THESIS

THE UNIVERSE WORKS ON A MATH EQUATION THAT NEVER EVEN EVER REALLY EVEN ENDS IN THE END: CHARLES SANDERS PEIRCE'S EVOLUTIONARY METAPHYSICS AND THE LAW OF LARGE NUMBERS

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ABSTRACT

THE UNIVERSE WORKS ON A MATH EQUATION THAT NEVER EVEN EVER REALLY EVEN ENDS IN THE END: CHARLES SANDERS PEIRCE'S EVOLUTIONARY METAPHYSICS AND THE LAW OF LARGE NUMBERS

Recent work on Charles Sanders Peirce's evolutionary cosmology and scientific metaphysics has revealed a tension between two accounts Peirce gives of the laws of nature. Andrew Reynolds points out that Peirce seems to have thought that the laws evolved both in a statistical way—according to which the laws themselves are the statistical result of the Law of Large Numbers applied to instances of the laws—and also in a more directly evolutionary way, according to which instances of the laws reinforce one another making future instances conform to past ones. By forming "habits". These two analyses are straightforwardly incompatible, since the Law of Large Numbers requires events in the series to which the statistical analysis applies to be independent from one another, whereas the other account explicitly involves future law instantiations depending on past ones. Reynolds calls this problem the Incompatibility Problem. Despite the apparent contradiction, the work of this paper attempts a rational reconstruction of Peirce's evolutionary metaphysics, and on this reinterpretation of Peirce's cosmology, the incompatibility problem does not arise. On this view, the laws of nature remain statistical results of chance property instantiations, including dispositional property instantiations. It is argued, however, that Peirce need not be committed to the idea that instantiations of laws are dependent on one another. Rather, the view according to which habits in nature are formed is argued to apply to properties of the universe as a whole, thereby explaining why the universe contains any regularities at all. The so called "law of habit" is shown to be a special case of the Law of Large Numbers as applied to the world's

properties, and the laws of nature are shown to be statistical results of various property instantiations.

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DEDICATION

For Kylan: Verticality

TABLE OF CONTENTS

Introduction

Not all works of philosophy proceed in the same way. It would be nice if every great philosopher fashioned her thought linearly, so that one could easily trace the course of her argumentation over time, noting here and there where her thoughts on a matter diverged from their previous path. No human writer has ever produced such niceties as far as I am aware, or at least no very good writer. But there is a spectrum of organization of thought, and some writers fall far enough to one side to approximate the ideal to some degree.

Charles Sanders Peirce was, sadly, no such writer. His thought hangs together much like a magnificent painting or architectural structure or, perhaps, a fugue. The parts are easier understood once the whole has been taken in. This is not to say we cannot study Peirce's thought piecemeal to some extent. Historians of philosophy have been doing just that for around a century. It is, rather, to say that a *systematic* exegesis of Peirce's writing is notably difficult. To understand the significance of one aspect of his thought, the reader sometimes needs to have an idea of five or six other topics Peirce takes for granted. He even goes to say at some points how his reader will not understand a current paper/lecture unless she is familiar with other lectures he has given or papers he has written (and sometimes one's he has not!).

This essay is about Peirce's account of the laws of nature. It is possible to give the reader a thorough account of the assumed background knowledge requisite for seeing in one glance how the picture fits together, but to do so in a technical way would, I think, tire the reader and would be better explicated differently.

For this reason, I have chosen to introduce the first chapter by way of an old but familiar rhetorical device: a dialogue. The reader should *not* be mislead into thinking this choice was made to skirt past technicalities or to be lazy. I promise, there will be more than enough technicalities in later chapters. The point here is to convey the main idea of the thesis in a natural way without burdening the reader. With any luck, the reader will be able to discern fairly quickly the main motivation for creating a piece of philosophy such as this, as well as have a general idea of why Peirce thought the laws of nature evolved over time.

It is always so much easier to discuss these things with a friend, so the remainder of this introduction starts with my old roommate, Kylan, at my favorite bar, Social, an underground speakeasy in Fort Collins, Colorado.

KYLAN: So, Joshua, now that we're settled in, I've been meaning to ask you about your thesis.

JOSHUA: Ask away, my friend.

K: Well, I don't really know where to begin. What's it about, I guess?

J: Well, you already know I'm working on Peirce.

K: Yes, I remember that. Something about laws of nature and metaphysics.

J: That's right. My advisor told me not to write about Peirce's cosmology, but I spurned his advice

K: Okay, so what's the deal?

J: Well, Peirce has some cool ideas. Like he thinks the laws of nature evolved over time rather than starting out in the beginning just as they are now--assuming there even was a beginning.

K: Weird. Why?

J: Well, for one thing, he really hated the idea that anything should go unexplained. So the laws of nature, since they seem to be obvious candidates for scientific inquiry, should be explainable. We

should, in principle, be able to explain why there are any laws at all and also why the laws we observe are the laws we observe.

K: But why would the laws have to evolve?

J: Well, I suppose he thought if they didn't then there is no reason they would be the way they are. They would be arbitrary.

K: So explanation was really important to him then--

J: Yes, very much so! He was very concerned with making sure everything requiring an explanation gets one.

K: That seems to imply that some things might not require one.

J: Well, not logically, but yes, he did think chance itself doesn't require an explanation.

K: What do you mean? What's he mean by chance?

J: That's a little complicated, but it seems part of the reason he didn't think chance required an explanation is because of the kind of thing it is generally. The definition of chance is that it is such as to have no explanation. We could think of events in nature proceeding like an argument. If a chance event had an explanation, that would mean there is a kind of argument which would produce the event as the conclusion of previous premises. But then it wouldn't be chance! In that case, the event would be quite determined.

K: Right. So you're saying chance just wouldn't be chance if there were explanations for chance phenomena? So chance is unexplainable?

J: It doesn't *require* explanation.

K: Okay...but then why think it's even a thing?

J: Good question. Peirce has lots of reasons for this, but the main one is that he thinks the variety of nature can't be explained without chance, because from like causes follow like effects. So he thinks

we would never see the emergence of anything organic in a world without chance, or in a world governed solely by mechanical causation.

K: Oh, okay. Basically he's worried that you can't explain irreversible processes without chance? Like I can break an egg, but I have never seen an egg spontaneously reform.

J: Yeah, that's part of it, or it's at least related. He thinks just the variety of nature all by itself is enough to postulate chance, but irreversible phenomena are another kind of evidence for it.

K: Alright, so chance, according to Peirce, is a basic feature of the world. Can't the laws of nature have come about by chance?

J: Well, in one sense they do come about by chance. In another sense, they didn't just emerge the way they are fully formed.

K: Speak more about this. I guess for your part, you don't have to go into too many details as to why he thought they couldn't have come about fully formed right?

J: Right, I mean, that's an interesting question, but I'm more concerned to show, given that he thought they must have evolved, how that occured.

K: So what's the story?

J: Peirce makes frequent appeals to mathematics, so we should take a minute to note the difference between a formal and a material law. What needs explaining are material laws, laws of nature. Formal laws, such as would be found in mathematics or deductive logic don't require explanation in the same sense, because they are, Peirce thinks, simply the conditions of knowledge in general, which would hold as long as there were *any* laws at all.

K: What's so special about material laws then?

J: Well, for one thing, they are *contingent*. Nobody--or at least almost nobody--thinks that formal laws are contingent. But the law of gravity could have been way different and yet all the Newtonian

equations would still work out consistently. So why are the values of the physical constants what they are? That's what requires explanation.

K: So how does it work?

J: Peirce thinks that we don't have very much reason to think the constants involved in the laws of nature are exact in the first place. He says our science shows them to be exact only to an impressive degree of approximation. You might think that just means our instruments are inaccurate, but he suggests instead that the laws themselves are not exact and are much more like the statistical uniformities guaranteed to arise by the chance interplay of any large number of objects.

K: You're talking about the law of large numbers.

J: Yes, exactly. The law of large numbers helps explain why, for example, there is a tendency for a gas to achieve a state of equilibrium. Peirce thinks the laws of nature are all like gas laws. There are fluctuations around central mean values for constants.

K: So all laws are statistical in some sense?

J: Yeah, all the laws of nature. If that were the case, then they could be explained by the operation of chance--which you will remember, requires no explanation--and formal laws...

K: Which are necessary and presupposed in any rational world, because they are conditions for knowledge generally.

J: Exactly!

K: Something tells me this isn't the whole story.

J: It's not. The problem is, this isn't the only account of law evolution Peirce gives. He also gives an account involving something called the "law of habit." So with that he proposes an account that looks like he's saying that habits or tendencies are formed in nature by occasions of one kind of event increasing the likelihood that an event like that will occur again. So then laws of nature are like

habits of things that have taken hold over a long time. They start out irregular, but they eventually become nearly inevitable in their effects as habits "catch on".

K: What's the problem? Is that at odds with the other account somehow?

J: Good question. I don't think it has to be, but it depends on how we read it. Supposedly there is a problem, because if the statistical account is right, then the events going into the calculation have to be statistically independent of one another. If they are influencing each other's likelihood of occurrence, then they are connected and so not independent afterall. Then, the uniformities that result will not be due to the law of large numbers and chance. The problem with that is more fundamental than this simple incompatibility, however. The problem is: how can Peirce explain law and regularity without assuming the very regularities he has set out to explain?

K:What do you mean?

J: Well, even on the statistical account, there have to be some regularities. If we know there are red and black marbles in a bag, we can discover through random sampling certain statistical facts about the marbles, but if sometimes the marbles change color or even all their other properties so that a marble might spontaneously transform into a small bird or something crazy, then the statistical account will really be of no use.

K: Oh, I see. So how do those basic regularities arise, since they are already lawlike?

J: Exactly. If that can be answered, I think we automatically get an answer to the other problem about incompatibility.

K: Well I can't wait to read it.

J: You'll be the first to know when it's finished!

Chapter One

Cimmerian Darkness

Charles Sanders Peirce was a wildly systematic thinker of magnificent intellectual proportion. His studies were wide ranging and consumed him for much of his life, during which he made significant advances in the fields of logic, philosophy of science, epistemology, semiotics, geodesy, mathematics, chemistry, and phenomenology, and he is often regarded among philosophers as one of the key founders of the school of American Pragmatism, along with William James. Despite such polymathery, the poor fellow died fairly unrecognized in his lifetime, except by the likes of a few close friends, such as James. Lesser studied among Peirce's work is his metaphysics and cosmology, which have largely been brushed aside by Peirce scholars, since it is very odd and appears to "[have] rather tenuous connections with the rest of the system, offering, apart from scattered flashes of insight, views which have a sociological or biographical, rather than a fundamental systematic interest".[1] Even Peirce's contemporaries viewed some of the work with suspicion, with William James commenting, circa 1903-1904, that Peirce's Lowell Lectures on Logic seemed to consist of "flashes of brilliant light relieved against Cimmerian darkness"[2]

I will assume without argument that Peirce was not crazy and that his metaphysics and cosmology are interesting and fruitful areas of study. I will also assume that an investigation into certain aspects of this nebulous area of his work can be illuminating for present scholars of metaphysics and philosophy of science. This is to say that, while I will not defend the usefulness of these ideas, I think a sufficiently versed scholar of contemporary metaphysics will find them

[1] (CP 6) Editorial Note, Hartshorne and Weiss

[2] James, p.6. Presumably James had in mind, among others, "The Seven Systems of Metaphysics" (EP2: 179) in which Peirce makes a defense of his three-category ontology, which plays a large role in his cosmology.

interesting and useful, for reasons which will be obvious to anyone who works on the metaphysics of laws of nature. The project Peirce had going may be somewhat haphazard, and it may well be wrong--it is certainly unpopular--but it is worth taking a look at it, because at the very least it presents a consistent account of an explanation of one way the laws of nature might be. Or so I will argue.

What stands in my way, however, is the fact that Peirce's account of laws of nature *looks* contradictory. In particular, Andrew Reynolds, a contemporary scholar of Peirce's metaphysics of science, has argued that the account of laws of nature Peirce gives contradicts itself, because the conditions Peirce requires to make his cosmology an evolutionary one, where the laws of nature emerge over time, relies on two competing explanations involving mutually unsatisfiable constraints. Let me first give the elevator pitch version of this problem.

Peirce is convinced that the laws of nature could not have just been laid down at the beginning of time as brute, unexplainable facts about the world. They must instead have developed or grown over time to be what they are observed to be today. His project is to give an explanatory account of how this could happen and why we observe the laws as they are. To do this, he provides two analyses. First, he assumes that absolute chance is operative in nature, thereby anticipating some of the later interpretations of nature that would come to dominate discussions of quantum mechanics in the early Twentieth Century. Moreover, he appeals to statistics as a means of getting clear about chance events, and in particular he looks to Bernoulli's law of large numbers. If the laws of nature developed over time, they must be, in some sense, statistical in nature. They will, accordingly, obey the Law of Large Numbers.

On the other hand, Peirce is also convinced that there are real tendencies operative in nature, such that evolution (whether biological or not) proceeds partly by virtue of things acquiring habits of behavior over time so that they behave more and more regularly. Peirce thinks he needs this sort of explanation to make irreversible processes such as the growth of organic objects understandable. It also allows him to attempt bridging the explanatory gap between mind and matter, since the development and manifestation of habits in nature, at the level of physical material phenomena, mirrors the development of habits of the mind.[3] It would be nice if such an explanation were forthcoming.

The short of the problem is this. In order to make sense of the laws of nature by appealing to the Law of Large Numbers, certain mathematical constraints applicable to the Law of Large Numbers have to obtain. For example, the Law of Large Numbers only makes sense if the objects in the statistical distribution to which the law applies are independent from one another. In the case of a law of nature, this would be like requiring that the occasions on which the law is manifested do not influence one another so as to increase the future probability that the law will have a certain value at some later manifestation. However, if the laws of nature are *also* supposed to have come about by things in nature taking habits, then it seems the various manifestations of the law are *ipso facto* connected in some way and so highly dependent on one another. Andrew Reynolds calls this contradiction *the incompatibility problem*.

The aim of my project is to take the sting out of the incompatibility problem. Strictly speaking, I do not think the incompatibility problem is solvable. If the problem is simply that the laws of nature evolve by updating the transition probabilities of event types in the series of

[3] I will not address this issue in this essay, though it is interesting.

instantiations of the laws, then this kind of evolution is just not compatible with an explanation of the laws in terms of the Law of Large Numbers. Maybe there is some other statistical account available, but straightforwardly there is a contradiction here.[4] My aim is not to solve the problem by trying to make the contradiction compatible with itself, nor is it to simply play hardball and commit to one horn of the dilemma as the right analysis of laws. I will also not attempt the very audacious historical task of trying to figure out exactly what Peirce meant. I hope that the account I will give is what he actually meant, but I would be delighted if some historian would come along and prove me a dunce. Instead, I provide a rational reconstruction of Peirce's cosmology and metaphysics of evolutionary laws of nature. I will show that underlying the incompatibility problem is a much deeper issue, which is a question of how Peirce is to explain the emergence of regularities, such as laws of nature, without appealing to those very regularities he has set out to explain in the first place. If there is a solution to that, then the incompatibility problem loses its force. If I have succeeded, then nothing will be found here which contradicts what Peirce actually wrote, although it may not be exactly what he said either. My account is an offering of what Peirce might have responded with if charged with the incompatibility problem, and in some sense I argue that this is what he ought to say given his other commitments.

The way I will embark upon this project is by first offering an account of the laws of nature which I think best fits what Peirce actually says about them. To my knowledge, this task has never been done before. Most of the exegesis on Peirce's metaphysics and cosmology either provides only a cursory overview of the laws of nature according to Peirce, or else it simply eschews it entirely. This is understandable given that Peirce himself never provides a worked-out theory of lawhood, or

[4] In fact, Reynolds points to the possibility that Peirce had a non-stationary Markov chain in mind as the proper statistical analysis of law evolution. The problem with this account is that there is effectively zero textual evidence that this is what Peirce had in mind.

if he does at all, it's not very systematic and is scattered throughout his writings on other topics. His paper, "Laws of Nature," for example, is extremely unsatisfactory to read, because while he offers some notion of lawhood, it is rather difficult to connect it to what he says in other pieces concerning the evolutionary development of laws and nature generally. Besides this, there is the persistent equivocation on the term "law" which sometimes is used to refer to an underlying reality constituting part of an ontology and sometimes used to refer to the formulation in mathematical terms of that underlying reality.

It seems clear to me that Peirce would not want to identify laws with the simple representation of them in mathematical terms. Whatever laws are, they are not just formulae. The realist picture of metaphysics he espouses will make this fact obvious later. What Peirce seems much more interested in, throughout much of his writing on metaphysics, is the nature of "what breathes fire into the equations," as Stephen Hawking has remarked regarding laws of nature.[5] Any satisfactory account of laws of nature should be able to at least sketch a rough portrait of this fire-breather. Or so Peirce and I both think.

I. Reynolds on Peirce's Cosmology

Andrew Reynolds calls the inherent tension between Peirce's conception of the statistical mechanical account of chance and the Law of Habit *The Incompatibility Problem*, which involves an apparent contradiction between Peirce's use of the Law of Large Numbers from statistics as a means of analyzing the explanatory power of chance, and his commitment to the thesis of the Law of

[5] See Hawking, chapter 12

Habit. Reynolds spends a few pages on this problem, after leading up to it for several chapters.[6] He has also published a separate paper related to the problem called "The Incongruity of Peirce's Tychism".[7] It is not necessary to recount the entirety of the chapters leading up to the problem here, but an overview of some of the background will help. The Incompatibility Problem can only be understood as a *problem* after the components of Peirce's tychism that are allegedly incompatible are articulated clearly. These components are the Law of Habit and the "doctrine" of chance. I have been deliberately vague in the preceding paragraphs not to mention what is meant by either of these notions, especially 'chance'. Now it is time to take a closer look at what Reynolds means by these notions and how he thinks they play a role in generating the Incompatibility Problem.

Right from the beginning of *Peirce's Scientific Metaphysics*, Reynolds makes it clear that on his view, much of the important metaphysical work that Peirce was concerned with while developing his scientific metaphysics relied on Peirce's understanding and interpretation of scientific and mathematical results that played a prominent role in 19th Century intellectual discourse. Specifically, Reynolds points out that the results from statistical thermodynamics and Darwinian evolution appear to have played a significant role in Peirce's thought throughout his life and especially in his later creation of a cosmology. In addition to this scientific streak, Peirce was influenced significantly by the German idealists, especially Kant, Hegel, and Schelling. Together, these influences resulted in his being fascinated with the idea of a developmental account of nature, an *evolutionary* cosmology. In particular, as Reynolds notes, Peirce wanted a way to explain a variety of phenomena that seem to require an explanation but for which such explanations do not seem forthcoming. Among such phenomena in need of an explanation are: the growth and complexity of both biological phenomena

[6] I do not want to be misleading here. Reynolds' book is interesting for a number of reasons that are quite independent from the Incompatibility Problem. The problem itself does not occur until Chapter 6.
[7] Reynolds, 1997

and, Peirce argues, the universe as a whole; the variety of nature or the extreme differentiation between various observable phenomena; the laws of nature, or regularity more generally; and mind, including consciousness and "feeling".[8]

Of these phenomena, it is Peirce's contention that regularity and the laws of nature require explanation that most interests me, although it is virtually impossible to figure out what Peirce's views on any particular portion of his cosmology are without delving into all four of the issues above to some degree or other. Peirce was a wildly systematic thinker, and his solutions to one area borrow liberally from results or developments in the other areas. However, if Reynolds is correct, then one of the key scientific results that influenced Peirce's discussion of this issue (as well as the others) was the discovery and development of statistical thermodynamics. Moreover, Peirce sees statistical ideas such as the Law of Large Numbers and the Central Limit Theorem as indispensable to his evolutionary cosmology, because it is through these results that he is able to connect the ideas of evolutionary development at the level of organism to the cosmological development at the level of laws of nature.[9]

Lest we lose sight of the fact that, whatever else he is up to, explaining how the laws of nature came to be was high on Peirce's priority of things to explain, it is worth quoting Peirce directly. He says, for example, that, "Law is *par excellence* the thing that wants a reason."[10] And:

> Once you have embraced the principle of continuity no kind of explanation of things will satisfy you except that [the laws] *grew*. The infallibilist naturally thinks that everything always was substantially as it is now. Laws at any rate being absolute could not grow. They either always were, or they

[8] Reynolds 2002, 13 and 6.35-65; 6.613
[9] Reynolds, *ibid*
[10] 6.12

> sprang instantaneously into being...This makes the laws of nature absolutely blind and inexplicable. Their why and wherefore can't be asked. This absolutely blocks the road of inquiry.[11]

Peirce is here concerned that the infallibilist simply accepts the existence of laws of nature as unexplained brute facts, thereby making them cut off from rational inquiry. The laws of nature must be amenable to reason and inquiry, or else, Peirce thinks, we would have to admit that they are arbitrary and unreasonable basic facts of the matter, an admission which would violate the first rule of logic: do not block the road to inquiry.[12]

It is in the context of the explaining the development of the laws of nature (and thereby providing their explanation) that the Incompatibility Problem arises. If Reynolds is correct in thinking that the development of statistical methods in physics played a large role in Peirce's scientific philosophy of explanation, then one of the principal aims of Peirce's cosmological metaphysics is to *explain* how regularities such as laws of nature could develop from pure chance and evolve over time. The central question then is whether or not a successful explanation of the evolution of laws of nature is available to Peirce. He must have some way of explaining how such a process might take place. Peirce's thesis of tychism, which involves the postulation of absolute chance in nature, is supposed to form the basis of the explanation. But this alone is not very enlightening. First, without further explication, it is not clear what "absolute chance" refers to or what its role is in the tychistic thesis. Furthermore, unless there is some explanation of how chance can result in the production of law, we do not have the explanation we desperately need.

