely, rigidly & immoveably true?" (Peirce 1989, 548).

7 This Leibnizian response was brought to my attention by Richard T.W. Arthur

why did these determinate causal structures emerge and not others?). I think it is also important to note that Peirce's emphasis on the metaphysical aspects of the PSR might be explained by what Andrew Reynolds has identified as Peirce's commitment to the research tradition of *Naturphilosophie* with its emphasis on the need to explain all manifestations of order, including the laws of nature themselves (Reynolds 2002, 3).[8]

At this point in our discussion we should make explicit what evolution (on the Darwinian model) requires. First, it requires variations that can be passed on to progeny (in this case, subsequent universes, or subsequent states of the same universe). Second, it requires a selection mechanism (e.g., a struggle for existence) that determines or influences which variations get passed on (DeWitt 2010, 289). It seems that if the laws of nature evolve then there must be some point in time at which they are subject to violation (so that we can get the variations which are a necessary condition for evolution). Peirce ascribes this to *absolute chance*: "I suppose that on excessively rare sporadic occasions a law of nature is violated in some infinitesimal degree; that may be called *absolute chance*" (Peirce 1989, 549).[9] Note that Peirce is not referring to situations where there are epistemic obstacles that are preventing us from subsuming phenomena under physical laws; he is talking about situations where there is indeterminacy on a metaphysical or ontological level. We should also note that Peirce draws a distinction between "ordinary chance" (or "relative chance") which is explicable by reference to specific mathematical structures (i.e., the notion of chance as it is employed in statistics) and *absolute chance* which is absolute in so far as it is not explicable in principle (though it may itself play an explanatory role if it is integrated into a narrative or evolutionary account). So the distinction between the two kinds of

8 Reynolds offers an interesting characterization of Peirce's metaphysics as "Hegelian dialectical idealism meets darwinian evolution and statistical thermodynamics [!]" (Reynolds 2002, 6).

9 I should note that Peirce is thinking of chance in what he takes to be Aristotelian terms in the sense that chance, on his view, is an absence of cause: "chance in the Aristotelian sense, mere absence of cause" (Pierce 1989, 547). In his entry on chance in the *Century Dictionary* he speaks of events coming about by chance "without any determining cause or principle whatever, by lawless, sporadic originality" (quoted from Reynolds 2002, 149). However, Peirce's characterization of this conception of chance as Aristotelian is misleading because chance for Aristotle is a cause (i.e., not a "mere absence of cause") even though (on Aristotle's view) events brought about by chance are inherently unpredictable (Dudley 2012, 27-30, 39). Hence, as Reynolds has noted, Peirce's characterization of Aristotle's conception of chance as the absence of cause is rather strange (Reynolds 2002, 149).

chance is not a distinction between subjective and objective chance, but rather a distinction between a kind of chance that can be understood in terms of laws, and one that cannot. When Peirce claims that "everybody is familiar with the fact that chance has laws, and that statistical results follow therefrom" (quoted from Reynolds 2002, 145), he is referring to the first kind of chance. Of course, Peirce does not make any references to quantum mechanics (which was developed after his death), but his views on chance do not preclude the possibility of there being non-deterministic laws, involving the first kind of chance (Reynolds 2002, 138).[10]

Peirce draws a connection between the PSR and chance, "the hypothesis of absolute chance is part and parcel of the hypothesis that everything is explicable" (Peirce 1989, 549). We have to be careful in order to avoid contradiction (because I take it that *absolute chance* is not explicable); perhaps one way to think of this claim is that the price we have to pay for extending the domain of the explicable at the general or global level is the admission of sporadic indeterminacy at the micro-level (Peirce's *absolute chance*).[11] Hence, strictly speaking, not everything is explicable because the sporadic violations of the laws would not be explicable (we would ascribe them to *absolute chance*), though they will figure as part of a narrative explanation for why our universe came to be governed by the laws that do govern it. Peirce seems to think that even laws that appear to be rigid (say the laws of mechanics for mid-sized objects) are in fact far less rigid than they appear to be, because they "repose upon others far less rigid themselves due to chance and so on in an infinite regress" (Pierce 1989, 551). Here, it appears to me that the regress can be taken in two directions. It can be taken as regress into the past (i.e., the further we go back in time, the more indeterminate the laws of nature become), or it can be taken as regress from the macro-level to the micro-level (and we treat the deterministic laws of the macro-level as being deterministic only because they are approximations).[12] It appears to me that Peirce wants to emphasize both directions of the regress. I should also add that with respect to the second kind of regress, Peirce explicitly appeals to the derivation of Boyle's law and Charles' law from statistical probabilities. In his words, these two laws are "known to be results

10 Burch (2014) notes that Peirce would not have been surprised by the results that have been obtained by measurements in quantum mechanics.

