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Distinguishing Metaphysical From Epistemological Randomness

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by

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ABSTRACT

The term 'random' is used both popularly and in science in different senses. Randomness sometimes refers to our subjective epistemological inability to discern structure and other times to objective lack of structure in an observed phenomenon. This thesis argues that the best understanding of 'random' should be as a profitable heuristic, similar to imaginary numbers and potential infinities, under the rubric of epistemological randomness (ER). It further argues that positive claims of metaphysical randomness (MR) must be justified by both *internality* and *indeterminacy*. *Internality* acts as a criterion that controls for external causal influences in a given phenomenon. *Indeterminacy* requires that the expressed observable behavior be considered an absence of physical law that regulates the behavior. While paradigmatic cases (e.g. gamma radiation bursts, genetic mutation, gene mutation, and radioactive decay) are assessed as potential validation of MR, no justification is found for distinguishing quantum *internally indeterminate* events from wrongful ascriptions of randomness from *internally determinate* entities (e.g. a ‘random number sequence’ from π). The thesis concludes that there is no substantive reason to assert metaphysical randomness over and above epistemological randomness.

DISTINGUISHING METAPHYSICAL FROM EPISTEMOLOGICAL RANDOMNESS

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INTRODUCTION

'Randomness' as a construct has historically suffered from confused usage in the sciences and philosophy itself.[1] In some uses, 'randomness' is meant to denote a lack of structure in our observations of reality.[2] So that when we say that genes mutate 'at random', we mean to say that 'randomness' is a general attribute of genetics as we have observed mutations over time.

In other uses, 'random' only describes our own inability to discern structure in things we encounter. For instance, 'That comment was random,' or 'Slot machines use a *formulaic,* yet random number generator' are generally trying to make the claim that these events were random *to us.*

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[1] Even iconic philosophers of science such as Michael Polanyi are guilty of using the term 'random' in vague ways without disclosing what sense of 'randomness' to which they are referring. E.g. "I shall anticipate it here by asserting my belief that random systems exist and can be recognized as such, though it is logically impossible to give any precise definition of randomness." Michael Polanyi. *Personal Knowledge: Towards a Post-Critical Philosophy* (Chicago, IL: University of Chicago Press, 1962), 38. Also, in his review of the book *Philosophy and the New Physics*, James Pages critiques, "There are occasional confusing passages such as an apparent conflation of indeterminacy with randomness in a discussion of radioactive decay." James Page, review of *Philosophy and the New Physics*, by Jonathan Powers. *The Philosophical Quarterly*, Vol. 34, No. 134 (Jan., 1984), pp. 75-76.

[2] For instance, John Winnie begins to clarify the meaning of mathematical randomness by saying, "…the deterministic chaos often found in these systems is grounded in the fact that most irrational numbers *randomly* store an infinite amount of information. Although he goes on to ground this in the definitions and categories of probability, it is unclear how this definition explains the objective reality of 'randomness'

The goal then is to be able to speak of randomness contextually and appropriately with some guides for what counts as epistemological (i.e. our inability to see a structure in phenomena) versus metaphysical (i.e. there is no law that structures behavior) statements of randomness.[3] Further, our guides should provide some justification for categorizing each form of randomness as such.

It is the purpose of this thesis to set out those parameters for distinguishing the epistemological use of randomness from the metaphysical. Accordingly, one goal along the way is to clarify what is meant by 'random' and what counts as justification toward a belief in metaphysical randomness.

This thesis will argue that if *metaphysical randomness* must be justified with respect to some phenomenon, then that event must *not be externally caused* (i.e. internal) and there must be *no law regulating the phenomenon* (i.e. indeterminate).[4] For epistemological randomness, we do not have to justify anything except that *we can find no structure* to the expression of some event. The less we are able to discern a structure, then the expression is said to be more random. Epistemological randomness is proposed as the more parsimonious and pragmatic version of randomness, even if we are only agnostic concerning metaphysical randomness.[5]

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and how it would compare to the way physicists use the term 'random'. Italics mine, John A Winnie, "Computable Chaos" *Philosophy of Science*, Vol. 59, No. 2 (June, 1992), pp. 263-75.