[11] 1.175 Peirce's ideas here about continuity and the growth of laws is cryptic, but see the section a few pages below on continuity for my account of why he thinks these are related.
[12] EP2:48

Above I said that Reynolds thinks that the Law of Large Numbers and the Central Limit Theorem play a large role in Peirce's cosmology. In particular, these statistical results help explain how laws could form out of pure chance occurrences. Before discussing the role of these mathematical results, it is important to get clear on why Peirce thought that the laws of nature had to evolve out of chance. According to Peirce, the reason that we need to explain why the laws of nature are the way they are is because of the *kind* of thing they are. Laws of nature are the sorts of realities that are intrinsically "reasonable"[13] and so are in need of an explanation. To simply assert of some particular reasonable fact or phenomenon that it is inexplicable is, according to Peirce, to commit the nominalist's error of thinking that reality is fundamentally divorced from our ability to understand or apprehend it fully. Such an admission involves the notion that the fact is cut off in a fundamental way from reason, and this is something Peirce is unwilling to grant as possible. Whatever a law of nature is, it is certainly an intelligible reality of some kind, Peirce thought, so the idea that a law of nature is a brute fact, inexplicable in principle, Peirce practically countenanced as an intellectual sin. To assert that an intelligible thing is inexplicable is just to say that it is incapable of being intelligibly understood and therefore not intelligible. Laws of nature are determinate realities about which we can reason, so if we are not going to admit nominalism, in which case we would not be able to reason about laws of nature, there must be an explanation as to why the laws of nature, or regularities generally, exist; and there must be an explanation as to why they are the laws they are and not other laws.

[13] See for example "Variety and Uniformity," 6.88-101

Chance

According to Peirce, whereas generalities and regularities such as the laws of nature, along with particular facts or existing phenomena, require an explanation, such an explanation is not necessary for chance itself. Central to his philosophical project is the idea that philosophy should proceed in a scientific way, such that everything that deserves an explanation gets one. Like a persistent child, the scientist-philosopher should be able to say "but why?", and mother nature had better not simply reply "Because I said so." Peirce rejects metaphysical foundationalism on the grounds that it leads to nominalism.[14] If the ultimate explanation or ontological ground of a phenomenon were an unexplainable or ontologically independent fact (or object, property, etc.), something that is fundamental or "basic" in contemporary terms[15], then the ultimate level of reality would be nominalistic in nature. If Peirce were to say that the existence and nature of laws of nature are grounded in a fundamental entity or entities, then his explanation of the laws of nature would run afoul of the very nominalism that he is trying to avoid. Peirce has two options. Either he can go infinitist about explanation[16] whereby the chain of explanation does not terminate or "ground out" in a fundamental entity or explanation but proceeds indefinitely[17], or he can attempt to ground the explanation of the laws of nature on something that is categorically distinct, something that is not such that it even *could* require an explanation. In any case, Peirce thinks that chance is simply not the kind of thing that requires an explanation. This may seem like slippery chicanery on his part, but the truth has to do with what was mentioned above about nominalism and facts. Peirce thinks that the

[14] As a staunch realist, Peirce was strongly averse to nominalism. The reader need not worry exactly what Peirce means by "nominalism" except to note that, according to him, it is the denial of real generalities in nature. See Forster for a fuller analysis of this.
[15] See Schaffer, 2010
[16] Given his views, going infinitist about explanation will also result in going infinitist about ontology.
[17] This is sometimes what is meant by the phrase "turtles all the way down", a phrase that has its apocryphal origins with Russell.

nominalist commits the error of holding a *reasonable* aspect of reality to be incapable of being reasoned about. If, for example, a law of nature is the sort of thing that can be captured by reason, and Peirce thinks it can, then to say that it is merely a brute fact is essentially to assert that something capturable by reason cannot be reasoned about (it is brute, after all) and so is not capturable by reason. Peirce has no patience for this sort of contradiction, however subtle. It does not follow, however, that *all* facts whatsoever require an explanation. But such unexplainable phenomena have to be "reasonless" in a precise sense. The "reasonlessness" in question has to take the form of a hypothesis or abductive inference, such inferences being the sorts of things that help to explain phenomena--such as the diversity or variety of the world, for example. Only if this condition is met is Peirce willing to allow the possibility of a "brute fact" into his system.[18] According to Peirce, chance itself is not the kind of thing which could require an explanation because it is reasonless in just this way. He thinks that we can perform a kind of inference to the best explanation to discover that chance must be an operative feature of the world (e.g. it explains the world's variety), but chance itself would not be what it is if there were any prior premises from which it could itself be derived. It does not require an explanation, nor is it its own explanation, since to claim this would be tantamount to saying that chance is not chance.

As Reynolds is keen to point out, Peirce appears to mean several things by chance, such as *growth*, *variety*, *"nonlaw"* or *"real" chance*, *feeling*, *fortuity*, *freedom*, and *arbitrariness*.[19] Of these notions, it is the notion of chance as a violation of law, or *absolute chance* that Reynolds says Peirce focuses on as

[18]At the end of *A Guess at the Riddle*, Peirce mentions this. As an interesting side note, chance is not the only thing Peirce didn't think required an explanation. He mentions the haecceity of individual existing particulars as also requiring no explanation, since these facts are just the sorts of things that are not intelligible objects of reason but rather abductively inferred hypotheses which we simply cannot extricate from our experience without great difficulty. They are, however, *arrived at* by a reasoning process, i.e. abduction.

[19] 6.612, 6.613, and 6.322

being fundamental to his analysis of the increasing complexity of the world and the development of laws of nature. Without some notion of a law-violating kind of chance, Peirce does not think it is possible to explain the variety that we observe in nature, since he thinks that no number of absolutely determinate mechanical laws would ever be able to result in the extreme differentiation we observe between various phenomena in nature, since "like causes will always produce like effects."[20] If the universe started out at some level of complexity, and if the only laws governing the universe were time-reversible mechanical laws acting everywhere and always in identical ways, the world would continue to have just exactly the complexity that it started with, or so Peirce thinks. On the contrary, something must explain the "marvellous and infinite diversity and manifoldness of things."[21] The only thing that could account for this diversity is an "absolute chance" element in nature, something that would not be subject to strict law but which would spontaneously deviate from regularity. Peirce thought that we could *observe* the effects of this spontaneous aspect of nature: "That there is an arbitrary element in the universe we see--namely its variety. This variety must be attributed to spontaneity in some form"[22]

It will hopefully become clear to the reader later that Peirce cannot mean to be saying that the laws of nature are "violated" by "nonlaw" chance events in such a way as to contravene the pre-established patterns of Nature, which have already been laid down as unbreakable rules. But just in case, let us take note of it now. That account of laws would make no sense from the perspective of an evolutionary cosmology, which is intended to explain the emergence of those very laws. As Reynolds points out, Peirce cannot mean to say that the chance events in nature "violate" the laws in such a way as to deviate from fixed rules, because that account would presuppose the reality of those

[20] 1.174
[21] 1.160
[22] 6.30

rules, which are the very things chance is supposed to be explaining. On the contrary, there is a weaker sense of violation Peirce has in mind, although he does not do a very good job of signalling to his reader that he is employing this notion. The weaker notion is that of the laws of nature themselves not being strict or absolute. Peirce says,

> The first [mistaken metaphysical principle] to go must be the proposition that every event in the universe is precisely determined by causes according to inviolable law. We have no reason to think that this is absolutely exact. Experience shows that it is so to a wonderful degree of approximation, and that is all...We know that when we try to verify any law of nature by experiment, we always find discrepancies between the observations and the theory. These we rightly refer to errors of observation; but why may there not be similar aberrations due to the imperfect obedience of facts to law?[23]

Even here it is tempting to read Peirce as saying that the laws of nature are already fixed and that chance is merely the spontaneous departure from the law, but it is clear from other passages that, insofar as Peirce considers laws of nature to involve uniform regularities (which he does), if we are to interpret him consistently, he must mean that the laws are not exact at any given stage of time. He says, for example, that "uniformities [i.e. laws] are never absolutely exact, so that the variety of the world is forever increasing".[24] We see once again that Peirce is appealing to the observable facts of the variety in nature as being reason to think that there is spontaneity or absolute chance operative in the world, even amidst the governance of laws. In some ways it starts to look like Peirce thinks that law and chance are mutually reinforcing in their production of the world we observe.[25]

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[23] 1.402
[24] 6.91
[25] And indeed, this is undoubtedly the case. Both law and chance are postulated as the consequence of abductive inferences. That is, Peirce is convinced that we must postulate these in order to explain experience.

Continuity

Consider again the following,

> Once you have embraced the principle of continuity no kind of explanation of things will satisfy you except that they *grew*.[26]

It might strike one as odd that Peirce says that it is in virtue of accepting the principle of continuity that one will be led to the notion that the laws of nature grew and developed over time. Peirce is unclear about this, and this is perhaps one of the few passages where he brings these two concepts together as explicitly related, so it is instructive to pause briefly and note what Peirce has in mind with respect to continuity. For him, a true continuum of any kind is such as to contain non-denumerably many instances of whatever quality the continuum in question is a continuum of. Moreover, Peirce thought that the correct analysis of continuity is in terms of infinitesimal quantities, quantities which are merely *possible* until they are designated from the continuum itself.[27] This implies that the continuum Peirce has in mind is strictly denser than the ordinary continuum contemporary mathematicians and physicists are used to, which is usually understood as being one-to-one with the real numbers. On the contrary, the "true" continuum, according to Peirce, involves there being between any two members more members beyond all number.[28]

The exact nature of Peirce's continuum need not concern us here. What is important to note is that Peirce thought that the doctrine that continuity is a basic feature of the world, which he called

[26] 1.175
[27] See RLT Introduction by Putnam for an excellent overview of this topic.
[28] There is an interesting parallel to the contemporary concept of hypergunk in mereology. Hypergunk consists in a continuum of parts such that each part is composed of further parts of a cardinality strictly higher than the number of parts they compose. See Hazen, 2004 and Nolan, 2004

synechism, was the only acceptable explanation of a variety of phenomena found in nature, including the operations of the mind.[29] I believe that the relationship synechism has with the evolution of laws of nature is the following. In order to avoid nominalism, Peirce is committed to laws being explainable. A law must be explained by something which does not itself require explanation, and we have seen that Peirce thinks chance can do the job (though we have yet to see *how*). One might wonder why the laws could not simply spring forth from pure chaos in one fell swoop, going from complete disorder to perfect uniformity in an instant. That would, after all, still explain the laws in terms of something that does not require explanation thereby avoiding malicious nominalism, which is what we wanted. We can imagine a story such as what is sometimes given by popular contemporary cosmologists with respect to the Big Bang, according to which the laws of nature did not exist until the moment of creation when they spontaneously (by chance?) emerged fixed for all time.[30] As is evident from the quote above, Peirce would not accept such a story, and the reason I believe, is because of his commitment to synechism. According to this doctrine, time forms a true continuity so that between any two events there are non-denumerably many other events. There is no sense in which the laws of nature could spontaneously jump from a state of indeterminate non-existence to perfect regularity without going through the transfinite interval of time between states. Since this is so, the only explanation the synechist can give of the development of laws out of chance is one in which the laws of nature evolved over time, or "grew" to use Peirce's term, into what they are. Even if we suppose (as Peirce does not) that after some time they stopped growing so that they are now fixed, no matter how small an interval we take, the time during which the law

[29] See "Questions Concerning Certain Faculties Claimed for Man" EP1:11.

[30] I am not intending to suggest that this is the story cosmologists actually accept, that it is plausible, or even that it is remotely adequate for explaining the laws of nature. There is, for one thing, no clear parallel in this story to any chance-like events prior to the Big Bang out of which the laws could arise--although something like this seems to be up for discussion according to Krause, 2012.

emerged will always involve a process of coming to be rather than a discontinuous jump into existence.

II. Tychistic Tensions

Andrew Reynolds argues that there is a tension in Peirce's cosmology, which is a result of attempting to combine two different analyses of how the laws of nature are supposed to arise from chance. I thought it necessary to begin by catching the reader up to speed on the Peircean background so that she would not feel too lost. Now it is time to move into the heart of the problem.

Briefly, the problem, as Reynolds points out, is that Peirce relies upon two different explanations for how the laws of nature emerged from the primordial, indeterminate, chance chaos that preceded the existence of the universe: the Law of Habit and the Law of Large Numbers. The task of this chapter is to explore what these concepts amount to for Peirce and why Reynolds thinks they are mutually unsatisfiable analyses on Peirce's account.

The Law of Large Numbers

Although the term "law of large numbers" sounds difficult and technical, the intuitive idea behind the law is commonplace. An example will help illustrate this idea. I want to be clear, however, that the following example is not intended to track *Peirce's* understanding of the Law of Large Numbers. Rather, it is meant to give the reader an intuitive idea of the basic workings of the Law of Large Numbers as it appears in everyday life. The example to follow, therefore, somewhat

blurs epistemology and metaphysics, but this is no serious matter. We will attempt to *grasp the concept* first and become more precise later.

Imagine you are at a carnival, and situated between the petting zoo and the ferris wheel is a giant gumball machine filled with red and green gumballs. I approach you with a challenge: I will bet you cannot guess the correct proportion of green gumballs in the machine. Now, the rules are, you make take out one gumball at a time and observe it, but you must place it back in the tank before grabbing a new gumball. You may do this as many times as you like before making your guess. You may shake the tank around and shuffle the gumballs as much as you want as long as you are careful not to spill them.

Of course, in our toy example, it is I who will be conned, and the reason why is very commonplace. Suppose that you knew the gumballs had been shaken together quite thoroughly. You would have every reason to believe that your chance of picking out, say, five green gumballs at once on *this* occasion is just as likely as on any *other* occasion, because if the tank were shaken vigorously enough, the gumballs should be randomly distributed throughout the container. If I were to let you pick out *half* of the gumballs and compare them, and if you knew they were randomly shaken up beforehand, you would have a good reason to believe that whatever the proportion of green to red gumballs you observed there would also hold true of the total collection. After all, it would be very unlikely that you would draw that many at one time and observe a serious deviance from the true proportion, unless the gumballs were not really randomized beforehand. Likewise, the more times you were allowed to draw half of the gumballs and observe them, the more sure you would be that your estimation was correct.

It should be fairly obvious that how many gumballs you are allowed to take out of the tank at one time is not going to affect your ability to make a good guess as long as 1) you can be sure the gumballs are randomly distributed in the container, 2) you are allowed to pick out and throw back gumballs as many times as you want, and 3) you don't specifically try to pick certain gumballs. All you will have to do to guess the right proportion of green gumballs is draw a gumball and record the answer, toss it back in and shake the container to randomize the candy, draw again, record, shake, etc. After a while, you will be able to look at your recordings and simply count up how many green samples you took versus all the samples you took. That proportion will be close to the true proportion of green gumballs to all of the gumballs in the container. The more times you took samples, the more accurate your result would be.

This is an intuitive idea. It applies to many different fields of inquiry, generally wherever estimation is required. There are plenty of examples one could contrive to demonstrate how commonplace this kind of reasoning is; so much so that technical talk about statistics often seems to confuse the general point unless one really desires an extremely precise understanding of the law. We shall have to get a little more precise for our purposes here, but not much.

The reason you are able to estimate the number of gumballs in the example above is because two conditions hold. First, the gumballs are independent of one another, and second, your selection of them is a random process. There is nothing about selecting one kind of gumball that influences which one you will pick next. They are not connected in any way. Choosing a red gumball does not increase the probability that you will get a green one next time. Notice that it is important that you always put the gumballs back into the container. If you did not, then the choosing of a red gumball would increase the probability of getting a green one next time, because you would have changed the

overall proportion. Likewise, you shake up the container each time, which ensures that your selection process is fair. That way, you are equally likely to get any given gumball on any occasion as on any other. You pick them quite randomly. The fact that, given that these conditions hold and a large number of samples are taken, the average number of green gumballs in your samples will approximate the average number of green gumballs in the whole tank is just one example of the Law of Large Numbers.

More technically, what the Law of Large Numbers says is that if, for some population being measured, if the samples taken from the population are independent from one another (where a sample consists in making a measurement of a certain kind of variable), and if the samples are known to be or observed to be roughly alike in character (that is, they really do pertain to the same population) then the mean of the samples taken together approximates the mean of the population (or distribution of the intended variable) so that as the number of samples increases the sample mean approaches the distribution mean and, at infinity, reaches it.

Consider again the gumballs. The population is the total collection of gumballs in the container. The samples are your various occasions of picking a gumball. The variable in question is the green colored gumball. The Law of Large Numbers says that if you randomly take samples from the population, looking for some variable, and if the samples are *independent* from one another, then as the number of samples increases, the proportion of times that variable will be observed among the samples approximates the proportion that variable occurs in the whole population to an increasing degree of likelihood, such that the probability at infinity that the proportion of the variable found in the samples equals the proportion found in the population is one. If you take a billion samples and find that, on average, the gumball is green twenty percent of the time, then

(assuming the number of gumballs in the tank is much less than a billion) it is almost certain that about twenty percent of the gumballs in the tank are green.

Notice that the word "independent" could have different meanings. On the one hand, there is a notion of what I will call *metaphysical independence*, which is about the relationship the underlying objects of observation in the sample have to one another. On the other hand, there is the sense of independence which applies to the observations themselves, which I will call *epistemic independence*. For most mathematical purposes, these two senses of independence are interchangeable for one another in a pretty harmless way, which is perhaps why few mathematics textbooks appear to draw any distinction. They are different but related. In our toy example, it is both true that the gumballs in the sample are metaphysically independent--the color of one gumball does not affect the others, nor does the selecting of one color increase or decrease the likelihood of selecting any other color--and also that the observations taken when we take gumballs from the tank are epistemically independent, in the sense that nothing about taking any given gumball is going to increase or decrease the probability of observing one of the same or a different color the next trial. In one sense, the epistemic independence of the observations is explained by the metaphysical independence of the gumballs and the fact that we took samples at random; we would expect that if we took random observations of metaphysically independent objects, the observations themselves will not impact one another. They are, after all, randomly drawn, and the objects they measure are not connected with one another in any way that would cause the observation of one to affect a subsequent observation.[31] The two do not *have to* go hand in hand, however. It could be that the underlying

[31] One might object that the observations are then metaphysically independent, and so there is no need for this distinction. This is correct, and it probably accounts for why mathematicians usually don't draw this distinction, but it can still be helpful, because otherwise, we are likely to forget that there *is* a difference between saying the elements of the underlying distribution being observed are independent

distribution of objects are, in fact, connected and dependent, but we could still take random samples of the distribution in such a way that our *observations* were independent from one another. Indeed, if we did so long enough, we would discover that the underlying distribution consisted of dependent elements, because our observations of them would reveal a pattern different from what we would expect to see if they were truly independent.[32]

This account is, very roughly and without too much technicality, how the Law of Large Numbers works. It will be important later to remember some of the conditions that need to be met in order to satisfy the Law of Large Numbers. For the mathematics to work, the samples taken from the underlying distribution have to be independent from one another, and they must be taken randomly.