11 Though, I should add that Peirce sometimes speaks of great deviations that occur extremely infrequently.

12 I.e., on Peirce's account, even macro-level laws are not really deterministic.

of chance" (Peirce 1989, 551). Peirce does not seem to explicitly endorse a distinction in kind (or a qualitative distinction) between micro-level and macro-level chance in so far as he is committed to the view that laws as such (including macro-level laws) are not deterministic (Reynolds 2002, 147).[13] It seems that what Peirce wants to say when he talks of macro-level laws reposing on less rigid micro-level laws is that the role of chance is more pronounced at the micro-level than at the macro-level, so the distinction seems to be one of degrees (Burch 2014).

Note that Peirce, in so far as he thinks of chance as involving continually slight deviations from existing uniformities (as well as great deviations that occur extremely infrequently), still thinks that chance "can only work upon the basis of some law or uniformity" (Peirce 1989, 551). Peirce goes on to claim that chance involves departures from established uniformities, and these departures produce even more determinate (or to use his term, "stricter") uniformities. I take it that here Peirce is talking about how *absolute chance* would operate in what we would now describe as a cooled-down universe, and this is no way contradictory to the supposition that the early universe lacked uniformities (in the sense of determinate causal structures). On my reading of Peirce's account, in a universe lacking determinate causal structures *absolute chance* would be the norm (so that we do not have to think of it as manifesting itself in terms of departures from established uniformities). Note that Peirce's attitude towards causality (and in particular his attitude towards accounts of causation in terms of powers and dispositions) seems to me be rather ambiguous. On the one hand (in other works) he makes disparaging remarks about "those who make causality one of the original *uralt* elements in the universe or one of the fundamental categories of thought" and he claims that he is not one of them (Peirce 1992, 197).[14] Yet, on the other hand, it seems that Peirce still needs to employ an account of causality that treats causes as powers for he (as we shall see below) still wants to speak of tendencies, and it seems incoherent to speak of tendencies without presupposing causal powers.[15]

13 Though, they do become more deterministic in character (or more rigid) as time goes on, due to the effects of habit (see below).

14 Note that in this respect his view is different from Smolin and Unger's view on this issue.

15 One possibility is that Peirce wants to argue that understanding causation in terms of powers and dispositions does not commit us to thinking that there are necessary connections between causes and their effects. So we can read him as implicitly claiming that causal connections are both real (in the sense that

Peirce advances a thesis about the role of habit, understood as *the tendency to repeat any action which has been performed before* (Peirce 1989, 553), in the formation of physical laws. In fact, Peirce claims that the laws of physics might just be habits (or the products of habits) acquired by systems. Note that this presupposes that there is already some tendency towards the formation of habits in at least some systems (hence the need for some kind of real power).[16] It also implies that many events which we take to be independent (in the statistical sense) of one another, are in fact not independent (in this sense habit-taking, if it did take place, would undermine many statistical models that assume that the events in question are statistically independent of one another). The key issue is that we need something that acts as a selection pressure that affects which habits get passed on (I should also add that, in "Design and Chance", Peirce is not very clear on this issue). Peirce requires that selection should take place by the destruction of systems that form, or have a tendency to form "bad habits" (understood as habits that are not conducive to the survival of the system in question in a specific environment), but he does not really provide us with a determinate measure of relative fitness.

Perhaps at this point the reader might wonder whether it would not make more sense for Peirce to just speak of regularities and drop all talk of laws. It might seem that this is an attractive position for Peirce to take, but, as I have noted above, he cannot coherently replace all talk of powers with talk of regularities because he still wants to speak of tendencies and for this he needs causal powers. As we will see shortly, Smolin and Unger do not want to drop all talk of laws, but they do wish to argue that laws are dependent on existing causal connections, and not the other way around. In other words, they wish to argue that laws only emerge when causal connections attain a structural form. I am personally more inclined towards Smolin and Unger's account of causation in terms of powers and dispositions, as the usual alternative (i.e., the Humean account of causation in terms of constant conjunction or regularities) runs into some severe difficulties. One of the most damaging objections against the Humean account of causation

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there are real powers and dispositions) and contingent (one could also argue that, on this reading, talk about "violations" of laws is really superfluous).