[3] Attempting a mathematical and finite use of randomness, Ian Hacking begins, "What does the English word 'random' mean? Perhaps this can be answered briefly, but it would take 100 pages to prove any answer correct." *Logic of Statistical Inference*. (Cambridge: Cambridge University Press, 1965), 118.

[4] I am indebted to Jon McGinnis for this particular clarification of the argument.

[5] Why are internality and indeterminacy the dual criteria? Internality needs to be established so that we can confirm that no external source is causing the action we are observing. If there is any external source whatsoever, then there can be no metaphysical indeterminacy. If we can show that a phenomenon has no external funding, then we can look for the justification of indeterminacy. It is not enough to show internal

The method will be to pursue justification for metaphysical randomness (MR) and then determine whether or not that justification can be achieved based on observation of phenomena. As a control example of epistemological randomness (ER), we will examine an arbitrary number string from π as an instance of an *internal* but *determinate* expression. If justifications for metaphysical randomness cannot be distinguished from the justification for epistemological randomness, then we will have to remain agnostic about our ability to justify a positive assertion of metaphysical randomness.

These are the operative definitions for expression, metaphysical randomness, and epistemological randomness used throughout the essay:

> **Expression**: Expression is the observable behavior that is necessarily connected to a phenomenon that could reveal the internality of the entity. *Expression* is meant to capture the idea that entities reveal their internality through observable behavior. Just as π reveals itself through a function of its decimal expression[6], radioactive material could express its *internality* through decay events. We cannot therefore speak of MR or ER without some kind of expressive event as the referent. An inexpressive entity or event (if there is such a thing) gives us no motivation for speaking in terms of randomness.[7]
>
> **Metaphysical Randomness (MR):** Two events/entities (x & y) are metaphysically random with respect to each other if the one expresses *internality* and *indeterminacy*. *Internality* means that nothing external to the event can cause or influence the event.[8] Indeterminacy means that there are no law-like behaviors that regulate the phenomenon.[9]
>
> **Epistemological randomness (ER):** For ER, what we call 'random' is an appeal to our *ignorance of* or *inability to discern* some possible structure.[10]

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expression of an entity. We must go further to show that the expression cannot be determined *because* there is no underlying pattern.

6 "…most irrational numbers randomly store an infinite amount of information." John A. Winnie, "Computable Chaos", 263.

7 **Bounded Expression:** It is not that entities can express *any* possible or imaginable behaviors, but that phenomena are constrained to discrete expressions. These constraints (e.g. discrete particle warbles, discrete gene transversions, etc.) create an event that has a bounded expression.

8 Internality attains just in case x has no external effect on y, or vice versa, that x-y phenomenon is undetermined by any attribute of the entity.

9 And the expressed behavior of either x or y is *metaphysically indeterminate* if there are no possible expressions that come about as a result of conformities to physical law.

10 That 'structure' could be wholly absent (as MR would insist) or is currently obfuscated from us by complexity or insufficient technology. ER always contains within the construct itself the possibility that a particular state of affairs expresses itself by *internality* and *indeterminacy* and thus MR could be the direct antecedent to our epistemological reaction: 'randomness'.