But what has all of this to do with Peirce and the laws of nature? For one thing, Peirce thought that the Law of Large Numbers was the analysis whereby we can make sense of irreversible processes in the world. He was intensely concerned to demonstrate that the universe could not be governed merely by mechanical law, which he thought was a somewhat obvious fact deducible from observing irreversible processes such as organic development and the tendency of a gas to achieve thermal equilibrium. Such commonplace but--from the perspective of a purely mechanical understanding of lawhood--bizarre occurrences require an explanation. That is, if everything in nature is governed by purely Newtonian laws, which are time-reversible, it is odd that we never observe such things as an egg unbreaking itself or a glass of water unspilling itself. There is nothing

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from one another and saying that the elements of the set of observations are independent from one another. The former is about the world, whereas the latter is about our record keeping.

[32] For example: if there were a coin such that tossing it and getting heads increased the chance that heads would turn up in the future, then if we took random samples of coin tosses (where each observation was not influenced by any others), we would discover that there is a connection between the actual coin tosses.

in the Newtonian description of things which would make such occurrences impossible. And yet, we never do observe this; instead we are confronted with all kinds of *irreversible* phenomena.[33] What could explain this? As we saw earlier the only such explanation Peirce thought would not slip into nominalism is one that attributes such phenomena to chance. Fortunately, as Peirce was keen to note, there is a mathematically precise way of spelling out just how regularities and uniformities can result from chance processes, given by Bernoulli's law of "high numbers" as Peirce calls it, or the Law of Large Numbers. Peirce says:

> The conception of fortuitous variation is so exact that it can be expressed by a mathematical equation. In fact, it is expressed by the formula which expresses the conduction of heat, the action of viscosity, and the diffusion of gases. All these phenomena are explained by physicists as results of Bernoulli's law of high numbers, where the same idea of multitude reappears which is directly involved in the Darwinian hypothesis. The same formula shows itself in the doctrine of chances, in the theory of errors of observations, and in the logic of inductive reasoning. As well as we can make it out, the law of mental association, which is at least strongly analogous to induction, is probably of the same form. All these things seem to be connected. [34]

In the passage above, Peirce is pointing to the fact that the use of the Law of Large Numbers, which he calls "Bernoulli's law of high numbers," is commonplace in the natural sciences. From measurements of physical values to variations in temperature, variation appears to often center around a mean value fitting the normal bell curve, sometimes called the error curve since it can tell what the likelihood of error is based on how probable (or improbable) the observed value is.

[33] There is one exception that I know of, which is the phenomenon of laminar flow. It is only a pseudo-exception, but the reader is encouraged to look up videos online demonstrating the effect.
[34] NEM2: 200-01

The Laws of Physics as Statistical

Among the reasons for Peirce's interest in the statistical results in mathematics (besides their use in the theory of errors, chemistry, and observational science) is that Peirce aimed to show that the dominant account of laws of nature in the 19th Century, the so-called mechanical philosophy or "necessitarianism," as he sometimes calls it, is false.

What Peirce means by the "mechanical philosophy" is the belief, popular among 19th Century scientists, that the universe is like a gigantic mechanism or machine with the motions of its many particles forming a single system that, like some perfectly designed clockwork, behaves in an exactly regular way with respect to the Newtonian forces. The idea is that the motion of any given particle, being subject to exact, uniform laws of motion, would behave in exactly similar ways under identical circumstances, so that its position at any given time would be predictable given a sufficient amount of antecedent information concerning other like bodies with which the particle might interact. The same goes for every other particle in the universe. The picture of the world on this account forms the basis of Laplace's demonic thought experiment:

> We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes.[35]

It would be an understatement to say that Peirce took issue with this view of the world. In fact, he devoted a considerable amount of writing to refuting it in, for example, "The Doctrine of

[35] Laplace, *A Philosophical Essay on Probabilities*

Necessity Examined" and other places. What Peirce saw as insufficient with the mechanical philosophy is largely the fact that the deterministic view of the world implies (which suggests that the past determines the future as much as the future determines the past) that every phenomenon falling under its purview is in principle a reversible phenomenon. The world for a Laplacian demon looks the same both backwards and forwards, since all that is necessary for reversing any given mechanical process is for the Newtonian forces involved to change their directions without modifying their magnitudes. No such reversal is going to happen in general, but there is no reason it could not in principle. In one thought experiment, Peirce imagines that several particles travelling through space encounter a perfectly elastic surface, whereupon they are reflected back in exactly the same course as they had come with the exact same energy and velocity.[36] But, as a matter of simple observational fact, although it is possible, according to this view, for processes to run in reverse, such reverses are never observed. The mechanical philosophy thus leaves these processes unexplained, Peirce thought, because it would minimally have to explain *why* we never observe this. As we will see below, the mechanical philosophy would have a hard time answering this question--if it is even possible to adequately answer it within the mechanical framework--because it seems the only satisfactory account would involve commitment to at least some general (in contrast to particular) features playing a role in natural irreversible processes.

It is easy to see why Peirce thought this, especially once one comes to understand his reasoning in a little more detail. As Thomas Short points out in *Peirce's Theory of Signs*, the statistical mechanical account of explaining the behaviour of large numbers of objects--such as, for example,

[36] It might be objected here that no such situation could happen since there are no perfectly elastic bodies, and some of the energy would be lost to heat during the required transaction. To argue this, however, is to concede Peirce's point. For such an objection rests upon the assumption that we can make sense of the nature of heat by appealing to thermodynamics, which is the very sort of statistical theory that Peirce is trying to get his reader to understand as involving non-conservative forces.

the independent motions of trillions of molecules--involves a wholly different picture of the world from what the mechanical account offers, and this fact, though somewhat obvious once noticed, often does not get much attention. There is a widespread tendency to think that because the statistical account of the behaviour of gases near equilibrium is compatible with each gas molecule being governed by purely conservative Newtonian forces, that the statistical analysis of the tendency for the gas to achieve certain distributions is itself a mechanical one. But this is false, as Short explains. Keeping with the spirit of analysis that Peirce himself adheres to, Short notes that mechanical causation takes place between particulars, and a mechanical explanation is one that makes explicit reference to the relationship between two or more particular objects.[37] This sort of explanation is, by its nature, nominalistic, since it is ontologically committed to, and only to, individual existences. If we only consider two or three particles that move about according to classical Newtonian models, then, assuming we cash out the Newtonian forces involved as descriptions of behaviour and not metaphysically dubious realities, our explanation as to why particle A is observed to be barrelling down a certain path through space with thus and such velocity can be put entirely in terms of facts about its relationship to particle B into which it has just crashed, provided that we spell out in a bit of detail some of the specifics about particle velocities, masses, densities and so forth. Such an explanation does not make reference to generalities at all. It relates particulars to particulars, or tokens to tokens. It does not relate a token to a *type* or a particular to a general (kind, universal, etc.).

Statistical explanations, for example thermodynamic ones, are *not at all* like this. For they make explicit use of various *kinds* of outcomes (generally, equilibrium states in thermodynamics). Short gives a nice example of this kind of explanation, which looks to me to be an abridged version

[37] 'Object' here means simply an individual of whatever kind, provided that it is particular.

of the account Sklar gives in his *Physics and Chance*.[38] The account is this. Imagine that before us is a container filled with a gas. We imagine that the container is divided into *m* three-dimensional cubical cells, that the gas is comprised of *n* molecules, and that $m<n$. We will also assume that *n* is fairly large and that what it means for the gas to be evenly distributed (roughly) throughout the volume of the container is for each cell to contain n/m molecules, plus or minus *e*, where *e* is considerably smaller than n/m.[39] Since *e* can vary, there will be a wide range of even distributions of this type, and if we stipulate that *e* is not too small, the set of even distributions will form a class much larger than the complement class--the set of distributions that are uneven.

Once we have these concepts in mind, we can talk about certain observations of gasses that we are likely to make. We can observe that a gas is evenly distributed throughout a container, for example. We call this observed distribution the macrostate of the gas; it is the overall behaviour of the entire system of molecules as coarsely measured either by our senses or through instrumentation. For any given macrostate at a single time, there is exactly one microstate constituting it, where a microstate is understood to be the exact position of each molecule in the system relative to the volume of the container in question. Obviously, given what was said above, there are a huge number of microstates compatible with any given macrostate, because *e* can vary widely. No particular microstate is observable since such systems are far too complex to measure, their involving trillions of molecules in rapid motion.

Just as there are many possible microstates constituting any macrostate, there being far more evenly distributed microstates than unevenly distributed ones, there are likewise far more ways for a system of molecules to go from an unevenly distributed microstate to an evenly distributed one. And

[38] Short, 119-120, Sklar, chpt. 2 & 4

[39] Ruling out mereological gunk, we are assuming that *e* is a whole number much larger than zero.

so, it is far more likely in a given stretch of time that an observed macrostate of a gas will become evenly distributed--there are just way more possible microstates compatible with an evenly distributed macrostate than an unevenly distributed one. These facts explain why we almost never observe such strange events as mixtures of fluids unmixing themselves or heat spontaneously "collecting" on only one side of a pan.

But what makes this explanation so special and uniquely statistical? According to Short, such a statistical account requires a conceptual shift toward thinking of the world in a statistical way, rather than conceiving of it in a purely mechanical way. Short provides a thought experiment to help us see this.[40] Imagine, he says, that we were Laplacean demons in whose possession are extraordinary powers of calculation, especially that of computing complex differential equations. But, Short says, we must also pretend that, despite having godlike powers of observation, memory, and calculation, we have an extremely impoverished understanding of statistics. We have simply not needed this kind of analysis before. Now Short has us imagine that we observe a gas in a thermally isolated and fixed volume at time T. The world is assumed to be Newtonian, and we demons are able to observe each and every molecule of the gas at T and measure its momentum, velocity, position, etc. From this, we can calculate those qualities at any other time in the future (or past, if we want) T'. Now suppose that the gas is unevenly distributed. By dividing the region into cells as before, we can calculate the distribution of the gas at time T'. We will observe that the gas becomes more evenly distributed during the interval (T,T'). But without a statistical understanding of the universe, we will have no idea *why* the gas should do this except that, given the initial setup of the system of molecules, this is how things played out. If we continue to observe the gas, we will notice that, for any time T* later than T, the gas will continue to become more evenly distributed. No

[40] Short, 125-126

matter how many times we observe this happening, we will not be able to explain this phenomenon *in general* until we have a statistical understanding of the world. Importantly, the statistical explanation that we need to make sense of this general behaviour relies on understanding that certain distributions (even ones) come about with higher probability than others because of the *type, or kind, of thing they are*. Even distributions are the kinds of states that are easier to achieve given any particular microstate. To really explain the general evolution of a gas, as the Second Law of Thermodynamics does, the explanation in question must make essential reference to non-mechanical principles--principles that do not merely relate token particulars to particulars, but which relate particulars (e.g. particular microstates) to general *types* (e.g. even distributions).

This kind of explanation made a great impression on Peirce. It seemed to him that such statistical accounts were related to the concept of evolution and growth to the extent that only they could explain these processes. Regular mechanical causation simply would not do. Peirce says:

> The law of the conservation of energy is equivalent to the proposition that all operations governed by mechanical laws are reversible; so that an immediate corollary from it is that growth is not explicable by those laws, even if they be not violated in the process of growth.[41]

Peirce is clear that such statistical accounts are directly related to the application of the Law of Large Numbers to physical phenomena:

> [The] kinetical theory would account, in a remarkably satisfactory way, for non conservative phenomena...by representing that they are results of chance; or, if you please, of the law of high numbers.[42]

[41] 6.14
[42] 7.221

It is important to keep these things in mind, since Peirce also says that the only satisfactory account of the laws of nature--that is, why they are what they are--is that they are the result of growth. According to what was just said, growth can only be accounted for by means of a statistical explanation involving the Law of Large Numbers. We shall see later the ways this can potentially create trouble for Peirce.

In addition to working as the explanation for the lawlike behaviour of such irreversible phenomena as the Second Law, Peirce believed that a really scientific metaphysics would have to view even the allegedly exact mechanical laws as at best highly regular but inexact uniformities themselves the result of chance occurrences. Peirce was convinced that in order to explain the immense variety in nature, the scientific metaphysician must postulate the existence of real "absolute chance" as being an operative force in the world. Recall how he says, for example, that when investigating the world according to the lights of his synechistic philosophy (including the principle of fallibilism), among the first traditionally believed propositions that must be thrown out is "the proposition that every event in the universe is precisely determined by causes according to inviolable law."[43] Instead, "we have no reason to believe this is absolutely exact. Experience shows that it is so to a wonderful degree of approximation, and that is all." Note that, whereas it might seem that Peirce is merely pointing to the effects of observation, that whenever a scientist goes to measure an effect in the world, she will inevitably discover there is some error in her measurement, this is too weak for Peirce's purposes. Immediately following the above quote, he says:

> We know that when we try to verify any law of nature by experiment, we always find discrepancies between the observations and the theory. These we rightly refer to errors of

[43] 1.402

> observation; but why may there not be similar aberrations due to the imperfect obedience of facts to law?[44]

Here Peirce raises the possibility that chance is operative in nature to the extent that even the mechanical laws of nature are not exact. He continues:

> We are brought, then, to this: conformity to law exists only with a limited range of events and even there is not perfect, for an element of pure spontaneity or lawless originality mingles, or at least must be supposed to mingle, with law everywhere. Moreover, conformity with law is a fact requiring to be explained; and since law in general cannot be explained by any law in particular, the explanation must consist in showing how law is developed out of pure chance, irregularity, and indeterminacy.[45]

And also in *Variety and Uniformity*:

> Uniformities are never absolutely exact, so that the variety of the universe is forever increasing. At the same time we hold that even these departures from law are subject to a certain law of probability, and that in the present state of the universe they are far too small to be detected by our observations...We therefore suppose that all law is the result of evolution, and to suppose this is to suppose it to be imperfect.[46]

Presumably, the "certain law of probability" Peirce speaks of here is Bernoulli's "law of high numbers" or the Law of Large Numbers, which he makes so much use of when analyzing uniformities broadly. What he seems to have in mind is the idea that, just as an even distribution of gas molecules in a fixed volume, or equilibrium state, inevitably results from the chance encounters of trillions of molecules, so the ultimate value of a law of nature results from a statistical variance within a possible range of values. A law of nature, say the law of gravity, which subsists between two objects may be subject to minute fluctuations, but the aberrations would be extremely slight and infrequent, so as to likely be unobservable to us, and the overall trend will be for these fluctuations

[44] *ibid*
[45] 1.407
[46] 6.91

to cancel out as the Law of Large Numbers would require so that the trend over time is for the possible range of values that the law could take will get increasingly narrow and, at the end of eternity, become exact.

Earlier, I said that Peirce appeals to indeterminacy in order to explain the evolution of the laws of nature because he thinks that the extreme variety of nature could not be explained without appealing to absolute chance. I think it is worth pausing briefly to see how strange this can sound given what has been said above concerning the explanatory role of the statistical mechanical account of gas laws. Among the things that the statistical account is supposed to provide is an explanation of the existence of growth, in particular irreversible processes. Peirce seems to identify this kind of growth with both chance and heterogeneous variety.[47] But in the example of the diffusion of gases above, the only growth present was a growth toward an even and (relatively) homogeneous distribution of particles. There is very little variety about it, but there is still a process of growth toward an end. Why is Peirce so insistent that we must postulate absolute chance in order to explain the world's variety?

I suspect that what Peirce intends his reader to understand is that although a purely mechanical account of the motions of individual molecules combined with a statistical understanding of particle distributions is enough to explain the growth toward an even distribution of gas particles in a container, such an account could not explain the uneven distribution that we started with. Only chance could do that. It *is* chance in one sense.[48] The world that we inhabit is much more like an unevenly distributed gas than it is like the even homogeneous macrostate at the end of our thought experiment above. Additionally, if we ever observe an *increase* in variety, which

[47] 6.613
[48] *ibid*

Peirce thinks we do, then this fact cannot be explained by purely mechanical law, even if we have the statistical account at our disposal, because the Law of Large Numbers works to produce general uniformities out of diverse phenomena not the other way around.

We should, then, be careful. What Peirce means by *growth* is not the mere fixating on a mean value determined by the Law of Large Numbers as in the tendency of a gas to achieve thermodynamic equilibrium. Instead, he has in mind the kind of growth involved in the production of novelty:

> All the evolution we know of proceeds from the vague to the definite. The indeterminate future becomes the irrevocable past. In Spencer's phrase the undifferentiated differentiates itself. The homogeneous puts on heterogeneity.[49]

The Law of Large Numbers and, as we will see, the Law of Habit are what produce irreversible and non-mechanical lawlike behaviour in the world, but the source of variety and novelty is due to chance. As laws of nature, along with anything else that evolves, are produced over time, "the chance divergences from law are perpetually acting to increase the variety of the world...so that the general result may be described as 'organized heterogeneity,' or, better, rationalized variety."[50]

The Law of Habit

In addition to analysing the evolution of the laws of nature in terms of a statistical account, Peirce gave a second, and it can seem, more fundamental account of the evolution of laws via the "Law of Habit". In what follows, it will be important to keep in mind that Peirce's philosophical

[49] 6.191
[50] 6.91

architectonic is an idealist one. Peirce called his metaphysics *objective idealism*, and there are several respects in which his philosophical starting points are going to seem odd, if not downright implausible, to the contemporary reader. I do not think very much rides on Peirce's idealism, since his arguments are interesting regardless, and the idealism involved does not affect the substance of the central question of this paper. Nevertheless, it is a good idea to flag it right away, because doing so will help make sense of the analogy that Peirce makes between the behaviour of physical phenomena such as laws of nature and the behavior of biological phenomena, including nerve cells, and the behaviour of mind generally construed.

In his 1892 essay, "The Law of Mind," Peirce set out to give an account of the "general law of mental action," which he would in that essay call *the law of mind* but in other places refer to as *the Law of Habit*, and sometimes *the law of association*. In the introduction to the essay, Peirce mentions that he had previously given an inkling of an account of his evolutionary cosmology in terms of his concept of *tychism*, which is the idea that absolute chance is operative in nature. He says:

> I have begun by showing that ***tychism*** must give birth to an evolutionary cosmology, in which all the regularities of nature and of mind are regarded as products of growth, and to a Schelling-fashioned idealism which holds matter to be mere specialized and partly deadened mind.[51]

Here we see a bit of Peirce's inclination toward idealism, which he is very forthright about. The theme of matter being "partly deadened" mind is a recurring one in Peirce's writings. Recall, for example, how Peirce identifies chance with *feeling*. As we will see more of later, Peirce wanted to identify the chance spontaneity of nature with this feeling and formulate an evolutionary account of nature whereby reality grows from a state of energetic and, one might even say, lively feelings into a

[51] 6.102 emphasis original

general, predictable, and regular system. Peirce thought the universe was already part of the way through this evolution, the familiar material world consisting in "merely mind hidebound with habits."[52] He is aware that he is likely to face objections to his idealism on the grounds that it is too anthropomorphic, but he is, as Reynolds says, "surprisingly candid" on this matter.[53] Peirce says that "every scientific explanation of a natural phenomenon is a hypothesis that there is something in nature to which the human reason is analogous."[54]

In any case, Peirce thinks he needs to give an independent analysis of his evolutionary cosmology--one from the perspective of psychology--and this notion coheres well with his overall pragmatist epistemology, which treats all inquiry, philosophical or otherwise, as analogous to scientific reasoning. What he appears to have in mind is the idea that, just as a scientific theory is regarded as more likely to be true--and less likely to be ad hoc-- if multiple lines of inquiry lead to the formulation of that theory, his account of evolutionary cosmology has more going for it if multiple independent lines of philosophical work lead back to it as a hypothesis to explain the results in those areas. Accordingly, he sets out to explain his concept of continuity in "The Law of Mind," and he thinks this idea will lead back to the notion of an evolutionary cosmology.