16 We should also note that Peirce speaks explicitly of forces acting on bodies (Peirce 1992). So he does seem to think that there are active causal powers.

in terms of regularities is that it cannot distinguish between contingent and lawlike (or causally substantive) regularities (Chalmers 2013, 198-201). However, as we shall see, the powers and dispositions account of causation also leads to some difficulties for Smolin and Unger's account of the evolution of the laws of nature, but for now we will return to Peirce.[17]

In some of his later papers, Peirce attempted to explain how the tendency towards the formation of habits could arise in the first place. In *The Architecture of Theories* (1890), he seems to adopt a form of Schelling's version of absolute idealism,[18] "It [i.e., his evolutionary cosmology] would suppose that in the beginning – infinitely remote – there was a chaos of unpersonalized feeling....this feeling, sporting [i.e., varying] here and there in pure arbitrariness, would have started the germ of a generalizing tendency" (Peirce 2010, 110). In terms of whether we are justified in believing that the laws of physics cannot evolve, Peirce thinks that such a belief cannot be justified with reference to the available evidence. In *The Doctrine of Necessity Examined* (1891), Peirce argues that the laws of physics are only approximations: "try to verify any law of nature and you will find that the more precise your observations, the more certain they will be to show irregular departures from the law" (Peirce 2010, 118). Furthermore, Peirce notes that, given enough time, the Second Law of Thermodynamics, in its (correct) statistical formulation, does not forbid the emergence of configurations that have low entropy (though, we should note that the Second Law of Thermodynamics does indeed predict that eventually this low entropy configuration will be replaced by high entropy configurations).[19]

I think that it is important to note that if we think of physical laws as being contingent in character (as Peirce seems to do) then we may be able to side-step the Humean problem of induction (at least in some of its guises, in so far as it is

17 To the extent that Peirce thinks of causation in terms of powers and dispositions, these difficulties also apply to his views (but, as I have noted above, his views on causation seem ambiguous to me, so I will be focusing on Smolin and Unger's account when discussing these difficulties).

18 The connection between Peirce's view and Schelling's version of absolute Idealism is made explicit by Peirce himself in *The Law of Mind* (1892): "I have begun by showing that tychism must give birth to an evolutionary cosmology, in which all the regularities of nature and mind are regarded as products of growth, and to a Schelling-fashioned idealism which holds matter to be mere specialized and partially deadened mind" (Peirce 2010, 135). For an extensive discussion of why Peirce associated his evolutionary cosmology with Schelling's idealism rather than Hegel's see Paul Franks (2015).

19 Lee Smolin makes a similar point (Smolin 2013, 199-202).

often presented as a challenge to the physical sciences' account of nature in terms of necessary laws).[20] For example, Kant took Hume's problem of induction to constitute a challenge to Newton's mechanics, precisely because it undermined the epistemic warrant for attributing necessity to Newton's three laws of motion. This was the primary motivation behind Kant's attempt at deriving the three laws of motion, in his *Metaphysical Foundations of Natural Science* (1786), in such a way so as to demonstrate their necessity.[21] If we cease to regard the laws of physics as being necessary, then we can attenuate the worries that motivated Kant's attempted derivation.[22] Perhaps one way to understand this development is to say that evolutionary cosmology (or a historical approach to cosmology) transforms an epistemological problem about the impossibility of providing an epistemic warrant for the characterization of the laws that science discovers as being necessary in character (i.e., as discovering necessary causal connections) into an ontological or metaphysical insight about the character of the laws themselves (i.e., that they are contingent).

Peirce insists that variety (in general) is something that requires explanation. On his view, it is permissible for single events to be unintelligible, but generality (and uniformity) must be explained. But what exactly is the role of chance in Peirce's cosmological theory? Peirce clearly recognizes that chance, on its own, does not have sufficient explanatory power: "to undertake to account for anything by saying baldly that it is due to chance would, indeed, be futile. But this I do not do. I make use of chance chiefly to make room for a principle of generalization, or tendency to form habits, which I hold has produced all regularities" (Peirce 2010, 124). Hence, chance, coupled with a tendency to form habits (as well as determinate selection mechanisms, which Peirce is admittedly rather unclear about), is introduced in order to account for how heterogeneity

20 I should note that not all proponents of evolutionary cosmology seem to take this approach. For instance, Roberto Unger thinks that the invocation of the concept of contingency, "betrays bad faith or confusion: a surreptitious genuflection to rationalist metaphysics by those who pride themselves on having cast off its shackles" (Unger and Smolin 2015, 45).

21 Kant thought that the concept of laws of nature implies necessity: "the word nature already carries with it the concept of laws, and the latter carries with it the concept of the necessity of all determinations of a thing belonging to its existence" (Kant 2004, 4).