ER is distinguishable from MR precisely because its focus is on our epistemic state rather than an external and objective state of a particular phenomenon. The claim of epistemological randomness is not necessarily contingent on metaphysical randomness, but MR seems to demand some explanation like ER. Nevertheless, when we talk about circumstances like the outcome of rolling two dice being 'random', we usually mean to say that we are not aware of the causal conditions or 'prevailing order' (i.e. externality) that brought about the outcome. Hence, we are affirming ER and not MR. With ER, we are speaking of randomness in terms of the knower's ignorance, not the physic or metaphysic. So that when we say something is random, epistemologically speaking, we mean that we are ignorant of how the outcome of 'two sixes' is specifically related to the event 'role of two dice'.[11]

Epistemological randomness is the least demanding view for it only requires we admit to some subjective level of ignorance or indecipherability concerning some event's outcome. So ER only requires that *we cannot discern* a structure. Metaphysical randomness is a stronger claim that seeks to provide justification for an objective state of chaos. MR claims that the reason we cannot discern a pattern is because *there is no law-like behavior*. Hence, MR can accommodate ER into its explanation of our categories. However, the question for this thesis concerns the reverse, "If we can *only* give justification for epistemological randomness, then what can we meaningfully say about

[11] Because we do not believe any particular behavior caused the outcome and we are sufficiently ignorant of the type and amount of physical movements are in involved in any particular role, we then presume some kind of randomness. In this example, however, ER is a sufficiently pragmatic view of 'randomness' and we do not need to presume any sort of MR.

metaphysical randomness?"

Whether we remain agnostic about MR or not, we do want to say something meaningful, even if only to provide a basis of justification for MR. It may be the case that no justification would ever suffice (i.e. that justification for MR must remain non-reductive). This thesis is not making that claim. By clearly defining the two different categories of randomness, epistemological and metaphysical, we are creating a language to speak about the possibility of ER without the necessary contingency of MR. The reverse, however, would not be correct. If we can justify MR, then that justification provides inclusive justification for ER, *prima facie*.

Again, the method for proceeding will be to show what justification would look like for MR as the priority case. Our central focus for examining metaphysical randomness is this: If MR is to be justified with respect to some expressive phenomenon, then (a) *internality* and (b) *indeterminacy* have to be justified with respect to that same phenomenon in a way that is falsifiable.[12] If we can give justifications to satisfy both conditions (*internality* & *indeterminacy*), then we have positive reasons to claim an instance of metaphysical randomness. If MR cannot be supported with sufficient justification and does not turn out to have pragmatic payoff, then this thesis will prescribe agnosticism concerning MR and maintain that epistemological randomness is the

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[12] Karl Popper maintains that in order for a theory to be 'scientific' it cannot be 'irrefutable'. This means that our justification will have to be falsifiable and risky. 'Risky' is the qualification that Popper adds to avoid justifications that might support every possible hypothesis under an umbrella of theories. In order to be 'scientific', our justification for MR must not only support a belief in MR, but also defeat a belief in ~MR. Karl Popper, "Conjectures and Refutations", (London: Routledge and Keagan Paul, 1963), pp. 33-39; from Theodore Schick, ed., *Readings in the Philosophy of Science* (Mountain View, CA: Mayfield Publishing Company, 2000), pp. 9-13.

pragmatically superior account.[13] Basically, we do not need MR in order to reap the benefits of 'randomness'.[14] For instance, statistical heuristics can and do use ER to accomplish the tasks that 'randomness' affords.[15]

In the end, we must be able to distinguish what appear to be random sequences, such as arbitrary number strings from π, from events that could be metaphysically random (i.e. quantum events that have no external cause and no determinate outcome). Further, metaphysical randomness must be distinguished from indeterminacy since indeterminate events have some probability. Metaphysically random phenomena can have no probability because they have no physical law regulating them, and therefore 'indeterminacy' cannot be a sole justification for the claim of MR.

INTERNALITY

The concern about *internality* derives from the ever-present possibility of external influence of one phenomenon upon the other. Specifically, do entities express themselves because of some internal feature or external causal influences? This concern has been amplified by the findings of particle physics, specifically the question of the extent of quantum entanglement. Nonetheless there is legitimate concern regarding the notion that

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[13] This does not lead us to metaphysical determinism nor design, but merely to be agnostic regarding MR and seeking further ways in which we could justify a metaphysical claim of randomness.