Peirce begins with the law of mind. Reynolds says that, "The law of mind is essentially Peirce's expression of the eighteenth-century English school of associationist psychology developed by Gay, Hartley, Berkeley, and Hume."[55] He notes further that Peirce came to identify the law of mind with the law of association, according to which individual ideas are generalized over time to form new ideas and, in particular, habits of thought. While the advances of modern neuroscience

[52] 6.158
[53] Reynolds 2002, 22
[54] 1.316
[55] Reynolds 2002, 51

were unknown at the time, Peirce and his contemporaries were aware of the fact that nerve cells could be trained to behave in specific ways by being repeatedly stimulated together, so that eventually the stimulation of one nerve cell or group of cells will propagate a signal to another group of cells with some regularity. The earlier associationists, while having no access to these biological facts, were aware that once several thoughts are brought together in the mind repeatedly, the mind begins to generalize them into one idea, so that when one of a group of thoughts is thought, or one instance of a kind of idea is thought, a general idea or group of associated ideas is called up. An easy example is basic mathematics. It does not take very long for a child to realize, upon being made aware of the fact that one apple and another always makes two apples and one orange and one orange always makes two oranges, that one of anything and one of anything else makes up two somethings. Likewise, it is very soon after learning that individual barking things with four legs and a fluffy tail are called dogs that children generalize this idea to the notion of a dog in the abstract.[56] It is this idea that the law of mind essentially involves habits that is so important for our purposes here.

Reynolds says that habit is just another expression for generalization for Peirce. And Peirce identifies generalization with the "spreading" of ideas or "feelings" as Peirce calls them.[57] But this is a mysterious way of cashing out what is going on. What exactly are habits supposed to be? Reynolds says, "In essence, a habit is just a tendency to behave on future occasions as on similar past ones."[58] This accords well with what Peirce says on the matter, given that his law of mind concerns the development and spreading of ideas via habits. For example, Peirce says:

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[56] Note that I am not intending to make any presumptions as to how this occurs or what the nature of such abstraction is.
[57] Reynolds 2002, 52 and 6.268. By "feelings" Peirce seems to mean something like very rudimentary ideas, whereas once these feelings are "welded together" they become more general ideas.
[58] Reynolds 2002, 53

> The one primary and fundamental law of mental actions consists in a tendency to generalization. Feeling tends to spread; connections between feelings awaken feelings; neighboring feelings become assimilated; *ideas are apt to reproduce themselves*. These are so many formulations of the one law of the growth of mind.[59]

Notice here the idea that the process of association involved in the generalization of these "feelings" or ideas contains two notions:

(1) that the ideas become fused together and generalized by some form of reproduction,

and,

(2) that this process may not be an exact one, since the ideas are only "apt" to reproduce.

This points to what Peirce has to say about the nature of habits more generally, that they are what facilitate the process of evolution from variety to uniformity.[60] But moreover, it points to something else: a universal tendency--a general Law of Habit formation. Peirce is aiming to show that there is a universal principle operative in the world that is analogous to the law of mind, or association. Given his objective idealism, these amount to fundamentally the same thing. Just as general ideas evolve out of the spreading of ideas in the mind via the law of mind, which makes it so that "feelings and ideas attach themselves in thought so as to form systems,"[61] so laws of nature develop out of the spreading of "ideas" in nature, as habits form between phenomena and "weld" them together into a system. Although Peirce does not usually use the terms *Law of Habit* and *law of mind* interchangeably within the same essay, a judicious sample of quotes ought to make it obvious that he means the same thing by the terms:

[59] 6.21 emphasis mine
[60] 6.97
[61] 7.467

> [T]he laws of the universe have been formed under a universal tendency of all things toward generalization and habit-taking.[62]

> Instead of supposing mind to be governed by blind mechanical law, [Peirce's synechism] supposes the one original law to be the recognized law of mind, the law of association, of which the laws of matter are regarded as mere special results.[63]

These passages refer explicitly to the law of mind as doing the work of bringing about the laws of nature. But in "A Guess at the Riddle", one of Peirce's most explicit discussions of the development of uniformities (e.g. laws) in nature, he puts the matter this way (quoting him at some length):

> Uniformities in the modes of action of things have come about by their taking habits...the tendency to obey laws has always been and always will be growing. We look back toward a point in the infinitely distant past when there was no law but mere indeterminacy; we look forward to a point in the infinitely distant future when there will be no indeterminacy or chance but a complete reign of law. But at any assignable date in the past, however early, there was already some tendency toward uniformity; and at any assignable date in the future there will be some slight aberrancy from law. Moreover, all things have a tendency to take habits. For atoms and their parts...and in short every conceivably real object, there is a greater probability of acting as on a former like occasion than otherwise...this tendency...is a generalizing tendency; it causes actions in the future to follow some generalization of past actions.[64]

This is none other than the law of mind applied to the universe as a whole, which given Peirce's objective idealism is not too surprising of a move for him to make. Notice here that Peirce is arguing for the evolutionary development of laws of nature out of a general tendency for regular behavior. This tendency is exactly analogous to--and indeed, if we accept the thesis of objective idealism, just is--the law of mental association, or the law of mind. It works by establishing habits, or tendencies, between phenomena through the spreading of ideas, in the case of ordinary mental

[62] 7.515
[63] 6.277
[64] 1.409

action, or through the chance correlations between physical events. This Law of Habit results in generalities and in uniform behaviours, which, ultimately, Peirce thinks, results in quasi-mechanical and, at the end of eternity, perfectly regular behaviours.

The above process is a general description of (1) that was mentioned earlier with respect to the law of mind, and it goes part way toward describing (2), since Peirce speaks of there being a greater *probability* of objects behaving on subsequent occasions as on former ones. Once we notice that the law of mind and the Law of Habit are fundamentally the same, we can see that the Law of Habit, as with the law of mind, is to be understood stochastically, as is evidenced from the following:

> The law of mind only makes a given feeling *more likely* to arise. It thus resembles the "non-conservative" forces of physics, such as viscosity and the like, which are due to statistical uniformities in the chance encounters of trillions of molecules.[65]

This passage influences Reynolds to comment that, "the law of mind sets up certain correlations between ideas."[66] And he points out that it is the fact that there are asymmetric correlations between these ideas that the Law of Habit is really irreversible even though the law is a statistical one. In other words, Reynolds claims that while both the Law of Large Numbers and the Law of Habit are statistical, and so *dynamically* reversible, whereas the Law of Large Numbers would not rule out the possibility that certain past states could come about again, the Law of Habit is supposed to make this impossible.[67] Reynolds follows David Dearmont's account of Peirce's Law of

[65] 6.23
[66] Reynolds 54
[67] This might happen if, for example, the ergodic hypothesis were true in microphysics, according to which all microstates of a particle system are equiprobable over a long enough duration of time. In that case, a dynamically reversible system could reproduce past states (or could come arbitrarily close to reproducing them), only this would happen *extremely* infrequently.

Habit, whom Reynolds says "models the Law of Habit with what amounts to a nonstationary Markov chain."[68] In his paper, *A Hint at Peirce's Empirical Evidence for Tychism*, Dearmont uses a computer model to analyze, as he understands it, Peirce's Law of Habit. Dearmont does this by recreating the experiment envisioned by Peirce in his essay "Design and Chance". We need not go into detail over Dearmont's computer model here. What matters is that as both Dearmont and Reynolds see Peirce's Law of Habit, that law involves "an updating of the transition probabilities among types of events consequent on their occurring together in sequence."[69] Reynolds spells out his understanding of this process in more detail while raising the worry of the "incompatibility problem," to which we now turn.

III. The Incompatibility Problem

With the above three sections in place, if I have succeeded in my explication, the reader is in a good position to notice the main problem. Reynolds begins his discussion of the incompatibility problem by guiding his reader toward understanding "the general effect that follows from the Law of Habit."[70] Here he makes the point mentioned above, that the Law of Habit is stochastic in nature and that it works to increase the probability, on any given occasion, that an object or type of phenomena will behave as it did previously. Reynolds and Dearmont interpret this to mean that the transition probabilities between event types as those types are exemplified sequentially through time. Reynolds says, "What the Law of Habit does, essentially, is to establish and strengthen correlations between events of certain general descriptions."[71] But this creates a problem.

[68] Reynolds 209 note 26
[69] Reynolds 162-163
[70] Reynolds 162
[71] Reynolds 163

According to what we saw above, Peirce wanted to be able to explain the evolution of the laws of nature in terms of Bernoulli's law of large numbers. If he cannot get some account according to which the laws evolve out of chance processes, Peirce thinks he will have failed to *explain* the laws of nature at all, since in order to explain a regularity (e.g. a law of nature) it is not sufficient to simply postulate an absolute fact determining it. That way lies a blockade to inquiry. Genuine explanations do not make brute appeals to ontologically basic regularities. Peirce must explain the evolution of regularities in terms of something which itself does not require an explanation, and this is, he thinks, chance. But chance will be able to do the trick, he thinks, because there are "laws" to chance: the Law of Large Numbers is one.[72]

Somehow, the Law of Large Numbers is supposed to accord with the Law of Habit. But, Reynolds objects, to say that the Law of Large Numbers applies is to require that the events or trials in question are both independent and identically distributed. Two events E1 and E2 are independent just in case the occurrence of either does not affect the probability of the occurrence of the other. And a series of events, E1, E2, …,EN are called identically distributed when the probability of each event in the series is constant, where this means that the probability Pr(E) of some event, E, occurring at time *t* is the same as Pr(E) at *t'*.[73]

Each of these conditions on the Law of Large Numbers is apparently contradicted by the Law of Habit. For the Law of Habit, as understood according to Dearmont and Reynolds, stipulates that the transition probabilities between events get updated over time so that the probability of event type E occurring at *t* is *not identical* to the probability of the same event type occurring at *t'*. The

[72] Note, however, that the "law" of large numbers is a formal result of mathematics. It is purely hypothetical (and not metaphysical) in that it does not make any commitments to any actually existing entities.
[73] Reynolds 163

Law of Habit will work to increase this probability with each occurrence. So much for an identical distribution of events.

The independence condition fares no better on this account. As Reynolds says, "The Law of Habit is precisely meant to establish regular causal connections between certain types of events."[74] The events in the series cannot properly be independent from one another if the occurrence of one type of event impacts its own later occurrence. And yet, it would seem, in order to explain how laws of nature evolve, there need to be correlations between event types. Otherwise, Reynolds says, there could be no regular causal relationships at all, nor could there be any true lawlike generalizations such as "all As are Bs".

Concisely, the incompatibility problem is this: Peirce attempts to analyze the evolution of the laws of nature out of "absolute chance" by making use of both the Law of Large Numbers--which requires the chance events to be independent and identically distributed--and also the Law of Habit, which works by establishing connections between phenomena, thereby making them dependent upon one another in sequence. These look like mutually unsatisfiable conditions.

Reynolds is quick to note that this is a strange state of affairs, since Peirce himself was very aware that the independence condition needs to hold in order for the Law of Large Numbers to make sense.[75] One possible way out of the problem for Peirce, Reynolds notes, is to say that he uses the word "chance" differently in different contexts: one mathematical and one metaphysical. But this seems like a highly implausible reading given that Peirce seems to think he is only using one

[74] *ibid*.
[75] See for example 1.351 and NEM, III, i, 400

term the whole time. He says, for example, "when I speak of chance, I only employ a mathematical term to express with accuracy the characteristics of freedom or spontaneity".[76]

To make matters even worse, Reynolds is perhaps the first commentator to notice that for Peirce's account of lawhood to make sense at the level of a population via the Law of Large Numbers, it has to already be assumed that the independent elements in the series whose joint actions determine a law are themselves already regular enough in their behaviour not to spontaneously change their natures or go out of existence. It is of no use to the statistician attempting to measure the overall trend of a fair coin if the coin sometimes comes up heads, sometimes tails, sometimes sideways, and sometimes spontaneously evaporates.[77] In order to fix the behaviour of the elements or event types so that the Law of Large Numbers can apply, Peirce needs to rely on the Law of Habit at the level of individual members (whatever they may be). He cannot just stipulate this regular behaviour, however. Otherwise Peirce's theory will run afoul of "blocking the road to inquiry" in precisely the way he thinks nominalism does, and his account of the evolution of laws will be self undermining by its own criteria.

[76] 6.201
[77] Reynolds 169-170

Chapter Two

Parting of the Sensory

What follows is an overview of Peirce's cosmology. Some of the ideas mentioned above involving continuity and chance will come into play. According to the relatively few scholars to focus on Peirce's cosmology, the account given here is, I think, fairly uncontroversial, even if it is odd sounding to the contemporary ear. A fair warning to the reader: Peirce's cosmology is sketchy and somewhat vague. It can seem unsavory to some folks to speculate seriously on a systematic metaphysics so thoroughly wedged within nineteenth century idealist fashions reminiscent (if not borrowed from or expanded upon) of Hegel and his ilk. This reservation is misplaced but understandable in light of contemporary fashions. Lest the reader be too worried, keep in mind that Peirce understood that his evolutionary cosmology sounded odd, and he developed what little he did regarding it because he thought that it could be presented in the form of a hypothesis that was capable of explaining the world we have and also that it could, at least in principle, be disproven.

Peirce thought that it was necessary to give an account of the origin of the universe in order to explain how laws and regularities in the universe came about. The project of metaphysics, he says, is to account for the whole universe of being, and in order to do this, the philosopher must assume a state antecedent to the existence of the universe.[78] The cosmology that follows, then, begins at a consideration of this state of pure nothingness before the universe existed. Peirce is emphatic that this state of nothingness is not a state of "abstract being" but a state of nothing at all whatsoever. He considers the "nothing of negation" to be an insufficient analysis of this state, because to say that

[78] 6.214

something is not-A is to logically presuppose A itself, and the state of the universe prior to any existing being cannot assume this:

> But this is not the nothing of negation. For *not* means *other than*, and *other* is merely a synonym of the ordinal numeral *second*. As such it implies a first; while the present pure zero [the state of nothingness being considered] is prior to every first.[79]

A quick note about some of Peirce's terminology: I have previously neglected to speak of Peirce's three categories, *Firstness*, *Secondness*, and *Thirdness*. A full analysis of his categorical system would require far more than this work could begin to hope to accomplish, and besides this, Peirce's categories are themselves somewhat oddly defined and used even by himself. He has the tendency to slip between several different definitions of the categories throughout his work that may or may not be equivalent. The categories are at once very useful and also somewhat obfuscatory depending on where and how Peirce employs them. Nevertheless, I will make reference to them as minimally as possible. Here is what the reader should know about them. The categories are intended to make sense of phenomenology, and they are best understood as relating to mental phenomena. They are, according to Peirce, fundamental and undeniable modes of cognizing the world. He thinks we are led to them through phenomenological inquiry and that each captures an aspect of our cognition required to make the world understandable and rational. Peirce identifies Firstness with possibility, quality, and spontaneity; Secondness with existence or brute fact, heccaeity, and the "here-nowness" of events and objects; and Thirdness with mediation, law (in the non-rigid statistical sense), tendency, disposition, habit, relationality, generality, and continuity.

Given this, it is important to take note of the fact that Peirce draws a distinction between *reality* and *existence*. Reality, for him, is what cannot be denied come what may. It consists in being

[79] 6.217

what an indefinite community of inquiring minds *would*, in the infinite long run, agree upon. The subjunctive is important here. It is not just whatever will actually get discovered in the future; it is what would get discovered if an indefinite amount of scientific inquiry were done. This definition falls directly out of Peirce's lifelong commitment to the pragmatic maxim of 1878, which says to "Consider what effects, that might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object."[80] I say it falls directly out, though it does not *obviously* do so. There is some question about what the "practical effects" are supposed to be, but there is general agreement that Peirce understood this to mean the upshot of scientific scrutiny, at least by the time he was working on his cosmology.[81]

Existence is a slightly different matter. Whereas reality is understood to be what cannot be denied, existence is a mode of being that meets both the condition of undeniability and also is such as to involve Secondness. Peirce often speaks of existing things as having a kind of resistance or hardness to them. Existence involves a thing being related to another thing so as to react with it. My office chair exists because I can *sit* in it. It's the kind of thing that I can bump up against. I cannot deny its reality *because* I cannot deny its *existence*. I cannot deny that it exists because it is related to me in a certain way--it resists me. There is a reaction I have with it. Reaction is precisely the mode of Secondness by Peirce's lights. Compare this with the mode of being that things like laws or real relations have. They are not best understood in terms of secondness but thirdness; you don't take a

[80] 5.388

[81] It appears that misunderstandings on this point due to William James and others were what led Peirce to change the name of "pragmatism" to "pragmaticism" which is "a name ugly enough to be secure from kidnappers" EP2: 335

walk in the woods and trip over a pile of laws, nor are you ever bumped into by the taller-than relation.[82]

When Peirce says, then, that the state of the universe prior to any existence is prior to any Firsts, what he means is twofold. First, the universe at this stage is a nothingness devoid even of qualities or possibilities, i.e. Firsts or things understandable in terms purely of Firstness, if we want to be careful. Second, since there are no Firsts, there can be no reactions between them, so the universe cannot properly be said to *exist* either. For clarity, it will help to get an idea of what Firstness is. In "The Universal Categories" Peirce describes his three categories of thought, and he talks about the category of Firstness as being "Quality of Feeling, or whatever is such as it is positively and regardless of aught else."[83] Later, in "Objective Logic", he identifies the world of Firstness with the realm of *qualia.* A First is a quale. It is a specific determination of a possible object of consciousness. "Each *quale* is in itself what it is for itself, without reference to any other."[84] In "The Logic of Continuity" Peirce also calls Firsts, or qualia, "sense-qualities", and he identifies them with real possibilities or potentialities.[85] It is a bit odd to make this move, since usually Peirce makes potentiality/possibility the realm of Thirdness. It will become clearer later why he makes this move, but for now, it is worth noting that Peirce believes all three categories are equally important and inextricably linked. As I understand it, the whole point of "The Architecture of Theories" and "Seven Systems of Metaphysics" is to show that only a world consisting of all three categories of thought can make sense of our phenomenology, and these three categories are not capable of being completely abstracted from one another. I will later suggest that Peirce may mean two things by

[82] Humorously, we do use language like this sometimes, however, as when someone says, "Her beauty was striking." But no one has ever said (except maybe in jest), "My Lord! Her beauty was striking. It broke my nose!"
[83] 5.44
[84] 6.224
[85] 6.198

"quality" or "First". We can think of them, on the one hand, as being like transcendent universals (perhaps they really *are* universals) which are never fully instantiated.[86] They are *potentialities* for their own instantiation. On the other hand, any specific instantiation of a universal/quality is also called a sense-quality, first, or quale. Now, back to the beginning of the universe.