22 Peirce, unlike Kant, was perfectly content with the idea that nature can change in fundamental ways. As Burch (2014) has noted, this implies that Peirce was a fallibilist about scientific knowledge in general.

can arise from homogeneity over a long period of time, and to account for the specific forms of complexity that have arisen.[23] On Peirce's view, it is the tendency to form habits that ensures that the laws of nature will become more rigid as time goes on. The important thing to note here is that this mode of explanation is a kind of historical (or narrative) explanation. I will not deal here with the objections that have been raised against the thesis that historical or narrative explanations can constitute an adequate mode of explanation (for a science) simply because these objections (especially the objection that all explanations must take the form of "covering laws") have historically been associated with positivism, and have lost much of their appeal with the decline of positivism (Roth 1988). Furthermore, as Marie I. Kaiser and Daniel Plenge have pointed out, historical/narrative explanations are central to fields whose scientific credentials are well established: geology, palaeontology, and evolutionary biology (Kaiser and Plenge 2014, 3). At any rate, it is not at all obvious that the introduction of historical accounts in physics would diminish its scientific status.

We now turn to the views of Lee Smolin (and to some extent, to the views of Roberto Unger), who refines and extends Peirce's theory. Smolin calls his account of evolutionary cosmology "cosmological natural selection". Smolin's key claim is that "universes reproduce by the creation of new universes inside black holes. Our universe is thus a descendant of another universe, born in one of its black holes, and every black hole in our universe is the seed of a new universe" (Smolin 2013, 124). Note that on Smolin's account these multiple universes are (or have been at some point in time) causally connected with one another (which is not the case for the multiple universes in so called "multiverse models"). As I have noted above, evolution requires two factors: first, variations that can be passed on to progeny, these are, on Smolin's account, the parameters of the Standard Model of Particle Physics (i.e., the masses of the elementary particles and the strengths of the four basic forces),[24] and the variation takes place each time a new universe is born in a black hole.[25] Second, we require a determinate selection mechanism and/or a measure of relative fitness. We should note that Smolin

23 For empirical evidence that supports Peirce's claims see Dearmont (1995).

24 These are: gravitation, electromagnetic force, the strong nuclear, and weak nuclear forces.

25 Note that the claim that black holes give birth to new universes is presented as a consequence of the hypothesis that quantum gravity eliminates singularities.

specifies the selection mechanism by specifying a measure of relative fitness. According to him, "the fitness of a universe is then a measure of how many black holes it spawns. The number turns out to depend sensitively on the parameters"(Smolin 2013, 125), e.g., if in one of the many black holes that are in our universe, a universe is born with parameters that do not allow for the formation of black holes, then that universe will not have descendants. Furthermore, on this account, our universe is actually a fairly typical universe. This is the case because only universes that have parameters that are conducive to high fertility will have progeny (and over a long period of time, the population of descendant universes will come to have similar parameters. I take it that the assumption here is that the population has reached a local peak in terms of relative fitness). Also, note that the configurations of the parameters that give rise to black holes also give rise to a universe that is conducive to life (because it would contain the carbon and oxygen that are needed for the emergence of life). We should briefly note that, if this account is correct, then the fine tuning argument is completely undermined. Also note that we are not forced to invoke the anthropic principle, which attempts to explain why our universe has the parameters that it has by claiming that we can only exist in a universe that has parameters that are conducive to life. However, I think that the manner in which these parameters can be inherited is rather unclear. It seems to me that they can only be inherited if concrete entities, having the causal powers that determine these parameters, can somehow pass from one universe to the other (and hence carry the causal powers that give rise to the specific parameters and laws).

Can we get falsifiable predictions out of this account (note that Smolin is very Popperian!)?[26] Yes, one prediction is that "the most massive neutron stars cannot be heavier than a certain limit [around twice the mass of the sun]" (Smolin 2013, 127). Another prediction is that we cannot get a universe that has more black holes than ours by making minor changes in the parameters of our own universe (this is a claim about relative fitness, so there could be large changes in the parameters that yield universes that have more black holes than our own). Smolin thinks that for his account to work, it must also lead to predictions about how many universes have certain characteristics at each moment in time. Smolin

26 "If an idea is not vulnerable to falsification, it is not science" (Smolin 2013, 139).

therefore thinks that he needs a *preferred global time* to provide him with a notion of simultaneity across the whole population of universes. As Smolin himself recognizes, this would mean that the relativity of simultaneity, as established by special relativity, will have to be abandoned.[27]