[14] Fischbach and Tu found that π was an equitable source of random numbers when compared to recursive random number generators (RNG's). Per my correspondence with Dr. Fischbach, they are awaiting the comparative analysis of π versus quantum random number generators based on radioactive decay intervals. Ephraim Fischback & Shu-Ju Tu, "A Study on the Randomness of the Digits of π", *International Journal of Modern Physics C*, Vol. 16, No. 2 (2005) 281-294.

[15] See *Appendix B* for a summary of the White Noise Effort and pragmatic uses of 'randomness'. Statistical analyses and cryptology are only currently dependent on stochastic processes and their fruits. However,

there are truly internally expressed phenomena.

But for this thesis, we only need to concern ourselves with the *justification for internality* as opposed to requiring MR to give evidence of 'no external causes' in metaphysically random phenomena. For instance, if radioactive decay occurs at a rate completely impassive to anything else in the universe, then *internality* is sufficiently met. But how would we justify such a claim?

The number π is a precise example of *internality*.[16] The number π is expressive in that it is a ratio. This means that π can be expressed by symbol (π) or decimal (3.14159…∞). Of course the most interesting expression of π is its decimalization because it renders a very unique string of numbers. Specifically, π in decimal produces an infinitely long number string of which no structure has been found. For this reason, some have called the string of numbers after the decimal place in π 'random'.[17]

Internality & Determinacy from π

The number sequence that follows the decimal place of π (e.g. 3.*14159*…) is said to exhibit randomness because as the number is calculated out beyond the decimal point, there is no decipherable structure. Pragmatically, this means that as our knowledge of the number is extended through more computing power, we are not privy as to what digit (0-9) will come next in the sequence.

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these are not necessary conditions for analysis or cryptology. The introduction of quantum random number generators (QRNG) brings MR and statistical analysis together, but this thesis will test that claim as well.

[16] In using π as an exemplar, we are not admitting to Platonic Realism of number forms. Rather, we are merely appropriating a concept of the same kind that we can justify *internality* and *determinism* without controversy.

For the immediate purposes, we do not need to consider the number π *en toto*. Let us just take *any contiguous sequence of a billion digits out of any part of the number π following the decimal* (e.g. 3.141592 … n_1 - $n_{1,000,000,000}$ …∞). Now let us assume that we gave these identical number sequences from π to two individual and isolated parties with unlimited computational resources and asked them to discern a pattern from this billion digit number sequence. Further, let us keep the source of the number sequence (π) concealed from the two parties.

Given this setup and the ensuing calculations that could be applied to the number string, there is strong evidence to suggest that neither party will be able to find a pattern.[18] Is it now appears justifiable to conclude that this number sequence is random *because no structure can be found*?

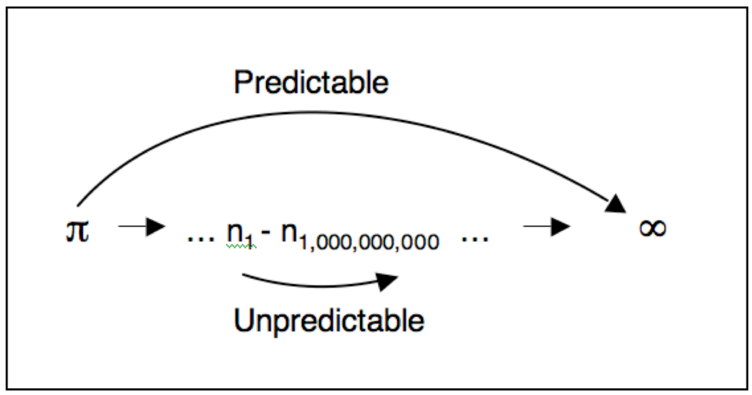

Figure 1

If we affirm the sequence as random, as is commonly affirmed, then we are ascribing the construct of 'random' to our inability to discern structure*, not to the number itself*.[19] This makes our ascription of 'random' refer to *the knower*, not *the entity* in question (re arbitrary number string from π). If this is correct, then in this context, 'random' is purely an epistemological construct (i.e. ER).