Despite his insisting that the state of nothingness prior to the universe was not a state of mere "abstract being," Peirce says only a few paragraphs later that "of *potential* being there was in that initial state no lack."[87] He says that the nothing in question is not the "nothing of death" but the "nothing of not having been born...in which the whole universe is involved and foreshadowed."[88] The nothingness, or "nullity" involved is not merely simple negation, since negation implies something to be negated, but less than reality, since it is prior even to real qualitative possibilities (Firsts). This state Peirce identifies as being *in general*: "In the beginning was nullity, or absolute indetermination, which, considered as the possibility of all determination, is being."[89] He says in other places that "*pure being* is *blank nothingness*". Strictly speaking, Peirce says that we cannot conceive of this state of nullity, but we can still talk about it in a vague way.[90] He says that in the state of nullity, "there must then have been a tohu bohu of which nothing whatever affirmative or negative was true universally. There must have been, therefore, a little of everything conceivable."[91]

[86] For reasons having to do with his understanding of continuity, he would say they are essentially never fully instantiated.
[87] 6.217, emphasis original
[88] *ibid*
[89] 1.447
[90] 6.490
[91] *ibid*

The state of nullity prior to the creation of the universe, then, can be vaguely understood as a state of pure potentiality, wherein every possible qualitative possibility was undifferentiated.[92] It is a nothingness consisting of not only the absence of any existing thing, since there are no reactions, but even the absence of any determinate possibilities, where possibilities are understood as ways a thing might be i.e. qualities, properties, or relations. This realm of pure nullity is *the general possibility for possibilities*. As such, it is completely vague and indeterminate. What arises out of this state of nullity is a "cosmos of sense qualities" or qualitative possibilities, i.e. Firsts.[93] Peirce candidly refers to this resulting state as the world of forms:

> The evolution of forms begins, or at any rate, has for an early stage of it, a vague potentiality; and that *either is or is followed by* a continuum of forms having a multitude of dimensions too great for the individual dimensions to be distinct. It must be by a contraction of the vagueness of that potentiality of everything in general but of nothing in particular that the world of forms comes about.[94]

This passage is taken from the lecture "The Logic of Continuity" of 1898, and it is worth noting what Peirce means here by "continuum". For Peirce, a true continuum is prior to any of its parts. It is, therefore, impossible to construct a continuum out of separate elements. Peirce rejects the idea that any number of points, however large, could come to form the continuity involved in a straight line, for example.[95] For him, a point on a line is secondary to the line itself, which forms a true continuum, since its number of *possible* points exceeds any given cardinality. With this in mind, we can see that in the passage above, Peirce is saying that the "world of forms" comprises a continuum much in the way that the points on a line do; that is, there are possible designations but

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[92] 6.139
[93] 6.197
[94] RLT, 258. Italics added.
[95] See RLT, Chapter Eight, and RLT, *Introduction: The Consequences of Mathematics*, especially pp. 37-54 by Ketner and Putnam. Also see *Philosophy of Mathematics: Selected Writings (Moore, 2010), 193 (On Multitudes)* and 207-210 (*The Bed-Rock beneath Pragmaticism)*

prior to their being designated they are not differentiated from one another. I suggest that this continuum of possible "forms", or qualitative possibilities, is itself just the "tohu bohu" or nullity spoken of above. Just as in a continuous line the points are indistinct and vague so as to be welded together and not individuated so that they cannot be said to exist (in Peirce's sense), so the continuum of qualities, or world of forms, is a continuity prior to the determination of any possible given quality.

Notice, however, that in the passage above, Peirce is describing how the world of forms *itself* comes about, so there is some clarification to be made here. He says that the vague potentiality (nullity) "either is or is followed by a continuum of forms." This passage is one of several in which Peirce slips between talking about the state of nullity and what he calls the primeval chaos. In some places, Peirce implies that the state of nothingness just *is* the primeval chaos, for instance when he says, "The chaos is a state of intensest feeling [Peirce identifies qualities with feelings], although, memory and habit being totally absent, it is sheer nothing still."[96] And he says in "Man's Glassy Essence" that "[The] primeval chaos in which there was no regularity was mere nothing...Yet it was not a blank zero; for there was an intensity of consciousness there…."[97] In other passages, Peirce seems to identify nullity with the world of forms only insofar as that world is potential. That is, he seems to leave room for entirely different worlds of forms coming about. He says, for example:

> I do not mean that potentiality immediately results in actuality...but what immediately resulted was that unbounded potentiality [the state of nothingness] became potentiality of this or that sort--that is, of some *quality*.

[96] 6.612

[97] 6.265. What Peirce means by "consciousness" is simply pure qualities or firsts, which he thinks of as involving *sentience*. It is unlikely that he intended to mean any sort of self-reflexive or intensional sense of consciousness. 6.221

> Thus the zero of bare possibility, by evolutionary logic, leapt into a *unit* of some quality.[98]

And,

> The very first and most fundamental element that we have to assume is a Freedom, or Chance, or Spontaneity, by virtue of which the general vague nothing-in-particular-ness that *preceded* the chaos took a thousand definite qualities.[99]

It is not clear if these passages are really contradicting each other, since it is not obvious that the "blank zero" of 6.265 is intended to be the same thing as the "zero of bare possibility" of 6.220, although the last passage does certainly seem to favor the reading that nullity is a state prior to the world of forms. However, it is pretty clear that Peirce only conceived of the state of nothingness as a hypothetical ideal state that we have to postulate in order to explain the emergence of law in the universe and that this state is prior to time.[100] I suggest that Peirce means two different things by the "nothing" of the early universe. First is the nothing involved in the *possibility* of a world of forms, i.e. a realm of eternal qualities or "eternal possibilities"[101] and second is the nothing involved in considering the realm of qualities itself, which being a world of Firsts cannot be said to *exist* and is in that sense "nothing". In any case, it does not seem to me that this issue impacts my interpretation of the law of habit.

One thing that should be flagged now, however, is that whatever the state of nothingness is, Peirce is emphatic that it involves real potentiality. The sense in which nothingness makes it possible for qualitative possibilities to be differentiated from the continuum (whatever it is) is one that

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[98] 6.220
[99] 6.200 emphasis added
[100] "I am inclined to think (though I admit that there is no necessity of taking that view) that the process of creation has been going on for an infinite time in the past, and further, during *all* past time, and further, that past time had no definite beginning, yet came about by a process which in a generalized sense, of which we cannot *easily* get much idea, was a development." (6.506) Also, see 6.200.
[101] *ibid*

involves some metaphysical, not merely logical, sense of possibility.[102] Peirce says that "the word 'potential' means *indeterminate yet capable of determination in any special case*,"[103] and he is clear in several places that the "logic of freedom, or potentiality, is that it shall annul itself. For if it does not annul itself, it remain a completely idle and do-nothing potentiality; and a completely idle potentiality is annulled by its complete idleness."[104] There is some sense in which the nullity prior to the existing universe (and perhaps the cosmos of qualities) consists in a tendency for a realization, though not a realization of any *particular* kind.[105]

Out of the state of nothingness arises a world of pure qualities, or Firsts, in the form of real potentialities or possibilities. These arise by chance, in the sense that nothing determines that this or that quality will arise, but Peirce thinks that *something* must arise out of the state of nothingness, because, the nothingness being wholly vague, has nothing to prevent the coming into reality of any given "form"or real quality. Speaking of this, Peirce says:

> We can hardly but suppose that those sense-qualities that we now experience, colors, odors, sounds, feelings of every description, loves, griefs, surprise, are but the relics of an ancient ruined continuum of qualities, like a few columns standing here and there in testimony that here some old-word forum with its basilica and temples had once made a magnificent *ensemble*. And just as that forum, before it was actually built, had had a vague under-existence in the mind of him who planned its construction, so too the cosmos of sense qualities...had in an antecedent stage of development a vaguer being, before the relations of its dimensions became definite and contracted.[106]

[102] Peirce would not put it this way because of his sense of the word "logic", but by logical possibility I here mean the contemporary sense.
[103] RLT, 247
[104] 6.219.
[105] It should be relatively clear that if it were a tendency for a specific kind then it would be a generality consisting in an ultimate primitive, which is exactly what Peirce is trying to avoid.
[106] 6.197 emphasis original

Here we can see the emergence of a world of forms out of the vague nothingness that Peirce talks about. In another passage, he says that the process whereby the indefinite possibility of qualities springs into reality took the form of a hypothetic inference of the form:

> Something is possible,
> Red is something;
> [therefore,] Red is possible.[107]

We are forced to attempt to understand this process as being prior to time, since Peirce explicitly says that it is a logical and not temporal "process".[108] In any case, Peirce thinks of this first emergence from the general state of "nothing-in-particular-ness" involves a springing up of a continuum of qualities, which are "mere potentialities"[109] or "mere eternal possibilities."[110] As Paul Forster puts it, "The first stage in the evolution of being, according to Peirce, is the development of more or less definite qualities or dimensions along which things might possibly vary or be distinguished."[111] Peirce tells us that this continuum of qualitative possibilities comes about by chance or spontaneity.[112] But this continuum of qualities is not such that it was created by this or that quality springing into existence by chance and then coming into relation afterward. Instead, Peirce tells us that "The general indefinite potentiality became limited and heterogeneous,"[113] so that the qualities "spring up in reaction upon one another".[114] By doing so, they spring into a "kind of

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[107] 6.220
[108] 6.200
[109] 6.343, 1.422
[110] RLT, 260
[111] Forster, 190
[112] "Such a definite potentiality can emerge from the indefinite potentiality only by its own vital Firstness, and spontaneity. Here is this magenta color. What originally made such a quality of feeling possible? Evidently nothing but itself. It is a First." (RLT, 259)
[113] RLT, 259
[114] *ibid*

existence".[115] This can seem to be at odds with what was said earlier about the difference between reality and existence, especially if Peirce says in one place that the world of forms is real but does not exist, whereas now he is saying that it does exist. It is telling, however, that Peirce says the qualities come into a *kind* of existence. He says in the same paper, "We shall naturally suppose, of course, that existence is a stage of evolution. *This existence* is presumably but a *special* existence."[116] It looks like what he might have in mind is that existence is not univocal.[117] It comes in various kinds and degrees.[118] This is further evidenced by his claims that, "the existing universe...is an offshoot from, or an arbitrary determination of, a world of ideas, a Platonic world,"[119] and "if we are going to regard the universe as a result of evolution at all, we must think that not merely the existing universe, that locus in *the cosmos* to which *our reactions are limited*, but the whole Platonic world, which in itself is equally real, is evolutionary in its origin too."[120]

I have emphasized two points of this last quote. First, Peirce speaks of the cosmos as if it were one thing of which our existing universe is a mere part. Second, he suggests that our actual universe is just a small subset of the real existing cosmos, which involves reactions between various qualities. This supports a reading according to which reactions between qualities in the actual universe are limited, but the whole world of forms should be understood as continually reacting against itself. This is further evidenced by his claim that, "We need not suppose that every form needs for its evolution to emerge into this world, but only that it needs to enter into *some* theatre of

[115] RTL, 259
[116] 6.195, emphasis original
[117] He even says as much in 1.433
[118] Indeed, Peirce says in 1.175: "There is no difficulty in conceiving of existence as a matter of degree...in the original chaos, where there was no regularity, there was no existence. It was all a confused dream...but things are getting more regular, more persistent, they are getting less dreamy and more real."
[119] 6.192
[120] 6.200, emphasis added

reactions, of which this is one."[121] This should not be understood to undermine Peirce's claim that the qualities that comprise the world of forms are any less general or potential in their nature. They are still real eternal possibilities, according to him, even though the cosmos that they comprise now "exists" as they react against one another. This certainly seems a bit obscure, but I suggest that this is why Peirce draws a distinction (at least implicitly, given his consistent use of the terms) between a quality's being *differentiated* from the continuum and its being *determined*. As he uses the terms, for a quality to be differentiated from the continuum is just for it to be possible that there can be determinations of that quality alone, where a determination of that quality involves a specific picking out of it, much like the designation of a point on a line, which occurs when that quality interacts with another. The nothingness prior to the world of forms is not even differentiated; it is possible that there are possible qualities, but even those are indistinct as definite possibilities. Once the "vagueness" of the nothingness "contracts" (as Peirce says), the world of forms is brought about, which consists in a totality of definite possible qualities. These definite qualities can interact, but we shouldn't think of them as interacting all at once, so to speak. For any given quality, Peirce thinks there are a non-denumerable number of instances that quality could take; it is not as though, when the qualities react, every possible instance of their potential being are reacting or related. The qualities are only partially determinate.[122] It looks like Peirce is suggesting that when the world of forms comes about, it automatically does so by various qualities reacting in partial ways. Otherwise, he says, they could not be united into a continuum.[123] Peirce clearly states that in and of themselves, the qualities are "mere eternal possibilities" but that the reactions between qualities should be thought of as (non-temporal) events.[124] These qualities and events spring up together, and in order

[121] 6.195, emphasis original. Also, see 1.433, in which Peirce suggests that there could be multiple existing worlds with "spaces and times of their own".
[122] See 1.434
[123] 6.199
[124] 6.200

for the universe to grow and evolve, chance determinations of the qualities must be constantly arising.[125] Although Peirce does not say it this way explicitly, I suggest that for Peirce, the partial determination of a quality as it reacts with another is just what contemporary philosophers would call property instantiation.[126]

Once chance determinations of qualities begin, Peirce says that in order for them to not go out of existence, they must acquire habits. Habits, he thinks, are generalizing tendencies for various property instantiations to go together. Moreover, since the process of qualities coming into relation or reaction against one another is a chance affair, without a principle of habit, there would be nothing to keep these existences around. Peirce likens the reactive coming into relation of qualities to "a flash".[127] This flash of an existence is a chance coming to be of a reaction between two qualities. But if it does not have with it a tendency to stick around so as to be able to interact with further chance existences, then it will simply go out of existence.[128] In "The Logic of Continuity" Peirce makes an analogy to the birth of the cosmos by using a blackboard to represent the continuum of possibilities.[129] Drawing a line on the blackboard, Peirce says that the white chalk line (which he subsequently notes is actually an oval) represents the chance determination of a possible quality. The white chalk line is a continuity itself, and it gets its continuity from the continuum prior to it, the blackboard on which it was drawn. Peirce notes that there is now a discontinuity in the

[125] Peirce probably does not intend to imply that it is logically impossible for the qualities to spring up in isolation, only that since our actual world involves a genuine continuity of qualities, they did not do so.
[126] If this is right, then Peirce subscribes to a bundle theory of properties, where properties are bundles of instantiated universals (i.e. determinations of qualities) bound together by habits or tendencies. At the very least, this is what he thinks substances are. See 1.414
[127] 1.412
[128] This is a little easier to think about if we consider the state of the universe prior to time.
[129] He is unclear as to whether he intends the chalk board to represent the original state of nullity or the world of forms insofar as it is prior to any determination within it: "The blackboard is a continuum of possible points; while [what it represents] is a continuum of possible dimensions of quality, or is a continuum of possible dimensions of a continuum of possible dimensions of quality, or something of that sort." (6.203)

continuum between the blackboard itself and the chalk. This is the boundary region between the white of the chalk and the black of the board. He says:

> [T]he discontinuity can only be produced upon that blackboard by the reaction between two continuous surfaces into which it is separated, the white surface and the black surface. The whiteness is a Firstness--a springing up of something new. But the boundary between the black and white is neither black, nor white, nor neither, nor both. It is the pairedness of the two. It is for the white the active Secondness of the black; for the black the active Secondness of the white.[130]

This "pairedness" or discontinuity in the continuum is a flash of existence--a brute reaction between qualities. But Peirce says that the line is a mere accident, and only if the white chalk has a tendency to stay around for a while will it be possible for it to interact with further lines. He proceeds to draw further lines, and notes how a new line can be formed by drawing intersecting lines tangentially to one another (the points where the lines intersect together form a new curved line, and eventually an elliptical shape). This process whereby some reactions between qualities tend to stick around and interact with further qualities or reactions is what constitutes a habit for those qualities. Peirce says that we can come to see that the individual lines, or "flashes" of existence, will slowly lose their individual identity as they interact and are subsumed into the new line.

Peirce is convinced that the world is chock full of habits, and part of the reason he thinks this is because, according to him, the existence of real objects consists in their having regular behaviors.[131] To this extent, even the first stages of evolution wherein qualities are reacting cannot

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[130] *ibid*

[131] 1.411: "The existence of things consists in their regular behavior. If an atom had no regular attractions and repulsions, if its mass was at one instant nothing, at another a ton, at another a negative quantity...such a disjointed plurality of phenomena would not make up any existing thing."

be said to really exist unless there are habits or tendencies for regular behavior present.[132] But once habits are present, the world comes into proper existence, and it is possible for systems of reacting qualities to be produced and to evolve over time. This evolution would be driven by the various habits or tendencies of objects to behave regularly in conjunction with the general tendency of the universe to produce habits. This latter tendency is what Peirce calls the law of habit. The law of habit, being itself a tendency, must be such as to increase its own power over time, he thinks.[133]

From the law of habit, which he suggests started as a chance offshoot of the primeval chaos as a "germ" of lawfulness[134], Peirce thinks all the laws of nature will eventually evolve. In "A Guess at the Riddle", Peirce suggests that all the laws of nature evolved out of habits, which have been strengthened over time by the law of habit itself. I will have much more to say about this process in the next chapter. We should be careful here to note, as we did earlier, that Peirce sometimes slips between two senses of "law". Strictly speaking, Peirce does not think the laws of physics are exact, even though he says such things as, "the laws of physics know nothing of tendencies or probabilities; whatever they require at all they require absolutely and without fail, and they are never disobeyed."[135] In the passage from which that quote is taken, Peirce is referring to the mathematical understanding of laws of nature, assuming that they are, in fact, precise. But on numerous occasions, he says that we have no good reason to think the laws of nature are presently exact in this way. According to him, the laws of nature evolved over time by the principle of habit-taking, or as a

[132] Plausibly, this state of things is what Peirce refers to as the primeval chaos, although, as noted above, he slips between two different uses of this term. In 1.411, he says that the original chaos was such as to have no regularity so that "nothing existed or really happened."
[133] 1.409, 1.412, 6.612
[134] 6.612, 7.521, 6.317, 1.409
[135] 1.390

result of the law of habit.[136] He further suggests that the laws of nature essentially involve regularities of underlying phenomena such as substances, which themselves come about by habit-formation:

> [In the early universe] pairs of states will also begin to take habits, and thus each state having different habits with reference to the different other states will give rise to bundles of habits, which will be substances. Some of these states will chance to take habits of persistencey, and will get to be less and less liable to disappear; while those that fail to take such habits will fall out of existence. Thus, substances will get to be permanent.
>
> In fact, habits, from the mode of their formulation, necessarily consist in the permanence of some relation, and therefore, on this theory, each law of nature would consist in some permanence, such as permanence of mass, momentum, and energy.[137]

Peirce may wish to identify laws of nature with real powers or dispositions that result from phenomena taking habits or possessing tendencies toward definite regular behavior, a fact which gains additional support from his analysis of the role of chance in the production of uniformities as he discusses in his lecture "Causation and Force."[138] Here he says that although he has said that a uniformity "or regular law" can result from a "fortuitous distribution", this uniformity can only arise if there are already regularities in whatever phenomena the uniformity or law is a uniformity of:

> Take, for example, Boyle's law that if the density of a gas is doubled its pressure will be exactly doubled. This is because if there are twice as many molecules in the space, twice as many in a given time will pound upon the wall of the receptacle. But this results not from fortuitous distribution alone, but from fortuitous distribution conjoined with the circumstance that the paths of the molecules are all very nearly rectilinear...Now this is something which, being true of *all* the molecules, is a regularity. The simplicity of the law is due to the simplicity of this regularity.[139]

[136] 1.402, 6.101, 6.317
[137] 1.414-15
[138] RLT, 210-211
[139] RLT, 211

Peirce goes on to say that "law begets law; and chance begets chance," so that laws of nature must come about by being statistical combinations of underlying regularities. These regularities he speaks of are, I think, just the various habits that chance instantiations of qualities eventually take.

Unfortunately, in the major passages wherein Peirce explains his cosmology, such as "A Guess at the Riddle", "The Logic of Continuity", and "The Logic of Events", he leaves much to be desired with respect to explaining exactly how it is that habits themselves are formed or evolved out of either the continuum of nullity or the world of forms. He hints that his law of habit is the explanation, but all this appears to amount to is the claim that once qualities are differentiated from the continuum, and once those qualities begin to interact, there will be a tendency toward "habit-taking" for various events or instantiations of qualities and that things will begin to become regular, even though there will be many chance departures from the regularities. In "The Logic of Continuity" where Peirce illustrates his evolutionary cosmology with the analogy of the blackboard, he says that only once things begin to take habits can they stick around and interact and so really exist. These habits give chance occurrences an "incipient staying quality, some tendency toward consistency". Furthermore,

> This habit is a generalizing tendency, and as such a generalization, and as such a general, and as such a continuum or continuity. It must have its origin in the original continuity which is inherent in potentiality. Continuity, as generality, is inherent in potentiality, which is essentially general.[140]

Somehow or other, habits must spring from the original continuum as well, and once they do, the tendency for the universe to take habits will, along with chance occurrences, go on to

[140] 6.205

produce new habits and, eventually, laws of nature.[141] But exactly how this process is to occur Peirce leaves to the reader to glean from other writings, and even then he only gives hints. We will return to this in the next chapter.

[141] 6.206-209

Chapter Three

A Magnificent Ensemble

In the first chapter we saw that there is a tension between the Law of Large Numbers and the law of habit in Peirce's account of evolutionary cosmology and more specifically his account of the evolution of laws of nature. The problem is that laws of nature are supposed to evolve out of pure chance and so must involve the Law of Large Numbers, which, being a formal mathematical result, does not presuppose lawhood or regularity; at the same time, laws are supposed to develop by taking habits, which work to connect types of events together in a way that violates the conditions of independence and identical distribution required for the Law of Large Numbers to work. Andrew Reynolds calls this tension the "incompatibility problem".