However, it seems to me that an evolutionary account of the laws of nature need not contradict the relativity of simultaneity. For if universe x gives rise to universe y, then the very fact that there is a causal connection between the two implies that there is a determinate order of succession with universe x preceding universe y (because the relativity of simultaneity, as laid out by the theory of special relativity, does not say anything about there not being a determinate order of succession between causally connected events). On the other hand, one could raise the objection that there could be no causal relation or connection that "passes" through a black hole because, at the singularity, there is a kind of rupture in space-time itself, so no causal connection can be said to take place across a black hole (i.e., the criticism would be that if we speak of a causal connection between two universes, we are using the word 'causal' in a very weak and metaphorical way).[28] I think that one response to this objection would be to argue, as Unger wants to argue (but, as far as I know, he does not relate his argument to this particular objection) that strictly speaking there are no singularities.[29] His point is that we should take Einstein's initial reaction to singularities at face value (i.e., that they indicate that there is a problem with the field equations of general relativity, so that singularities are a sign of failure under certain conditions). Unger himself is not aware of this but denying the possibility of singularities (involving actually infinite physical quantities) need not lead us to the rejection of actual infinities, if we adopt a Leibnizian account of infinity. On Leibniz's account there are indeed infinitely many things— for instance, on Leibniz's account, a body is comprised of an infinity of monads (Arthur 2014, 85). But this (qualified)

27 "Here's the price of admission: it means giving up on the relativity of simultaneity and going back to a picture of the world in which an absolute definition of simultaneity holds throughout the universe" (Smolin 2013, 156).

28 As Tim Maudlin puts it, "the singularity is an edge of space-time itself, where time-like curves cannot be continued" (Maudlin 2012, 144).

29 As Unger puts it, "The invocation of an eternal universe is no more defensible than the appeal to an initial singularity at the beginning our present universe. In both instances, a mathematical idea, with no counterpart in physical nature, is made to do service for missing insight" (Unger and Smolin 2015, 102).

admission of actual infinities does not imply that there are actually any infinite physical quantities in reality. At any rate, it is clear that this account of actual infinity does the work that Unger and Smolin require (i.e., it precludes the singularities which seem to offer an obstacle to the existence of causal relations between different universes across black holes), while not making any rash claims about the impossibility of there being an actual infinity of things in the universe (which is what Unger's blanket rejection of actual infinity would imply).

Smolin also takes on board Peirce's idea that habit formation is the only unchanging law. He calls this the *principle of precedence* (which he frames in reference to measurements, because he introduces it in relation to quantum mechanics), according to this principle "repeated measurements yield the same outcome" (Smolin 2013, 146). The point is that what we take to be instances where specific laws of physics are obeyed are to be explained by appealing to this principle, which still allows for new measurements to yield unpredictable results and genuine novelty. However, if we are formulating this principle in terms of measurements, then it seems to me that we would have a problem in terms of accounting for how a truly novel system can emerge without us. Hence, I take it that someone who holds that the laws of nature evolve does require something like Peirce's *absolute chance* and a general principle of habit formation. Moreover, as Smolin himself points out, it is important to answer such questions as "How does a system recognize all its precedents? By what mechanism does a system pick out a random element in the collection of its precedents?" (Smolin 2013, 151).[30] I take it that attempting to answer these questions was a motivating factor

30 I should also note that Smolin and Unger recognize that the plausibility of their view hinges on a resolution to what they call the meta-law dilemma. The meta-law dilemma takes the following form: are there laws that govern the changes in laws (this seems to be required by the PSR)? If there are, then either those laws are in time and hence subject to change (on their view, everything that is in time is subject to change) and then we would have to appeal to meta-meta-laws and so on in an infinite regress, or they are timeless and do not change (but then we are back again at the problem of not being able to answer the question: why these meta-laws?). Unger points out that this dilemma can be avoided if we reject the key assumption upon which it is based, namely, the assumption that causal explanation has to be underwritten by appealing to laws of nature (Unger and Smolin 2015, 9). Unger and Smolin want to argue that laws depend on causal connections and not the other way around (i.e., that the recurrence of causal connections, by way of something analogous to Peirce's principle of habit formation, leads to the formation of lawlike causal structures). However, we might question the assumption that to be in time is to change, for being in time is also a presupposition for things that do not change (this point was brought to my attention by Richard Arthur). Hence, being subject to change is not the only possible mode of existing in time (note that this is

for Peirce's "Schelling-fashioned idealism", and if we regard this view as being metaphysically extravagant, then we need to come up with an alternative if we are interested in maintaining the thesis that the laws of nature evolve. Smolin claims that his approach will enable us to answer the question: why these initial conditions and why these laws? However, we should ask how far back? For it seems that we are faced with either an infinite regress of universes stretching into the past, or a brute fact about the initial conditions of an ancestor universe.[31]