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[17] Ephraim Fischback & Shu-Ju Tu, "A Study on the Randomness of the Digits of π", *International Journal of Modern Physics C*, Vol. 16, No. 2 (2005) 281-294.
[18] Ibid.

The billion digit number sequence is taken from a decimalization of π. Accordingly, the sequence that the two parties might have affirmed as 'random because of our inability to discern a structure'is clearly the product of a wholly deterministic ratio. We can give those same two parties the ratio for π and ask them to calculate the number beyond the decimal place. Even though they are working independently, we expect them to produce identical number strings. Further, they can now find the place to situate their billion digit number sequence (re 3.141592 … n_1 - $n_{1,000,000,000}$ …∞) within their newly calculated string.

We are now confronted with a stark example of a number sequence that appears random. However, when that number is nested in the context of its computation, we see that the 'random' number string is wholly *internally determined*.[20] The claim of randomness with respect to this number appears true only if we analyze the number sequence apart from its derived source (π). When an entity exhibits random expression, but has internality and *determinacy*, *then we can only be dealing with epistemological randomness*.[21] And this number string, without knowledge of π as its source, appears to be wholly *indeterminate* and that is why π is often called 'random'.[22]

Now that we are aware of the full context of our billion digit number string, none of us would say that the number itself is random, but rather it exhibits random

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[19] If we say no, then what would justify calling a number sequence 'random' if it is possible at all? Considering the above cited study, it would appear unreasonable not to lean in favor of 'random' with a sequence from π, unless one was wholly unwilling to call any sequence 'random'.

[20] Winnie cites this as an instance of 'chaotic determinism' in reference to irrational numbers only. John A Winnie, "Computable Chaos", pp. 263-75.

[21] Again, 'expression' is meant to capture the idea that entities reveal their internality through expression. Just as π reveals itself through a function of its decimal expression, radioactive material expresses its internality through decay.

[22] Ford discusses the deterministic yet chaotic nature of certain functions, including irrational numbers like π, and concludes, "…chaos is a synonym for random." Ford, J. "Chaos: Solving the Unsolvable, Predicting

expressions because of our epistemic reaction to the lack of structure. This, then, is a plain instance epistemological randomness.

Quantum Instances of Internality

Because the broader context of our number sequence led us to wrongly attribute indeterminacy, the solution seems plain. We must consider more carefully the context of the phenomena that we suspect to be without any external cause or reason (i.e. internality*)*. In the realm of physics, we must consider the context of quantum events and cautiously nest our observations in the larger physical context.[23] Now we are speaking about internality/externality in metaphysical randomness.

In a universe of events, MR claims that there are two entities that have no effect on each other. For a working example, we could say that there is plutonium (Pu_{94}) decaying in a lab in Saint Louis. We presume the decay phenomenon is internal. The rate of that decay is wholly unaffected by any other entity in the universe. If it were even minutely affected by a particle on the other side of the universe, then we could measure

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the Unpredictable!" in *Chaotic Dynamics and Fractals*, eds. M.F. Barnsley and S. G. Demko. (New York: Academic Press, 1986), 7.

[23] At the fore, π was offered as a possible exemplar of randomness. But mathematical constructs for randomness and physical constructs such as plutonium decay reside in two different worlds. Numbers do not have the same ontological status as Pu_{94}. Whether one takes the Platonic view of *numbers qua forms* or not, we would not presume that π and Pu_{94} are direct counterparts in the physical world of entities. How then can we proceed to analyze these two instances of randomness as if randomness is monolithic between numbers and chemicals? This is the difficulty of distinguishing MR from ER.