We also saw that Reynolds raises another problem: that for the Law of Large Numbers to work in the first place, the objects going into the calculation have to be somewhat stable.[142] If I flip a coin, I expect it to come up either heads or tails. I don't expect it to turn into a puddle of coffee spontaneously. It appears, then, that Peirce must assume the very regularities he is trying to explain when making use of the Law of Large Numbers as an explanation of the regularities we find in nature, including laws.

I believe these problems are solvable for Peirce. The solution requires taking a different interpretation of the law of habit than Reynolds takes. As mentioned earlier, Reynolds, following Dearmont, suggests that Peirce intended the law of habit to function as a non-stationary Markov chain where the transition probabilities between event types get updated over time. This reading of

[142] I use "objects" loosely, and in the general sense, here to refer to whatever token instances of some type are involved.

the law of habit is a very natural one, especially given the passage Reynolds (and Dearmont) appeals to as the basis for it:

> [A]ll things have a tendency to take habits. For atoms and their parts, molecules, and groups of molecules, and in short every conceivable real object, there is a greater probability of acting on a former like occasion than otherwise.[143]

If this passage is taken alone to be the key to elucidating the law of habit, then there is a serious risk of misapplying the role the law of habit is supposed to play in Peirce's cosmology, which I argue is mostly explanatory. Specifically, while it is true that the law of habit will turn out to be an operative principle at every level of nature, I hold that the reason Peirce postulates it is first and foremost to explain the emergence of law and regularity in the universe *in general* rather than to explain the various stabilities of atoms, molecules, and the like. The stability of these phenomena is a correlative consequence of the application of the law at a much more universal description. In other words, whereas Reynolds and Dearmont make the case that the role of the law of habit is to establish correlations between various types of phenomena in nature, I hold that Peirce need not be committed to this, and that he can appeal to the law of habit to explain why the universe contains certain kinds or types of habits or tendencies in the first place, as opposed to others. In conjunction with Peirce's thesis of tychism and his definition of existence, which has a special meaning for him according to which a thing can only properly be said to exist when it is in relation to something else, the law of habit gives us what we need to understand *why* it is true that there is a "greater probability of acting as on a former like occasion than otherwise" for any given phenomenon without acting like some mysterious force that updates the transition probabilities between event types when those types are instantiated.

[143] 1.409

Here's the plan for the rest of the chapter.

I will suggest an interpretation of the law of habit which involves the following notions.

(1) The universe contains tendencies, or what contemporary metaphysicians call dispositional properties as a basic ingredient.

(2) These properties can be understood statistically--they can combine with each other to form further tendencies which are themselves understandable statistically, and existing objects just consist in bundles of dispositional properties.

(3) Dispositional properties (or tendencies or habits, etc.) are understandable in terms of limit frequencies given by the Law of Large Numbers such that tendencies just are the statistical uniformities that *would* result given an indefinite application of the Law of Large Numbers to instantiations of the tendencies themselves.

And finally,

(4) the law of habit is itself a tendency (Peirce says as much) understandable in terms of the above criteria. This last point opens up room for explaining what it means for the law of habit to be operative at a universal scale. It also, conveniently, provides an explanation for why event types of the kind Reynolds mentions remain stable over time (so that we do not get problems such as dice spontaneously disappearing when we flip them).

After this, I will provide a summary of Peirce's cosmology in light of my interpretation, and I will return to the incompatibility problem in order to make it clear how the above interpretation solves it. We will also take a look at the other problem regarding the stability of properties over time.

I. An Interpretation

The overview of the cosmology given in the second chapter is, I think, relatively standard fare, at least among the small number of scholars who study it. I have tried very hard not to say anything in the above section that would be too contentious--that is, given what Peirce himself says, which is contentious enough by itself. But as noted already, it is an unfortunate fact of Peirce's writing on these topics that he never in one place gives a very satisfactory account of the nature of habits, the tendency to take habits (the law of habit), or the production (differentiation?) of habits out of the original continuum of nullity. To be sure, he seems to think his ideas are obviously contained in such works as "The Law of Mind", "The Laws of Nature", and "Habits", but it is, after all, not so easy as this. This is partly due to the way that Peirce draws together various ideas from psychology, physics, mathematics, logic, and chemistry to talk about these issues.[144] In his mind, he is revealing an overarching principle, but it is often confusing and leaves the reader somewhat lost. Just when things get interesting in a physical case, for example, he will start talking about psychology and protoplasm, leaving it to the reader to work out the physical details by analogy, something that is difficult if not impossible to do without all the resources Peirce himself had.

In light of this, I will try for an interpretation that strings together various hints and glimmers from both the texts we have seen thus far as well as from additional manuscripts.

[144] Here is a humorous quote that I think illustrates Peirce's general methodology when it comes to writing, 1.217: "I fear I may be producing the impression of talking at random. It is that I wish the reader to "catch on" to my conception, my point of view; and just as one cannot make a man see that a thing is red, or is beautiful, or is touching, by describing redness, beauty, or pathos, but can only point to something else that is red, beautiful, or pathetic and say, 'Look here too for something like that there,' so if the reader has not been in the habit of conceiving ideas as I conceive them, I can only cast a sort of dragnet into his experience and hope that it may fish up some instance in which he shall have had a similar conception." This pretty well illustrates three things: 1) Peirce is often very unclear, 2) he knows it, and 3) his sentences are often paragraph length.

Fortunately, Peirce gives little nuggets here and there which will, I think, be quite useful in this endeavor.

Here are the important claims that I will make:

(1) Peirce identifies (or should identify) tendencies with statistical uniformities that would obtain in the indefinite long run.

(2) What Peirce means by "habits" are much like the dispositional properties of contemporary metaphysics. As such, they are like qualities that can arise by chance out of the continuum. The difference is that they require actual instantiations of qualities in order to apply to anything.

(3) The Law of Large Numbers is a purely formal law, and its role in Peirce's metaphysics is to make *understandable* the nature of a tendency, not to produce one. It tells us what a tendency is if we were to measure instances where that tendency is operative.

(4) The law of habit, being a tendency, need not be intended to explain how tendencies themselves either arise or get strengthened. It is intended to explain why certain tendencies stick around and others do not. It explains why the world, as a whole, is regular. In a certain respect, the Law of Habit just *is* the Law of Large Numbers applied to the various property instantiations in the universe as a whole.

Before going on, let's summarize what has been said about the cosmology so far. First, Peirce postulates that in the beginning there was a state of nullity that had its being only potentially. This state was a kind of pure potentiality consisting of all possible determinations of quality before such qualities were even differentiated as distinct possibilities. This potentiality, furthermore, required that something, but nothing specifically, arise out of it--namely some realm of qualities

would have to be produced, or else it would not be a real potentiality. There is some sense in which the state of nullity is like a massive tendency itself, but if so it is simply the tendency for *something in general* not any particular thing or collection of things. Out of this state of nullity arises a realm of qualities, which are real possibilities capable of determination in particular cases. These qualities interact against one another by chance, and these interactions form a collection of distinct existences. Eventually, habits are formed between existences so that they stick around and can evolve. This last stage, or some subsequent similar process, marks the coming into existence of the actual world. The actual world continues to evolve as chance qualities are differentiated and instantiated over time; qualities interact, and tendencies between qualities compete so as to make probable or improbable further higher order tendencies or bundles of habits. The laws of nature grow and evolve as relations between tendencies or habits.

Let's begin with the first point above. This section is intended to make a little clearer what habits are and how they go about producing regularities. Here is a suggestion: I maintain that Peirce either thought that habits are or are understandable in terms of statistical uniformities that would arise in the long run. That is, they are statistical uniformities of the various instantiations over which they range. Suppose, for example, that there is a habit or tendency for some quality, say red, to go together with some other, circularity, for example. Then the habit consists in the statistical uniformity that would result in the long run if compresent instantiations of these properties were randomly measured. There is some textual evidence to back this up. In "Notes on The Doctrine of Chances", Peirce discusses his notion of probability, and he uses the example of a die having a one-third probability of coming up on a number divisible by three. He tells us that to say that a die really has such a probability of doing so, is to think that the die has a certain habit or tendency for this behavior.

I am, then, to define the meanings of the statement that the **probability**, that if a die be thrown from a dice box it will turn up a number divisible by three, is one-third. The statement means that the die has a certain "would-be"; and to say that a die has a "would-be" is to say that it has a property, quite analogous to any **habit** that a man might have. Only the "would-be" of the die is presumably as much simpler and more definite than the man's habit as the die's homogeneous composition and cubical shape is simpler than the nature of the man's nervous system and soul. And just as it would be necessary, in order to define a man's habit, to describe how it would lead him to behave and upon what sort of occasion--albeit this statement would by no means imply that the habit **consists** in that action--so to define the die's "would-be," it is necessary to say how it would lead the die to behave on an occasion that would bring out the full consequence of the "would-be"; and this statement will not of itself imply that the "would-be" of the die **consists** in such behavior.[145]

I have quoted Peirce at length because there are several important things to recognize about this passage. In the first place, Peirce is telling us that a die's behavior is governed by a habit, which is statistical in nature. Second, he means to make clear that the habit itself cannot consist in the sum total of what the die *actually* does. The "would-be" of the die involves how the die would behave in the long run, but it cannot be made up of any actual number of throws. This notion is close to the heart of Peirce's theory of generality itself; he thinks that what is possible far outstrips what ever could be actualized. And since a tendency or habit is a real potentiality, the "would-be" of the die cannot simply consist in its actual behavior. However, it can be *defined* by its behavior:

> To get back, then, to the die and its habit--it's "would-be"--I really know of no other way of *defining* a habit than by describing the kind of behavior in which the habit becomes actualized. So I am obliged to define the statement that there is a probability of one-third that the die when thrown will turn up either a three or a six by stating how the numbers will run when the die is thrown.[146]

What, then, constitutes a habit? Here Peirce gives a brief thought experiment. He says that we cannot come to know for absolute certain that the die has a particular character after an endless series of throws, because we can imagine a situation in which we run an endless experiment that gets

[145] 2.664, emphasis original
[146] 2.666, emphasis added

interrupted and resumed wherein whenever we roll the die it comes up a six, but during the time of interruption, when some friends have it, it behaves just like an ordinary die. What he says next, however, is quite revealing:

> I say it **might**, in the sense that it would not violate the principle of contradiction if it did. It sanely **would not**, however, unless a miracle were performed; and moreover if such a miracle **were** worked, I should say...that during this experimental series of throws, the die took on an abnormal, a miraculous, habit. For I should think that the performance of a certain line of behavior, throughout an endless succession of occasions, without exception, very decidedly **constituted** a habit.[147]

Notice that Peirce thinks either kind of behavior--whether the die turned up a six every time indefinitely, or whether it behaved like an ordinary die--counts as a habit. This suggests that when he says that perfectly regular behavior "decidedly constitute[s]" a habit, we should understand this as a sufficient but not necessary condition. For otherwise, we will have to give an account of what it means for a die to behave in the ordinary way, which is statistical, throughout an "endless succession of occasions, without exception". It's not clear what it would mean for a die to come up six with a probability one-sixth "without exception", unless all that is meant by this is that such is the statistical uniformity that would result in the indefinite long run. If that is what is intended, all the better for my interpretation, however.

Nevertheless, I think if we look to a few other sources, we can gather together enough evidence that habits just are statistical uniformities that would hold true in the long run. Consider, for example, that Peirce says that laws of nature are "prognostic generalizations of observations".[148] They are generalities, and so involve possible instantiations that exceed any possible multitude of

[147] 2.667, emphasis original
[148] EP2, 68

instances.[149] That is, a law of nature concerns not just what will be the case but what would be the case; it is a "would-be" and so a habit. In "Design and Chance," Peirce says that he supposes all the laws of nature to be "statistical results":

> Now when we take into account that feature of chance which I have been bringing to your notice, we find that this agent, although it can only work upon the basis of some law or uniformity, or more or less definite ratio toward uniformity, has the property of being able to produce uniformities far more strict than those from which it works.
>
> It is therefore possible to suppose that not only the laws of chemistry but other known laws of matter are statistical results.[150]

And later in the same work:

> [T]he formation of habits could be accounted for by the principles of probability,

Finally, we have an interesting clue given in the plan for a lecture:

> The law of high numbers. Important consequences of certain numbers being large in different branches of science; such as political economy, theory of gasses, physiology, doctrine of natural selection, *and wherever there is a tendency toward an end.*[151]

One might object that this does not prove my case but at best shows that *some* habits are statistical, since the evidence given this far shows that being a law of nature is sufficient for being a habit and that laws of nature are statistical, but it does not show that all habits are statistical results. A few things can be said here. First, it seems unlikely to me that Peirce would want to divide his account of tendencies and laws into this sort of bifurcation. His principle of continuity or synechism

[149] EP2, 183: "[T]he idea of a general involves the idea of possible variations which no multitude of existent things could exhaust but would leave between any two not merely *many* possibilities, but possibilities absolutely beyond all multitude." Emphasis original.
[150] EP1, 221-222
[151] NEM III, ii, 1096, via Reynolds, 46. Emphasis added.

flatly rejects dualities of that kind as a general rule.[152] Secondly, the above passages, taken together, still seem to make the view plausible to some degree. And third, the merits of this reading will be measured by their theoretical utility, which I hope will help to make sense of Peirce's overall project.

More can be said of habits, however, than that they consist in statistical uniformities that would result in the long run. That certainly seems to characterize them as "would-be's", but it does little to explicate their origin. Recall that this is where things get weird in the cosmology that Peirce offers. When he gives his account of the development of the early universe, which he gives in some detail in three distinct places,[153] he gives us very little to go on with respect to what habits are or how they come about.

This brings us to (2) above. As I see it, there is nothing contradictory about holding both that the tendencies or habits in the universe are statistical uniformities and also that they are dispositional properties. These may just be two ways of looking at the same thing. To say that a tendency is a statistical uniformity that would result after an indefinite amount of time--that is, via Peirce's theory of inquiry, they are realities that the indefinite community of scientifically led minds would come to agree upon as realities--is just to say that there are realities in nature which are disposed to realize themselves in certain ways. There can be different *kinds* of statistical uniformities, after all.

[152] Indeed, so much so that in one place Peirce rejects Parmenides' claim that everything either is or is not, arguing that the principle of continuity requires that there is a gradation of being from non-existence to existence. See 7.569

[153] "The Logic of Continuity", "A Guess at the Riddle", and "The Origin of the Universe": see 6.185, 1.354, 6.214 respectively

I suggest that we interpret Peirce to be saying that among the possible qualities that may get differentiated from the primordial continuum are various dispositional properties. These will be "mere eternal possibilities" in the same way that all qualities are, with the main difference (if there even is a difference)[154] being that dispositional qualities, as real potentialities that act as general predicates, logically require their subjects. Their having to do so does not imply that they have to do it in any *particular* way, of course. That would destroy the whole notion of their being dispositions or tendencies. Just as the original continuum of nullity is an "indefinite potentiality" that must "contract" to produce definite potentialities (the "world of forms") lest it be a "do nothing potentiality"[155], likewise, if among the resultant definite possibilities are dispositional properties, then in order to be *real* tendencies, they must also be such as to get themselves realized in actual instances.

Peirce nearly says as much in several passages including:

> Permit me further to say that I object to having my metaphysical system as a whole called Tychism. For although tychism does enter into it, it only enters as a subsidiary to that which is really, as I regard it, the characteristic of my doctrine, namely, that I chiefly insist upon continuity, or Thirdness...and that Firstness, or chance, and Secondness, or Brute reaction, are other elements, *without the independence of which Thirdness would not have anything upon which to operate*.[156]

[154] I leave it open whether or not qualities like redness are actually just tendencies for occurrences of red, although this is a very plausible reading, since Peirce says that qualities have their being potentially and that this potentiality consists in a real possibility of determination (RLT 247). There is more to say about this, especially if we consider Peirce's claims in "Issues of Pragmaticism" about the underlying reality of unobserved objects possessing certain characters, wherein he says "[The pragmaticist] is therefore obliged to subscribe to the doctrine of a real Modality, including real Necessity and real Possibility". (5.457)

[155] 6.219-220

[156] 6.202

And,

> [The reader] might discern that the theory of those cosmological articles [i.e."The Logic of Continuity" and "The Origin of the Universe"] made reality to consist in something more than feeling and action could supply, inasmuch as the primeval chaos, where those two elements were present was explicitly shown to be pure nothing...the third category of thought, representation, triadic relation, mediation, genuine thirdness, thirdness as such--is an essential ingredient of reality, yet does not by itself constitute reality, since this category (which in that cosmology appears *as the element of habit*) can have no concrete being without action, *as a separate object on which to work its government*.[157]

And,

> [A] law of nature left to itself would be quite analogous to a court without a sheriff...its law might be the perfection of human reason but would remain mere fireworks, *brutum fulmen*.[158]

And finally,

> There are certain ideas which have a character which our reason can in some measure appreciate but which it by no means creates, which character insures their sooner or later getting realized...the laws of nature have, I suppose, been brought about in some way; and if so, it would seem that they were of such a nature as inevitably to realize themselves.[159]

Paul Forster, when analyzing Peirce's cosmology, suggests that Peirce thought a teleological account of the laws of nature is required to explain how the laws, regularities, and habits can come about in the first place. As Forster sees it, Peirce thought that the nothingness preceding the universe had a tendency for habit-taking as one of its possible differentiations, this tendency (the Law of Habit) being necessary for the world to be understandable at all to us. Accordingly, this tendency, since it is itself a *real* potentiality, logically requires chance occurrences of events in order

[157] 5.436, emphasis added.
[158] 5.48
[159] EP2, 72

to play itself out.[160] Likewise, I suggest that all tendencies, not merely the Law of Habit, must be such as to require subjects over which they can range--that is, Firstness and Secondness are logically required if we are to take the notion of habits *seriously* the way Peirce does, as real potentialities.

That Peirce thought of final causation as a primary component of his philosophical system cannot be denied, whatever the case. He says, for example, that (by the principle of synechism), "all phenomena are of one character, though some are more mental and spontaneous, others more material and regular. Still, all alike present that mixture of freedom and constraint, which allows them to be, nay, makes them to be teleological or purposive."[161] Furthermore, in the Collected Papers, under the section "A Detailed Classification of the Sciences," Peirce goes on at length about the power of general ideas to get themselves represented in the world by actual objects. They have, "a power of finding or creating their vehicles."[162] He says moreover:

> If you ask what mode of being is supposed to belong to an idea that is in no mind, the reply will come that undoubtedly the idea must be embodied...in order to attain complete being, and that if, at any moment, it should happen that an idea...was quite unconceived by any living being, then its mode of being...would consist precisely in this, namely, that it was about to receive embodiment...and to work in the world. This would be a mere potential being, a being ***in futuro***;"[163]

And a few lines later,

> [E]very idea has in some measure...the power to work out physical and psychical results. They have life, generative life.[164]

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[160] Forster, 182-184
[161] 7.570
[162] 1.217
[163] 1.218
[164] 1.219

Peirce goes on to describe that what he means when he says that an idea can confer existence on things is that it gives them the power to "work out results in the world". In contradistinction, regular efficient causation, while useful for understanding how a thing works, cannot give "life" to things.

> [T]he real life of them, depends upon the idea of them, which simply finds its opportunity in those circumstances that are enumerated in the definition [what efficient causation reveals]. Efficient causation is that kind of causation whereby the parts compose the whole; final causation is that kind of causation whereby the whole calls out its parts. Final causation without efficient causation is helpless; mere calling for parts is what a Hotspur, or any man, may do; but they will not come without efficient causation. Efficient causation without final causation, however, is worse than helpless, by far; it is mere chaos; and chaos is not even so much as chaos, without final causation; it is blank nothing.[165]

A couple of points about this passage are worth pausing over. First, it should be clear that Peirce takes the idea of final causation, or teleological cause, very seriously. Second, this passage seems to suggest that even the state of chaos prior to the universe, despite being without any regularity and consequently totally indeterminate, still possessed a kind of teleological power. This is further evidenced by the fact that in "Man's Glassy Essence" Peirce says, "[The] primeval chaos in which there was no regularity was mere nothing, from a physical aspect. *Yet it was not a blank zero.*"[166] What this suggests, to me at least, is that Peirce thought the state of nullity (or chaos, depending on where one starts) was itself a kind of absolutely general tendency for things. It was, perhaps, a pure "being in futuro". It is a state that is not quite real (because it is irregular and prior to reactions and determinate qualities) but it nevertheless had a mode of being. This is maybe why Peirce says that the state of nothingness just is pure being and also why he says that in that state there was no lack of

[165] 1.220
[166] 6.265

potential being.[167] I submit that "potential being" just is the very "being *in futuro*" that Peirce characterizes as a dispositional final cause.