It is clear that lurking behind this discussion is the contentious status of scientific laws and their relation to laws of nature. Smolin himself does not distinguish between the two, but philosophers of science have sometimes tended to distinguish between a scientific law (understood as an approximate representation of the way that certain systems behave) and a law of nature, understood as "a fundamental feature of the universe that is responsible for the way the universe works" (DeWitt 2010, 184). Smolin, Unger, and Peirce are claiming that not only scientific laws evolve but that even laws of nature evolve. Smolin's point is that causal relations are the fundamental features of the universe (and not laws, understood as mathematical formulations), and that these relations evolve, hence the laws of nature (understood as emerging from interactions between different causal powers) also evolve. The proponents of cosmological natural selection may be interpreted as making a stronger claim than the claim that, in the distant past, the universe had a different structure than the one that it has in our current cooled-down universe. Unger explicitly claims that "the implication of the conception of the original state is that it had no structure at all" (Unger and Smolin 2015, 26). Both Unger and Smolin seem to think that we can employ the concept of causality without associating it with the repetition of phenomena in a specific order by understanding causation in terms of powers

not meant to resolve the dilemma, it is only meant to show that their understanding of what it is to be static or unchanging is inadequate).

31 Unger seems to think that this problem cannot be resolved. He calls this problem "the antinomy of cosmogenesis", and he thinks that the only thing we can do is to take it as "a sign not only of the limits to the powers of science and of its ally in natural philosophy but also of our groundlessness - our inability to grasp the ground of being or existence" (Unger and Smolin 2015, 102). I should also add that while Peirce and Smolin accept the PSR, Unger rejects it; he thinks that at some point in our inquiry we will encounter sheer, inexplicable facticity.

and dispositions (i.e., constant conjunction is only one of the ways by which causal relations are made manifest, and this only takes place in our cooled down universe).[32] What is fundamental on this view of causality is time, not laws. However, it seems questionable to claim that an account of causation in terms of powers and dispositions can support such a view. For if, as Unger claims, there was no structure at all in the early universe, then it follows that the causal powers and dispositions of the entities in question (the entities that existed in this "original state") were undergoing abrupt and incessant changes.[33] Now, if entities are individuated by their powers and capacities (and I assume that Smolin and Unger would have to say that they are), then we have a situation where entities are changing their identities abruptly and entirely inexplicably (note that here we are talking about wholesale changes in their causal powers and not just incremental ones). This inability to track self-identical entities through time (because in a situation where entities are abruptly and inexplicably changing their causal powers and properties there are no self-identical entities over any extended period of time) becomes especially problematic when we consider that Smolin and Unger want to provide us with a historical account that explains why our universe has the laws and parameters that it has. For I take it that this historical account will have to make reference to self-identical entities that existed in this "original state" and then describe the selection mechanisms that operated on these self-identical entities that led to the reproduction of entities behaving in a certain way (and the destruction of entities behaving in ways that were not conducive to survival under the conditions that existed then).

On the other hand, one could respond to this objection by claiming that it begs the question in so far as it presupposes that becoming must begin with being, i.e., with what is identical with itself. A serious advocate of the priority of becoming over being will hold that you can have causal activity without there being an underlying self-identical substance. I take it that by the "priority of becoming over being" Unger and Smolin mean to advocate for a view that is

32 Arguably, Peirce holds a somewhat similar view (but I will not be explicitly discussing his account here, because, as I have noted above, Peirce's views on causation are rather ambiguous).

33 I should note that Peirce also thought of the "original state" in similar terms: "the state of things in the infinite past is chaos. . . the nothingness of which consists in the total absence of regularity" (quoted from Potter 1996, 137).