This thesis will argue that what can be said of the 'random' characteristics of numbers such as π cannot be distinguished from cases of MR such as the observed characteristics of the decay of Pu_{94}, the sources of gamma radiation bursts in our universe, the mutations of genes, or the spin of photons fired through slits. All of these have been offered at some time as possible exhibitions of randomness and therefore qualify to be critiqued as candidates for metaphysical randomness.

To be clear, we are not arguing for a new version of randomness, but rather ER as a preferred heuristic. Additionally, it is not debated whether or not randomness is an epistemological function. Any statistician will affirm that randomness needs only to mean 'epistemologically hidden' in order to get a modest statistical efficiency out of numbers. Likewise, even proponents of MR should affirm ER as the primary *explanans* for most ascriptions of randomness.

that particle's interaction with our plutonium and discern something *about* the plutonium's rate of decay in Saint Louis.[24] If this were the case, then it would be difficult to make a physical claim for the internality of Pu_{94} decay in Saint Louis.

To make a strong case for internality, we must be able to provide justification that the observed expression of a phenomenon is a product of something internal to the entity so that it is not externally caused, affected, or motivated. We could state it this way:

> The rate of Pu_{94} decay in Saint Louis is metaphysically random just in case there is nothing else in the universe that has an external effect upon a nuclei's rate of energy release (*internality*) AND if that discrete decay event is has no law-like behavior (*indeterminacy*).

So the matter of physical context imposes itself here in the first half of the definition: internality. There cannot be entities that motivate or affect each other with respect to the expression of internally indeterminate behavior.

We have assumed that radioactive decay is a phenomenon expressed by an internally and unmotivated source, though this will have to be argued more thoroughly below. An element, such as Pu_{94}, exhibits internality in that it can express itself through observable behaviors. The fact that radioactive nuclei stabilize through decay gives us an observable action that does not *a priori* necessitate external explanation, motivation or generation. And the process of decay through energy stabilization is an internal attribute of that atomic arrangement, seemingly not due to an outside force.[25] However, our

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[24] This would be inherently complicated if it were the case that all particles everywhere were entangled and 'communicating'. This view of the universe as completely entangled, if correct, would have serious differences with the current thesis. Although, it would not necessary negate the problem of internality.

[25] In the same way, other quantum phenomena such as photon spin appears to be an attribute of the photon itself, not caused by a force. The trajectory of photons fired through a slit is what expresses its internality.We can classify 'photon fired through slit' as expressing internality by describing the photon vector, velocity, and encounter with the slit.

confidence about the internality of quantum actions varies significantly as we survey the currently inexplicable 'rules' that govern that physical world.[26]

In the end, internality can be modestly maintained as reasonable criterion and attribute of quantum events. Although we might remain open to the possibility of external causes in events like radioactive decay, appealing to the mere possibility of external causes is ultimately an argument from silence. Therefore, we will not put it forth as an argument against the idea that radioactive decay can occur independently of external causes.

INDETERMINACY

Indeterminacy is the second of our dual criteria for MR. And because internality is very difficult to confirm,[27] it will be tentatively presumed from this point forward.

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[26] Positive claims of MR have come precisely because of quantum mechanical findings. However, questions arise within the field of physics itself whether or not we can assert absolute internality. Einstein generally held that complete descriptions of quanta would be eventually accessible. Einstein's supposition is based in the external interaction between entities. For Einstein, if entities are expressing themselves from a pure internal mechanism, then there is no hope for a complete theory of interaction ("A Letter from A.Einstein [concerning completeness to Karl Popper]", Appendix xii. *Logic of Scientific Discovery*, 459.)

But aside from Einstein's unanswered challenge against the notion of internality, we must ask if we have physical reasons to exclude external influences at the quantum layer? More recent particle physicists are not willing to look at the empirical and theoretical work and assert the total internality of entities. J.S. Bell notes that the 'problem' of quantum mechanics is that, "…any sharp formulation of quantum mechanics has a very surprising feature: the consequences of events at one place propagate to other places faster than light." (*Speakable and Unspeakable in Quantum Mechanics,* p 63.) In other words, there are *propagations exterior to indeterminacy* that we are not yet fully accounting for in our current understanding of quantum mechanics.