This last point seems to beg the question. How is Peirce to explain the emergence of law and regularity--such regularities as habits--if the original state of nullity is just itself pure being *in futuro*, and so characterized as being itself a tendency or habit? Moreover, there is a worry that, if tendencies are just statistical regularities that would result after an indefinite length of time, that this is meaningless for the early universe, since it is far from clear what it could be a uniformity *of*. A couple things can be said here. With respect to the first point, Peirce can (and does) say that this initial state of the universe, although general insofar as it contains the potential for absolutely everything, is not among the things that requires explanation because it is purely indeterminate. While it is a tendency for every other tendency and possibility, there is no sense in which any particular tendency or possibility need arise out of it. It is only by the operation of chance that anything even could arise, and chance is just the thing Peirce thinks requires no explanation.[168] This reply draws a subtle distinction between ordinary tendencies and the state of nullity as a tendency, which consists in the fact that whereas ordinary tendencies are tendencies of a certain kind, the primeval tendency (to give it a fun name) cannot be of a kind at all--it contains the possibility of all kinds.[169]

As to the second point, a related answer is possible. It is compatible for the primeval tendency to consist in a future statistical uniformity while at the same time holding that this uniformity is as yet undetermined with respect to what kinds of objects will be its instances. That is

[167] 6.217
[168] See Peirce's reply to Carus in Appendix A of CP volume six.
[169] Some support for this can be given by looking to Peirce's understanding of a potential aggregate in "The Logic of Continuity".

just to say that some statistical uniformity is possible. If no statistical uniformity were possible, Peirce would likely say that the world could not be rational at all, since even a world that is as "chancy" as a world could get would still obey the laws of chance, i.e. the Law of Large Numbers, since this is a formal law[170].

This last point brings us to (3) above. I have said there that Peirce understands the Law of Large Numbers to be a purely formal law and also that the role of the Law of Large Numbers in Peirce's philosophical architectonic is to *explain* and make understandable tendencies in the world.

This first half of this is relatively straightforward. Peirce devotes an entire section of a lecture from 1866 to the notion that there are laws of chance and that they are "the formal conditions of all knowledge".[171] In this lecture, Peirce outlines what it means for nature to be uniform, and he says that one way of understanding this is to suppose that if we were to take a sample a certain class of objects of having some character, it will generally be the case that the whole class has that same character.[172] But, Peirce goes on, we may wonder if this same sort of thing would apply in a world of chance. He says that such occurrences would be rare where that principle would apply. Presumably what he means here by a world of chance is that of a purely chaotic state of things with no regularity whatsoever. Of course, that is not the world that we live in, and Peirce goes on to note that "*chance* is not the abrogation of all laws," since it is possible to show that there are "some very curious laws" relating to the throwing of a die--a chance affair.[173] It seems he can have none other than the Law of Large Numbers in mind here.

[170] See below for more on this notion.
[171] 7.138
[172] Notice that this is just a statement of the Law of Large Numbers.
[173] 7.136

Peirce notes subsequently that there is a difference between two different kinds of laws: formal and material. And formal laws "do not depend on any particular state of things,"[174] so that they would hold true no matter what our experiences were, but to discover material laws would require discovering "just such facts as we did". He goes on to say that the law that "as is [a] sample so is the whole" is a law that would hold "as long as there were *any* laws, though only formal ones," and they are such that no matter what the world was like they would apply.[175] They are, he says, not laws of nature but conditions of knowledge in general.

It seems that, given this, Peirce thinks he can appeal to a chance indeterminacy in the state of nullity or chaos prior to the universe as playing an explanatory role for the evolution of the cosmos because (what he calls) absolute chance already obeys certain formal laws, such as the Law of Large Numbers. This should not be a problem, however, because the laws of chance are such as to apply to *any* possible world whatsoever--that is, any world that is even capable of being reasoned about. Worlds that could not, even in principle, be reasoned about lie outside of the realm of cognizability, and to suppose that they even could be real, Peirce would probably say, is just a flagrant violation of both the pragmatic maxim and a commitment to the possibility of unintelligible realities as brute primitives.

It is a little bit more difficult to establish that Peirce thought that the role of the Law of Large Numbers is to make the nature of tendencies understandable, although some evidence from this can be gleaned from what was said above. Since the Law of Large Numbers is a formal law, it should not be viewed as some kind of governing relation, in the contemporary sense. It is not as though it *makes* anything happen. Rather, it *explains* something by being of the form of a hypothetical

[174] 7.137
[175] *ibid*

inference. It says that *if* there are certain characteristics of a distribution that are independent and randomly sampled, *then* the ratio of the sample mean of characteristics to the distribution mean of them approaches unity near infinity. Now, this can be taken in several ways. As stated, it makes no commitments as to what the characteristics really are. It is non-committal with respect to either epistemology or metaphysics. I think, however, that the reason Peirce was so interested in the Law of Large Numbers is because of what it can tell us about distributions themselves. In particular, if we desire to know whether some object, or some class of objects, has a certain characteristic in general, then if we take a randomized sample of measurements of that object, each measurement being independent from the others such that they together form an identical distribution, then we can discern with a degree of probability whether or not that object has the sought-after characteristic. If we discover, from some sufficiently large sample, that thirty percent of the measurements have a character in common, then we conclude that, since the sample mean (of measurements) approximates the distribution mean, there is a thirty percent chance that the object actually has that characteristic. Or, if it is a collection, we reason that roughly thirty percent of the members of the whole collection have that characteristic. Of course, we can never be absolutely *sure* of this, as Peirce notes in several places.[176]

There is some question as to the priority of the Law of Large Numbers and the phenomena that result as "statistical result" of an application of this law to various phenomena. Is the law really *making* the phenomena behave this way? If so, it cannot be in any sense of efficient causation. If that were the case, then there would have to be particular objects being related to each other in a mechanical way, and the law would cease to be statistical in nature. The only sense Peirce can give to the idea that the Law of Large Numbers *makes* things to behave a certain way must be in a

[176] EP1, 180: "That we ever do discover the precise causes of things, that any induction whatsoever is absolutely without exception, is what we have no right to assume"

teleological sense, like what was mentioned above. On the other hand, Peirce might simply appeal to the Law of Large Numbers for establishing accurate inductions, as in the previous paragraph. He certainly thinks it has its use in the latter case.

Probably, Peirce makes use of the Law of Large Numbers for both purposes. There is *some* sense (a teleological one) in which the Law of Large Numbers explains the behavior of, say, a gas, and this is (perhaps) not *merely* an epistemological notion. That formal law is something that is applicable to any world that is capable of being reasoned about, and it will apply whenever its conditions are met. The particles of a gas meet the conditions, and our world is one that is capable of being reasoned about.

When it comes to tendencies and habits, I suggest that Peirce thinks the role of the Law of Large Numbers is twofold. First, it makes *understandable* the nature of the tendency or habit, on the assumption that a tendency consists in a statistical uniformity that would result in the long run. That is just to say that the nature of the tendency consists in the uniformity that would result (in the long run) if its instances were independent from one another and formed an identical distribution. Of course, on Peirce's view, what is possible far outstrips what is or could ever be actual, so no such state is ever really attainable. But this does not detract from the "would-be" nature of the tendency.

Secondly, and more importantly, the Law of Large Numbers makes a tendency *knowable*, in that, were inquiring minds to take random samples (measurements) of some instances of the tendency, the Law of Large Numbers reveals the true nature of the tendency. It is not necessary that anyone should actually do this in order for the tendency to be what it is, but every tendency must be the kind of thing that is knowable in some sense if Peirce is to avoid positing brute incognizable

general facts. The Law of Large Numbers makes tendencies and habits reasonable and knowable by acting as a formal condition of scientific knowledge (as we saw above).

With all of this in mind, I now turn to the final point, (4). Once this point has been elaborated, it will be possible to draw the four claims together and give a summary of my interpretation. Instead of building up to the point, I will start in reverse by restating it and tipping my hand right away. Here is my claim (copied from above) : The law of habit, being a tendency, is not intended to explain how tendencies themselves either arise or get strengthened. It is intended to explain why certain tendencies stick around and others do not. It explains why the world, as a whole, is regular. In a certain respect, the Law of Habit just *is* the Law of Large Numbers applied to the various property instantiations in the universe as a whole.

Note how this is different from what Reynolds and Dearmont say. According to Reynolds, the law of habit works to update the transition probabilities between event types conditional on their instantiations. In other words, the law of habit, according to him, makes any given tendency increase itself over time as that tendency manifests itself. If, for example, there is a probability of Pr(E) = P for some event E to occur at time T, Reynolds thinks that the law of habit makes it so that, for some time T*, there is an increased probability Pr(E) = P+r of E occurring then, where r is some number. That is just to say that P increases over time. As we have seen in chapter two, this is a problem if Peirce thinks that the law of habit is a statistical law, since it will violate Bernoulli's Law of Large Numbers' requirements of independence and identical distribution. Here are the definitions given by Reynolds:

Independence: and event B is independent from A just in case the probability $Pr(A|B) = Pr(B)$, i.e. the probability of A's occurring does not affect the probability of the occurrence of B.

Identical Distribution: a series of events $e_1\ e_2\ e_3...e_n$ is identically distributed just in case there is a constant probability $Pr = p$ of occurring for each e_i.[177]

The problem is that if the probability of some e_i increases the probability of another event of the same type, e_{i+1}, then e_{i+1} is not independent from e_i since $Pr(e_{i+1}|e_i)$ does not equal $Pr(e_{i+1})$ by itself. $Pr(e_{i+1})$ is affected by $Pr(e_i)$ in such a way that the latter increases the former. Likewise, since there is not a constant probability between e_i and e_{i+1}, which is obvious from what was just said, the condition of identical distribution is also violated.

This problem results, I maintain, because Reynolds is attempting to use the law of habit to explain the wrong kind of phenomenon. Despite some passages that seem to say the contrary (which we will look at below), Peirce, I claim, is best understood as appealing to the law of habit *not* to explain how any particular tendency or habit increases its own power over time. Rather, he is attempting to explain why we should find ourselves in a universe that contains tendencies or habits of a certain *kind* rather than others. And that is just to say why we should find that the universe is chock full of emergent regularities. The law of habit is intended to explain a property of the universe as a whole, not of individual tendencies. In a certain sense, as we will see, the law of habit just is the statistical upshot of considering what would happen over time to a universe in which various tendencies were to arise as chance occurrences. It is, then, fully compatible with the Law of Large Numbers.

[177] Reynolds, 163

Let's start by looking at some of the things Peirce says about the law of habit in the first place. There are numerous examples to choose from; some of them will seem to be at odds with the description I have given above, and so I will try to contend with these difficulties if not as we go along then once we are in a good position to evaluate them.

Peirce says that the law of habit consists in a "tendency to generalization".[178] He furthermore says that it is a tendency for all things to take habits and that it can grow by its own virtue.[179] What is needed is an explanation of how this can be true without falling back on Reynold's understanding of the law. Peirce says that the primordial state of chaos must have contained--since it contained "a little of everything conceivable"--a "little undifferentiated tendency to take [habits],"[180] and that, furthermore, this tendency would have a "growing virtue".[181] How does it grow? Evidently by its own accord: "[I]t is clear that nothing but a principle of habit, itself due to the growth by habit of an infinitesimal chance tendency toward habit-taking, is the only bridge that can span the chasm between the chance-medley of chaos and the cosmos of order and law."[182] And:

> [A] tendency to act in any way, combined with a tendency to take habits, must increase the tendency to act in that way. Now substitute in this general statement for 'tendency to act in any way' a tendency to take habits, and we see that that tendency would grow.[183]

[178] 6.21
[179] 6.101
[180] 6.490
[181] EP1, 297
[182] 6.262
[183] 6.490

And finally in a reply to Dr. Carus (Peirce evidently getting fed up),

> Almost as unthinking is the objection that absolute chance could never beget order. I have noticed elsewhere the historical oblivescence to this objection. Must I once again repeat that the tendency to take habits, being itself a habit, has *eo ipso* a tendency to grow; so that only the slightest germ is needed? [I] can find no difficulty in the production of that first infinitesimal germ of habit-taking by chance, provided [the realist like Peirce] thinks chance could act at all. This seems, at first blush, to be explaining something as a chance-result. But exact analysis will show it is not so.[184]

This last passage has a lot going on that is worth taking a look at. First of all, notice that Peirce says that the tendency for habit taking would have started as a "germ" of a tendency. Second, he seems to contradict himself here, since he says that the first germ of a tendency itself arose by chance, but then he goes on to say that "exact analysis" will show that he is not explaining something as a chance-result. I think what he means can be resolved by looking a few paragraphs earlier in the same paper. Here, Peirce says that "Everybody is familiar with the fact that chance has laws, and that statistical results follow therefrom. Very well: I do not propose to explain anything as due to the action of chance, that is, as being lawless."[185] In conjunction with the passage above, this suggests that Peirce views the production of the infinitesimal germ of habit-taking, or we might say the seed of the law of habit, as a statistical result. In this way, it is still something that is subject to the laws of chance, and so is not the result of complete lawlessness, although, as we have seen, Peirce does not think this is a problematic or question-begging claim, since the laws of chance are purely formal laws from which nothing necessarily results. If this is right, however, we are left to wonder what it would mean for a "germ" of habit-taking to come about by chance. Is it merely one among the various tendencies that could get differentiated from nullity, or what? While that is a plausible reading, given some of the things Peirce says, I will opt for a different interpretation.

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[184] 6.612
[185] 6.606

The "germ" of the law of habit, I claim, comes about as the statistical upshot of the many tendencies or habits that themselves arose as chance differentiations of the continuum. It would be better, then, to say that the law of habit began with *germs* (in the plural) of habits or tendencies. And in fact, Peirce does say something like this, in two places that I can find.

> But I only propose to explain the regularities of nature as consequences of the only uniformity, or general fact, there was in the chaos, namely, the general absence of any determinate law. In fact, after this first step is taken, I only use *chance* to give room for the development of law by means of the law of *habits*.[186]

There are two things to notice here. First, this passage suggests that whatever the law of habit is, it is related to chance in an important way, and this I believe will come to support my claim that the law of habit is itself a statistical result. Second, I do not think it is a mere coincidence that Peirce uses the word "habits" in the plural. Instead, whether deliberate or not, I suspect that what he has in mind is that the law of habit ("habits") is a statistical law that ranges over habits much in the way that the gas laws of thermodynamics range over individual molecules. There are other hints that this is what is going on, as when Peirce writes to Christine Ladd-Franklin:

> We have on *our* side of things in which there is some absolute spontaneity counter to all law, and some degree of conformity to law, which is constantly on the increase owing to the growth of *habit*. The tendency to form habits or tendency to generalize, is something which grows by its own action, by the habit of taking habits itself growing. Its first germs arose from pure chance. There were slight tendencies to obey rules that had been followed, and these tendencies were rules which were more and more obeyed by their own action. There were also slight tendencies to do otherwise than previously, and these destroyed themselves.[187]

This is a very revealing passage. Peirce tells Ladd-Franklin that the law of habit is what produces conformity to a law, and he hints that this process started with "germs" of tendencies that

[186] 6.606, the second italics are mine.
[187] 8.317

arose by chance. Note, once again, the plural. This accords well with the interpretation I am advancing, according to which tendencies are dispositional properties that emerge from the continuum by chance and then together form an overall tendency for order. Additionally, there are some places where Peirce says things that sounds suspiciously just like this. He says, for example, in "Design and Chance," that his opinion (on cosmology) is "only Darwinism analyzed, generalized, and brought into the realm of Ontology,"[188] and when, in "Variety and Uniformity" he says that,

> In so far as evolution follows a law, the law of habit, instead of being a movement from homogeneity to heterogeneity, is a growth from difformity to uniformity. But the chance divergences from law are perpetually acting to increase the variety of the world, and are checked by a sort of natural selection and otherwise...so that the general result may be described as 'organized heterogeneity,' or, better, rationalized variety.[189]

What I think Peirce is suggesting is that chance occurrences bring about instantiations of qualities and tendencies and these go together in various ways, some tendencies working against one another, some being self destructive, and so forth. Over time, those which are either precluded by others or are self-annihilating will tend to get weeded out of the existing universe, so that there is a sense in which the more regular tendencies will survive, having been selected for by a kind of cosmic natural selection. Moreover, this passage is revealing about the structure of the universe itself. What he has in mind, it looks like, is that whereas the action of chance is to diversify the world, the action of the law of habit is to increase order, so that the end result will be a world of a wide variety of differing systems at multiple levels.[190]

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[188] EP1, 222

[189] 6.101

[190] Recall Peirce's metaphor of the blackboard. In 6.207 he says, "Many such reacting systems may spring up on the original continuum; and each of these may itself act as a first line from which a larger system may be built, in which it in turn will merge its individuality."

Peirce does go on to say, in a number of places, that tendencies that are self-destructive will end up getting eliminated from the universe. As we saw above, in his letter to Ladd-Franklin, he says that some tendencies would destroy themselves if they had a tendency to do otherwise than on former occasions. In another passage he elaborates this thought:

> But there are some habits that carried beyond a certain point eliminate their subjects from the universe. There are many ways in which this might happen. Thus a tendency to lose mass will end in a total loss of mass. A tendency to lose energy will end in removing its subject from perceptible existence. A tendency to gain energy will end in the body's shooting through the universe too rapidly to produce any effect, etc.[191]

And likewise in "A Guess at the Riddle," Peirce says that when it comes to the evolution of substances, they come about because pairs of states (Peirce is here referring to states as the "flashes" of Secondness mentioned in an earlier section) take habits, and these habits will tend to bundle together. Some of them will have a tendency for persistency, he says, and so will stick around, while those that do not have this tendency will "fall out of existence".[192] Over time, substances, i.e. bundles of habits, will become permanent because of this.

Let's pause for a minute here in order to see what is going on. I have claimed that the law of habit is a statistical law, not merely in the sense that it can be understood statistically, since any tendency will be like that, but in the sense that it is analogous to the gas laws of thermodynamics. Just as a gas released into an empty container has a tendency to achieve equilibrium, such tendency being understandable in terms of the chance behavior of many different molecules, so the law of habit is a tendency for regularity and order in the universe, which is the statistical result of the chance arising of various tendencies or dispositional properties. Since some of those properties will

[191] 6.490
[192] 1.414

be such as to eliminate themselves, there is a general discernable trend toward regularity on the whole (but it will be a regularity of various systems, or as Peirce says, an "organized heterogeneity"). To support this claim, I have, so far, pointed to some places where Peirce talks about how the law of habit begins as a "germ" of habit taking. We have seen further that there is some reason to think that Peirce did not think the law of habit begins as a *single* germ but was the result of early combinations of chance tendencies for regularity. I then pointed to some passages where Peirce talks about these tendencies and why some would stick around and some would not. There are two things that I have yet to show, although I think what has been shown above already implies them. First, we need a good reason to believe that Peirce actually thought the laws of nature evolved by this process according to which certain dispositions stick around and others are lost. If that is shown, then since we have already seen that Peirce thinks the laws of nature come about *because* of the law of habit, this process must just be the law of habit in operation. Second, there must be some sense in which this process is a statistical one, and it would be nice to see Peirce say so. I believe I can show textual evidence for both of these claims. I will not, however, address the claims separately, because while they are distinct, the textual evidence for them overlaps considerably.