close to the one that Socrates ascribes to Heraclitus, Empedocles, and Protagoras in Plato's *Theatetus*: "there is no single thing or quality, but out of motion and change and admixture all things are becoming relatively to one another, which 'becoming' is by us incorrectly called being, but is really becoming, for nothing ever is, but all things are becoming" (quoted from Chenyang Li and Franklin Perkins 2015, 5). In fact, this seems to me to be an adequate description of what Unger has in mind when he talks about the "original state". I wish to suggest that one way in which Unger and Smolin could add philosophical depth to their account is to draw connections between their views (in particular their views about the possibility of causal processes without the existence of self-identical things over any significant period of time, at least in so far as this is presupposed in their conception of "the original state" of the universe) and early Chinese metaphysics which takes change and becoming as having ontological primacy over individuated and self-identical things. Unger and Smolin associate their views with what they take to be an undercurrent in the history of Western philosophy that has emphasized the priority of becoming over being.[34] However, it seems to me that the problem which I have outlined above is precisely the sort of the problem that could be rendered more tractable if approached from the perspective of Chinese philosophical traditions. For, as Franklin Perkins (2015a) has noted, metaphysics in Chinese philosophical traditions has historically been centred around the problems that arise from adopting a basic framework that emphasizes holism and the constancy of change (these problems include problems about the status of individual entities, including the nature and presuppositions of individuation). Hence, it is to be expected that important insights into the resolution of this problem as well as access to a more adequate philosophical vocabulary for dealing with this problem can be attained by turning to Chinese philosophical traditions.

The problem of self-identity (which we can also re-describe as a problem of individuation) that I have raised above might be resolved if we approach the problem of individuation from the perspective of Chinese process metaphysics, where to be an individuated thing (i.e., a *wu*) is just to have a specific appearance,

34 They make explicit references to Heraclitus, Hegel, Bergson, and Whitehead (Unger and Smolin 2015, xv).

here we have an identification of the individual entity with its attributes without any reference to a substance which possesses these attributes (Perkins 2015b, 63).[35] So perhaps one way to get around the problem I have raised is to speak of things just as causal powers (and not as things *possessing* causal powers), and to simply accept that the narrative explanation will have to speak of things whose character as particular individuated things is ephemeral (and this is just a consequence of taking the priority of becoming over being seriously), especially in the "original state". It should be clear that we are here dealing with a weaker notion of individuation (but I do not think that this fact tells against its adequacy).[36] In fact, one can point out that Zhuangzi's claim that "their [referring to individuated things] division is their completion, their completion is their destruction" (quoted from Perkins 2015b,66) is a perfect description of the fate of individuated entities in the "original state" as described by Smolin and Unger, for in that state the entities (now identified with their causal powers) are subject to individuation, but because there are no lawlike causal structures they are destroyed just as soon as they emerge (and then replaced with others). The point is that early Chinese metaphysics provides us with a philosophical vocabulary that is adequate for describing the "original state" (and that what may seem to be a metaphysical conundrum, when looked at from the perspective of Western metaphysics, is a perfectly acceptable state of affairs when looked at from the perspective of philosophical traditions that have historically emphasized becoming over being). It is important to note that having access to an adequate philosophical vocabulary to describe the thesis that one is advancing is not a trivial gain. First, it provides the conceptual tools for refining one's thesis. Second, it allows one to respond to the sorts of objections that are inevitably raised against any radical thesis that overturns the basic metaphysical presuppositions of the framework within which it is being discussed (i.e., the framework in relation to which it is "radical", for the term 'radical is context dependent).[37] These objections often take the form of claiming that the thesis in question is so incongruent with the philosophical

35 According to Perkins "the use of *wu* in a discourse of individuation arose in the middle of the fourth century BC" (Perkins 2015b, 57).

36 In fact, it is interesting to note that some Chinese thinkers, such as Guo Xiang, attempted to argue for the claim that each individual thing is its own kind, or has its own *xing* (Perkins 2015a).

37 Using the term 'radical' as a synonym for 'revolutionary'.

vocabulary that we are familiar with that it must be, in some sense, incoherent (or at the very least, highly implausible). Such preliminary objections can be overturned if one is able to point out that there are philosophical discourses that adopt (or have adopted) the presuppositions of this thesis as part of their basic metaphysical framework (this would be a kind of inference from the actual to the possible). Of course, this fact does not by itself establish the truth of the thesis in question, but it does give it a fighting chance by enabling us to graft it onto mature philosophical traditions (in this case, these are the traditions of early Chinese metaphysics).

The upshot of evolutionary cosmology (or the hypothesis of cosmological natural selection) on the methodological level is that "cosmology must be a historical science if it is to be a science at all: a historical science first, a structural science only second, not the other way around" (Unger and Smolin 2015, xv). Of course this has wider implications, the fact that fields such as biology, history, sociology, anthropology and so on are not dealing with structures that do not change will not be held against them. On this view, the overarching metaphysical framework is the priority of becoming over being; hence all sciences will be historical in character. I think that the adoption of such a philosophical framework will have positive consequences in terms of ridding some of the practitioners of the human sciences of the illusion that dehistoricization is a necessary condition for rigour and intellectual seriousness. As Herbert Lüthy has perceptively noted: "at bottom, the disintegration of the human sciences stems from the illusion, pursued with a methodological obsessiveness, that it is possible to escape from the reality of the interpretation of consciousness within human history and from the decisions concerning values and power which characterize this history, into the ahistoricity of the mathematical formula" (quoted from Schmidt 1983, 1).[38] It should be clear that what I am arguing against is not the adoption of mathematical formulations or mathematical models in the human sciences as such, what I am arguing against is the naïve belief that the construction of mathematical models is itself a sign of success, especially when such models are employed without a thorough and sincere examination of the