This matter concerns the *presumption of internality*, not internality itself. There is a newly discovered phenomenon in genetics that may be analogous: epigenetics. Epigenetics concerns the propagation of particular 'gene mutations' over multiple generations. What might have appeared to be a 'random mutation' in the past, can now be causally linked to an epigenetic cycle three times removed from the current genetic event. *Just as Bell notes*, what was once considered a complete and internal account of genetics, now has to account for sophisticated genetic transmission far removed from the first generation that causes the epigenetic mutation. If there is anything like epigenetic causality happening between particles, then we cannot presume absolute internality. It must be shown to be the case. The history of science is rife with examples that should bring caution to presumptions of completeness.

Einstein and Bell are merely cautioning us about making the same hard and fast metaphysical distinctions in world where there is no complete description of an entity's internality. Of the descriptions that do exist, there is no current reconciliation of cosmological descriptions with quantum descriptions.

Indeterminacy is meant to describe the lack of law-like behavior in some event. While there is an obvious epistemological use of the term, as in 'x is indeterminable *to me*', this thesis will use 'indeterminacy' to refer to the belief that there is no law that regulates a phenomenon and therefore, there is no probability of a particular outcome.[28] Because 'indeterminacy' is in reference to the absence of a fundamental regulating cause underlying some event, then the question of our ability to affirm or falsify indeterminacy will also need to be addressed below.[29]

Because we merely raised modest skepticism concerning our ability to claim internality with quantum events, we must now look to indeterminacy as the pointed concern of the justification for metaphysical randomness.

We will consider possible physical candidates for MR: radioactive decay and photon spin. Again, the guiding principle here is to justify indeterminacy in a way that is suitably falsifiable, and then establish those justificatory principles among physical observations in the sciences. In the end, if MR is an accurate description of phenomena such as quantum events, then we should be able to justify that belief in indeterminacy by appealing to observations of those quantum phenomena.

Indeterminacy, in the metaphysical sense, means that we cannot cohere structure because *there is no law-like expression and hence, no probable outcome*.

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[27] See footnote 24.

[28] One problem encountered in a review of scientific and philosophical literature was the constant mingling of these two senses of indeterminacy. Consequently, those two senses have been retooled in this conversation of randomness.

[29] In this usage, 'indeterminacy' is not referring to problem of quantum uncertainty (i.e. Heisenberg's Uncertainty Principle), but whether or not there may be an unaccounted external influence upon *bounded expressions* of an entity. The Uncertainty principle accounts for the external influences that necessarily influence the location or spin of a particle. Under this thesis, we are attempting to establish the possibility that there is no necessary connection to any external events.

Physical Observation of Indeterminacy

The following section is meant to review several scientific and paradigmatic cases for indeterminacy as instances of metaphysical randomness. The goal will be to affirm whether or not we can distinguish the justifications for MR from the justifications for ER.[30]

For instance, gamma radiation bursts were considered to be a mysterious phenomenon in the cosmos from the 1960s until the very recent present. Their seemingly indeterminate trajectories looked to be possible candidate of genuinely random events. The indeterminable source of these bursts were recently resolved in the study of collapsing stars and their ability to create a 'barrel' of energy that bursts out like a cannon.[31] Similarly, gene mutation is often taken to be a random event, but more recently, biochemistry has challenged the notion that mutations are properly chemical events, but rather the product of quantum events.[32] This reductionism of mutations plus the problem of epigenetics[33] turns our attention directly to quantum mechanics. The instances we will consider are photon spin and rates of radioactive decay.

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[30] And again, this is not a claim against the possibility or reality of randomness as a true metaphysical state. Rather, if the two claims cannot be distinguished by their epistemic support structures, then this will add emphasis toward rejecting MR as the best explanation.