Peirce's manuscript "Design and Chance" turns out to be particularly helpful here. Peirce gives an account as to how chance events can combine together to produce various uniformities, such as when gamblers play games involving dice. He notes that if there are variations in the dice, for example, then just by chance, that is in the long run of chance occurrences acting in conjunction with the individual die, certain separations of players will result. This is because the dice might, for example, become worn down over time on certain edges, leading to an increased probability for certain outcomes. Even though the throw of each die is independent from the others, there will still arise non-uniform siftings of various outcomes, "If these effects were to be alternated after billions

of trials, the effect would be to make numbers of distinct classes of players."[193] This is just the sort of action of chance that will produce heterogeneity from an initially homogeneous set of events. The reason Peirce brings this up is in order to talk about the laws of nature and how they come about. He notes that "Certain laws of nature...are known to be the results of chance--statistical facts so to say," and he goes on to say that, "I cannot help but believe that more of the molecular laws...will be found to involve the same element."[194] Moreover, a statistical law only works because there exist underlying regularities to the objects over which it ranges, and yet it is, according to Peirce, "able to produce uniformities far more strict than those from which it works."[195] Immediately after this, Peirce says that it is plausible that all the other laws of nature are statistical results of this sort.[196]

After all this, Peirce goes on to say, "I have several times shown to my classes [presumably at Johns Hopkins, where the lecture based on this manuscript was given] how some of the main laws of cerebration and particularly the formation of habits could be accounted for by the principles of probability."[197] This is revealing, although it doesn't quite get what we need, since we would have to establish that the method by which habits come about involves something like the natural selection process applied to dispositional properties or tendencies. But just a few lines after this, Peirce goes on to say (quoting at some length):

> For every kind of an organism, system, form, or compound, there is an absolute limit to a weakening process. It ends in destruction; there is no limit to strength. The result is that chance in its action tends to destroy the weak & increase the *average strength* of the objects remaining. Systems or compounds which have bad habits are quickly destroyed, those which have no habits follow the same course; only those which have good habits tend to survive.

[193] EP1, 220
[194] EP1, 221
[195] *ibid*
[196] EP1, 222, quoted above
[197] EP1, 223

> May not the laws of physics be habits gradually acquired by systems[?] Why, for instance, do the heavenly bodies tend to attract one another? Because in the long run bodies that repel or do not attract will get thrown out of the region of space leaving only the mutually attracting bodies. Why do they attract inversely as the square of the distance? *This may be only their average law of attraction*;"[198]

This is probably as close to a smoking gun as we are going to get in terms of Peirce telling us how it is that "inveterate habits [are] becoming physical laws"[199] in a way that accords directly with the interpretation of the law of habit I have been trying to advance. Here, it is clear that several things are going on. In the first place, Peirce is trying to explain how it is that the laws of nature develop by the action of chance. But additionally, he gives us the two things we want--that this process is evolutionary, which works by infelicitous habits (or tendencies) eliminating themselves and each other and also that the laws of nature that result from this are the statistical result of this process; they are the *averages* that obtain given what tendencies are left after "bad habits" are eliminated.

Since Peirce thinks that the laws of nature evolve because of the law of habit, it is difficult not to identify this process with the law of habit itself. The law of habit is itself a tendency, but, I claim, it is not a tendency that pops into existence as a single First quality. It is, rather, like the tendencies involved in statistical thermodynamics. It is a statistical result of the average of other tendencies in the universe. This is perhaps why Peirce says in "Variety and Uniformity" that, "on the other hand the law of habit is a simple *formal law*."[200] What he probably means here, if my interpretation is correct, is that the law of of habit just is the result of applying the Law of Large Numbers to the vast number of tendencies or dispositional properties in nature.

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[198] Ep1, 223-224, emphasis added
[199] 6.25
[200] 6.101

If the above points are correct, then it seems there is good reason to believe that the law of habit is not intended to explain how any particular tendency strengthens itself over time. It is, rather, intended to explain how the universe has a whole is tending toward an increase in various "systems" of habits due to the statistical uniformity that would arise in the long run of stable dispositions/tendencies/habits sticking around and unstable ones "falling out of existence" (i.e. out of relation to other reactive systems). It is true, in some sense, that the law of habit increases itself, but this is not by virtue of some mysterious self-action, although Peirce often cryptically refers to it that way. It is, rather, just what the law consists in statistically. It will increase itself in the sense that it is sure to be the case, statistically speaking, that as time goes on there will be more and more regular systems and fewer and fewer "bad habits".

A metaphor can help here. It is a slightly odd or implausible one, as thought experiments usually are, but it will help visualize the process, I think. We can imagine tendencies or dispositional properties to be like bees flying in more or less erratic patterns. For our thought experiment, we will want an infinite number of bees, although we don't have to have them all at the same time. Let's not worry about how they come about--we'll suppose them to pop into existence quite randomly. Each bee is independent of the next, and there is nothing about any one bee that makes any other bee more or less likely. All have their existence by chance. Furthermore, every bee has its own erratic pattern of behavior, though some will be more or less similar. On any given occasion, which direction a certain bee flies is a random chance affair, although no bee will fly outside of the range of its pattern of behavior. To even call it a "pattern" is misleading--all I mean is that some bees will *tend* to fly in regular concentric circles, some will tend to fly in a zig-zag, some will tend to cover a large area, some will not, etc. Now, imagine that the bees are flying down a tunnel, indefinitely long. And we will imagine that the interior of the tunnel is electrified, or in some other way would produce the

death of any given bee were it to encounter it by chance. What will happen to the whole collection of bees as time goes on? It is not difficult to see that the bees that have more or less regular tendencies to fly nearer the center will survive in a greater proportion than those that don't; this is even true if bees are coming into existence at random, since the kinds of tendencies they will exemplify will also be just as random. Over the very long run, a statistical tendency would play itself out, that bees with regular behaviors to stay near the center would be, mostly, the only bees around. If we were to add other factors into the mix, say that some bees, upon collision, would destroy each other whereas others would not, this universe of bees would become further differentiated into systems of bees, each of which is likely to be found nearer the center than otherwise, but which are likely to avoid each other. This is akin to Peirce's idea of organized heterogeneity. By chance, those tendencies will arise over time, so that the whole universe is at the same time growing and becoming more uniform, each system becoming increasingly uniform as well until new systems are grown or differentiated out of them. Moreover, these systems themselves can act in unison, and so regularly, to be combined with other systems to form new statistical regularities, which will be new objects with their own tendencies. We could say that there is a general tendency for tendencies, or that the law of habit is operative here, because chance combined with tendencies is going to produce further tendencies or systems of habitual behavior. But it is not as though the universal tendency for tendencies is somehow strengthening the individual tendency of any given insect. Those tendencies are increased only by finding themselves in greater proportion relative to the whole, much in the same way that Peirce thinks the law of attraction between heavenly bodies (we can only assume he has gravity in mind) is strengthened over time as the result of the dispositions of the bodies themselves interacting and coming to converge statistically on a single value.

There are some natural limitations to the metaphor. In the first place, there is no container for the universe to act as the tunnel, but this is unimportant, as can easily be seen once we take note of the fact that the chance interactions between various tendencies, which would destroy them, will affect the same change in the overall system. There is also some question as to the natures of the tendencies themselves. In the metaphor they are bees, so they are already complex existences. Are the habits of nature also complex? Just as above, it is open to Peirce to say that even these complex habits consist in statistical regularities of uniformities undergirding them, and these consist in habits that are themselves statistical regularities of uniformities undergirding *them*, and so on. This will naturally lead to an infinite regress, but Peirce has no problem with this. He says *exactly* this in fact:

> It is therefore possible to suppose that not only the laws of chemistry but other known laws of matter are statistical results. Thomson supposes matter to consist of eddies in fluid.[201] If a fluid is composed again of molecules its laws will be mainly due to chance. Now I will suppose that all known laws are due to chance and repose upon others far less rigid themselves due to chance and so on in an infinite regress, the further we go back the more indefinite being the nature of the laws, and in this way we see the possibility of an indefinite approximation toward a complete explanation of nature.[202]

The oddity of this can perhaps be quelled a bit by noting that this infinite regress would only extend infinitely back in *time*, but not necessarily into the state of nullity itself out of which time is supposed to have arisen. At any rate, one might wonder if there is any place where this process "grounds out" (to use a contemporary phrase). Peirce does give a little hint at this. He says that, because the statistical uniformities that arise by the operations of chance are due to fortuitous distributions, which require "some uniformity of the objects of the collection"[203] of which there is a statistical uniformity, that "Law begets law; and chance begets chance."[204] Peirce knows that this is a

[201] A somewhat fun and popular notion in the nineteenth century
[202] EP1, 222
[203] 7.519
[204] 7.521

problematic thing to say given his synechism and commitment to avoiding brute regularities. He immediately notes that in order to escape the duality, we must suppose that "the first germ of law was an *entity*, which itself arose by chance, that is as a First."[205]

What this suggests to me, if we take Peirce to really mean "germs" (the plural), is that while the laws of nature and habits, as statistical uniformities, that form the existing universe depend upon statistical uniformities of further habits--statistical uniformities all the way down, as it were--for as far back and time as we could ever wish to investigate, the principle of abduction requires that we make sense of the universe prior to time, in the state of chaos or nullity. Here, it seems, Peirce wants to say that there are irreducible tendencies that arise as Firsts. But this is just to say what I have suggested above, that among the qualities that initially get differentiated from the continuum are certain dispositional properties.

II. Cosmology redux in light of the interpretation

With the above interpretation, we can take a quick look at how all the pieces of the cosmology fit together on that view. Here is an overview of the whole picture, given the interpretation above and starting with the state of nullity.

The universe begins in a state of total nothingness that is not merely a "blank zero" but a state of real potentiality. We have seen that Peirce has some kind of notion of final causation built into even this state, but it is not any kind of brute regularity, and so it does not violate his principles of inquiry. The universe in this state is prior to any differentiation or determination. It is much like

[205] *ibid*

the possibility of all possible worlds and of all possible qualities. From this state is differentiated a continuum of qualities or firsts, among which are certain dispositional properties, or what Peirce calls tendencies. These are also real potentialities. This continuum Peirce calls the "world of forms". In order to to be such as to be capable of getting realized, which they must be if they are to be *real* potentialities and not mere logical possibilities, there must arise chance reactions between them. These instantiations of qualities are existing "flashes" of existence, but without any regularity. For dispositional properties, there must arise chance reactions of qualities disposed to go together in certain ways. Among such dispositional properties must be dispositions for various kinds of regularity (these are, after all, possible ways a disposition could be). We can imagine that there were tendencies for the property of redness and circularity to go together, for example. There might be tendencies for redness and circularity to go together on increasingly frequent occasions, tendencies for redness and circularity to go together on decreasingly frequent occasions, and so forth. These latter ones would fall out of existence over time (they would, in a sense, be subsumed back into the continuum of possible qualities). Those which were regular would tend to stick around. The statistical upshot of such behavior defines the law of habit, which is itself just a general tendency for the universe, as a whole, to differentiate itself into increasingly regular determinations of its tendencies. Such regular tendencies themselves will go together to form further tendencies by acting as the kinds of uniformities that the "laws of chance" (i.e. Bernoulli's Law of Large Numbers, for example) applies to. So substances will be formed as bundles of habits and qualities. Likewise, there will be relations between substances which will go together on average to constitute general laws of nature. Because the underlying uniformities of the various substances in the universe are statistical and inexact, so the laws of nature will be inexact. But they will be growing all the time toward central values because there is a general trend in the universe (the law of habit) for those tendencies that are not regular to get destroyed and for regular tendencies to get selected for (a kind of cosmic natural

selection). In the very end of things, if there ever were an end (which Peirce thinks there never *actually* will be), the laws of nature would be perfectly exact and, as he says, crystallized.

III. The Law of Large Numbers and The Incompatibility Problem Revisited

I have already suggested above what the solution to the incompatibility problem will look like on this perspective, but it is worth getting clear about here. The incompatibility problem arises in the first place because Reynolds characterizes the law of habit as being something that increases the *power* of any given tendency, including itself. But if my interpretation is correct, this is a mistake. It is a misapplication of the law, because it is trying to use it to explain the wrong thing. If it were the case that the law of habit were intended to explain how tendencies could strengthen themselves over time, then it would indeed be incompatible with the Law of Large Numbers. This is because, as we have seen, instances of any given tendency would no longer be independent from one another, its being more probable on a subsequent occasion that a tendency would act in some way than on a former one. Furthermore, since the probability of acting in any given way would be increasing over time, the requirement of Bernoulli's Law of Large Numbers that the events in a distribution (where this is the instantiations of the tendency in question) would not form an identical distribution--there would not be a constant probability between events.

However, if the law of habit is instead intended to explain why the universe as a whole would come to have regularities and order--that is, how it would become an "organized heterogeneity"--then we can see that the Law of Large Numbers is not violated here. In some ways, we could view the law of habit just *as* the Law of Large Numbers applying to all the various *kinds* of tendencies, or dispositional properties, that the universe contains. There is some sense, it is true, to

the idea that the law will strengthen itself over time, but this is nothing special. It is just to say that, as the Law of Large Numbers would lead us to predict, a statistical uniformity will arise out of the chance instantiations of various elements, each of which is independent from the others and some of which are going to get eliminated. That is no different than the way in which the Law of Large Numbers applies to ordinary cases of evolution such as speciation.

On the interpretation above, each dispositional property in the universe is selected out of the continuum--differentiated--by chance. There is no special reason why the universe starts with the tendencies that it does. The selecting of one tendency does not affect the selecting of another. Chance is a basic "ingredient" of the universe. Likewise, there is a constant probability of finding any given tendency (for the same reason: all of them come about spontaneously). Yet, once they arise and begin to interact, there will emerge an overall pattern, a tendency for those which don't eliminate themselves from existence to stick around. That is the law of habit, and it is just an application of the Law of Large Numbers. From there on, anywhere there are statistical uniformities, there are possible chance interactions between those uniformities, which can bring about further uniformities. That is the sense in which the law of habit spreads throughout the universe; but this spreading should not be thought of as starting in some specific place and moving outward. It is more like a spreading "into". It will first only have very basic phenomena to apply to, but over time those will combine to make up more complex phenomena to which it will continue to apply.

There is one objection that I think should be addressed, since it looks like it could be a problem for my account generally, or perhaps for any account that tries to solve the incompatibility problem. The incompatibility problem arises because there is supposed to be a contradiction in analyzing the evolution of laws and regularities by means of the Law of Large Numbers--with its

requirements for *independence* of events and identical distribution--and the Law of Habit, which *seems* to suggest that the transition probabilities between event types get updated and so involves the events being *connected*. First of all, I will note that Reynolds is, I think, simply mistaken that the Law of Large Number *requires* an identical distribution of events. That is not exactly accurate as far as I understand the mathematics. An identical distribution that results from an application of the Law of Large Numbers is a feature of the randomization process. If the selection of samples is fair and random, *then* an identical distribution will be formed among the samples, such that, if we were measuring some variable, the probability distribution over the samples would form a normal bell curve. If the underlying distribution of events in the population are randomly distributed, then we would expect a normal curve. If they are not, we would discover that they are not, because the distribution of our samples would *not* be "normal" or identically distributed. That method is how physicists discover new fundamental particles, for example. Or, what is basically the same idea, if we measure a phenomenon, then measurements of the aberrancy from the mean value of the phenomenon in question will form a normal bell curve, provided we take samples randomly. For the Law of Large Numbers to tell us something, we have to take the samples randomly, but it doesn't follow that the underlying phenomenon has to be totally random itself!

Moreover, the requirement of independence is not, I think, going to be a problem for the Law of Large Numbers applying to the properties of the universe as a whole taken together. To see this, consider an analogy between all the properties in the universe and the molecules of a gas. Surely Reynolds would not want to say that the Law of Large Numbers doesn't explain how a gas evolves in a container. The reason we can apply the Law of Large Numbers to the particles of a gas and discover a tendency toward equilibrium is because the gas particles are independent of one another and highly random in their behavior. It does not follow, however, that the *states* of the system are

independent from one another in the statistical sense, nor does it follow that there is a constant probability between state types. It is true that this is the case once the gas has already reached equilibrium.[206] But the question under consideration is whether the states of the gas over time are independent from one another while they are evolving toward equilibrium. They obviously are not, since if they were, it would be equally likely that, once released into the container, the gas would evolve backwards. Essentially, the process of evolution takes place because the possible ways the gas could evolve is getting delimited over time; there are increasingly fewer ways for the gas to go backwards.

On my account, the various property instantiations found in the universe are like the molecules of a gas. They are statistically independent from one another, and it is because of this that a statistical result is produced, thereby explaining their tendency and evolution toward an end. Once they reach certain states (analogous to equilibrium--although they are always getting a little more precise), they can combine together to produce even more tendencies. On Peirce's account, everything in the universe is continuous, a feature of his synechism. Accordingly, even a gas molecule is really itself a statistical upshot of various property instantiations. As long as that statistical upshot is independent of other ones (the other gas molecules)--which, since the universe starts out chaotically, it will be--those systems can play off one another to produce novel uniformities, some eliminating others and so on. There is no problem about the Law of Large Numbers being in contradiction to the Law of Habit, because the Law of Habit is just a convenient name Peirce gives to the general fact that the Law of Large Numbers combined with various dispositional property instantiations will result in the "spreading" of statistical uniformities. Much like the states of a gas, the states of a law of nature are not independent of one another, although the

[206] See Sklar, pp. 44-48

underlying regularities themselves are. If the reader is still worried about this, because it seems to imply the possibility of an infinite regress, all I can say here is that Peirce is only concerned that everything that requires an explanation get one, and he already rejects foundationalism, so an infinite regress here will probably not be vicious according to him. Reality will get vaguer and vaguer, more wild, more chaotic the further "down" the chain of being we descend. It will bottom out only at an ideal point in the infinite past.

Lastly, if it is not already obvious from what has been said, this interpretation solves Reynolds' other problem about uniformities. Recall how Reynolds objects that in order for the Law of Large Numbers to work on a coin toss or the throwing of dice, there have to already be regularities present in either the coin or the dice. If the dice were to suddenly change their behaviors, the Law of Large Numbers would not even be a possible application of mathematics to the physical world. This is quite right. Fortunately, Peirce is well aware of this, and that is basically the point of two pages devoted to (apparently) this very problem in "Causation and Force".[207] This is solved by the fact that Peirce is willing to accept that in the early stages of cosmic evolution this very thing probably did happen all the time. That is, the properties of any given object, provided there even *were* objects in a physical sense, would have been switching out all the time for other ones. The result of this is just that the object itself only consists in those properties that do have the tendency to stick around. Over time, since things with tendencies to behave irregularly would go out of existence, all that would be left would be things with regular behaviors. That is not to say that they would be *perfectly* regular, but Peirce can (and does) just say that the departures from regularity are small enough that we cannot notice them. Compare: if the mass of a single electron on a die were to suddenly change, would it really affect the statistical distribution that would be formed by rolling

[207] RLT 210-211

that die? It obviously would not, and this is because the properties that the die has on a macro-level are themselves statistical results of the atoms making up the die taken together. The other properties would, on the whole, balance this aberrancy out. In the early universe these departures may have been frequent, but they would eventually eliminate themselves to the point that the probability of any departure from observable regularities would be miniscule. Interestingly, some modification of this idea can probably be used to solve an outstanding problem in the contemporary metaphysics literature on dispositional laws of nature called "the problem of retention".[208] But an analysis of contemporary dispositional accounts of lawhood involving Peircean intuitions has its being *in futuro*.

[208] See Tugby

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LIST OF ABBREVIATIONS

The following is a list of abbreviations for common works cited.

DECIMALS	References in decimals refer to *Collected Papers of Charles Sanders Peirce*, 8 vols. C. Hartshorne, P. Weiss, and A. Burks, eds. Cambridge, MA: Belknap Press of Harvard University Press, 1931-1960. Decimals refer to volume and paragraph, i.e. 6.197 is volume 6, paragraph 197. Citations to areas of the collected papers not labeled by paragraph are abbreviated CP:XX, where 'XX' is the page number.
EP	Peirce, Charles S. *The Essential Peirce*. Edited by The Peirce Edition Project, vol. 1-2, Indiana Univ. Press, 1992. References are given by volume and page number, i.e. EP2:25 is volume 2, page 25.
NEM	Eisele, Carolyn, and Charles S. Peirce. *The New Elements of Mathematics*. Vol. 1-4, Humanities Press, 1976. References are given by volume and page number.
RLT	Peirce, Charles S., and Kenneth Laine. Ketner. *Reasoning and the Logic of Things: the Cambridge Conferences Lectures of 1898*. Harvard University Press, 1992. References are given by page number.