38 We can also note in passing that one could argue that Leopold von Ranke established history as a science without mathematizing it (Beiser 2011, 253).

simplifying assumptions that have been made in order to arrive at the mathematical models in question.[39] The end of science is reliable knowledge and not mathematical models as such; if mathematical models do not introduce excessive distortions that render them inadequate as representations of the phenomena which are the objects of study, then we should certainly employ them.[40] However, if the use of mathematical models distorts the phenomena in question to an excessive degree, then we should not keep employing them just for the sake of appearing to be rigorous, for then we are not being scientific, we are merely engaging in empty posturing.[41] I should also emphasize that I am not at all interested in employing this argument to replace one hierarchy with one another. For just as there is a superficial hierarchy that places the "purer" (i.e., the more mathematical) sciences at the top and the less "pure" (i.e., less mathematical) sciences at the bottom, there is also an equally superficial (and unhelpful) hierarchy that inverts the other one, placing the sciences that are perceived to be more complex (i.e., the human sciences) at the top and the other "less complex" sciences at the bottom. My view is that both hierarchies have no place in a sophisticated account of the relationship(s) between the different fields of human knowledge. In conclusion, I hope to have illustrated some of the interesting philosophical implications of the thesis (as originally advanced by C.S. Peirce) that the laws of nature evolve. I also hope to have shown how some of the problems that are associated with the contemporary version of this thesis (i.e., the thesis as it has been advanced by Smolin and Unger) can be avoided. In particular, I have argued that, contrary to what Smolin seems to think, the hypothesis of cosmological natural selection does not require the overthrow of the relativity of simultaneity as established by special relativity. In connection with the issue of the possibility of causal connections between different universes (and

39 Anyone who has had the experience of applying mathematical models to accurately model physical phenomena knows that many simplifying assumptions are made when these models are constructed, and knows the importance of identifying the extent of the distortion that these assumptions produce (in some cases it is minimal, but in other cases it is intolerable and renders the model in question useless).

40 I should note that this argument is neutral between instrumentalist and realist conceptions of the character of scientific knowledge.

41 I should also note that this conflation of means and ends is prevalent in contemporary culture, and it would be naïve to think that academic discourse is completely shielded from the influences of contemporary culture.

the threat that is posed to this possibility by the existence of singularities), I have pointed out that a Leibnizian conception of infinity allows us to reject the possibility of singularities without committing us to a blanket rejection of the possibility of there being an actual infinity of things in the universe (unlike Unger's less nuanced approach). I have also argued that the identity problem (which we can also describe as a problem of individuation) that arises from Smolin's and Unger's account of the "original state" can be mitigated if we draw upon the philosophical discourse of early Chinese metaphysics, with its emphasis on the priority of becoming over being and the ephemerality of individual entities (i.e., its use and development of a weak concept of individuation). Finally, I have argued that the thesis that the laws of nature evolve, with its overarching metaphysical framework of the priority of becoming over being, undercuts the prevalent and pernicious belief that fields of knowledge that deal with atemporal structures are in some sense more intellectually rigorous than fields that deal with completely historical (i.e., changing) phenomena that are difficult to model mathematically without excessive distortion. To be sure, the truth of the thesis that the laws of nature evolve cannot be established by philosophical reflection alone, but philosophical reflection can have a positive role to play in its formulation (and in examining the coherence of its philosophical presuppositions and implications). Moreover, philosophy itself can be enriched by reflection on cosmological theories and their implications. So perhaps instead of the two misleading hierarchies that have been used to characterize relationships between different fields of human knowledge, we ought to develop an account that emphasizes the fluidity and porosity of the boundaries between different fields, and, more importantly, we ought to develop an account that emphasizes the fecundity of interactions at the boundaries between different fields.[42]

Africana Studies and Research Center
Cornell University
ze44@cornell.edu

42 From a historical point of view, there is nothing special about this claim (fruitful interactions between philosophical theories and what we would now describe as scientific theories and practices were the norm in early modern Europe). However, given the current hyper-specialized character of academia, it has become necessary to state this point explicitly.

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