[31] NASA Goddard Space Flight Center: "Gamma Radiation: Introduction to a Mystery"; available from http://imagine.gsfc.nasa.gov/docs/science/know_l1/bursts.html; accessed January 1, 2007.

[32] David N. Stamos "Quantum Indeterminism and Evolutionary Biology" *Philosophy of Science*, Vol. 68, No. 2. (Jun., 2001), pp. 164-184. See also P. D. Sniegowski; R. E. Lenski "Mutation and Adaptation: The Directed Mutation Controversy in Evolutionary Perspective"*Annual Review of Ecology and Systematics*, Vol. 26. (1995), pp. 553-578.

[33] Epigenetics concerns the propagation of particular 'gene mutations' over multiple generations. What might have appeared to be a 'mutation' in the past, can now be causally linked to an epigenetic cycle three times removed from the current genetic event. This justifies moving our search for indeterminacy to a layer of physics below chemical. See Bob Weinhold "Epigenetics: The Science of Change" *Environmental Health Perspectives*, Vol. 114, No. 3. (Mar., 2006), pp. A160-A167.

Photon Spin and Radioactive Decay

In quantum mechanics, we now have the possibility of *internality* and *indeterminacy*. For now, we will assume internality to be the case in all quantum occurrences. Two observable phenomena have been proffered as quantum expressions of *indeterminacy*.

First, radioactive decay is the event where an unstable nucleus (i.e. radioactive) gives up a particle in order to stabilize.[34] The rate of that energy release is not constant from instance to instance. In other words, at one observation of decay (d_1), it is not possible to predict when the next instance of nuclear decay will occur (d_2). However, over a longer series of observations (d_1 - $d_{1,000,000,000}$), the rate appears rather constant.[35] Radioactive decay is considered *indeterminate* because the precise time between d_1 and d_2 has no structure, not because of the overall stability in the rate of decay.

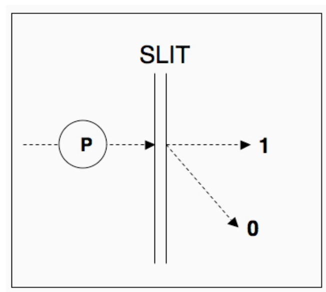

Figure 2

The second observable phenomenon is a photon's spin after being fired through a slit. This event is also used in some quantum random number generators, which employ the physic of

[34] "Radioactive decay: Many nuclei are radioactive. This means they are unstable, and will eventually decay by emitting a particle, transforming the nucleus into another nucleus, or into a lower energy state. A chain of decays takes place until a stable nucleus is reached." Hannah Sevian, Boston University Physics Department [Internet], "Radioactive Decay", Available from http://physics.bu.edu/py106/notes/RadioactiveDecay.html. Accessed 19 April 2007.
[35] Ephraim Fischback & Shu-Ju Tu, "A Study on the Randomness of the Digits of π", *International Journal of Modern Physics C*, Vol. 16, No. 2 (2005), 281-294.

spin to determine a number string.[36] Because the rate of decay and direction of spin are assumed to be *internal*, we must now focus on their *indeterminacy*. Now we are at the central problem of quantum events as instances of metaphysical indeterminacy.[37]

Over a long series of observations, we *do expect* that these discrete bounded expressions will act probabilistically. Without some longitudinal stability in the decay rate, there would be no 'half-life', which is the very basis of metrics such as radioactive dating. But MR also asserts that the *expressed* quantum behavior will be wholly indeterminate *within the bounds of each discrete behavior* (i.e. each photon spin or each decay event).[38]

There is a recorded probability that a photon will spin either 'up' or 'down' as it comes through a slit. There is also a probability that nuclear decay occurs within *particular* time frames, not unbounded time frames. But to affirm MR beyond ER, our indeterminacy must be of the metaphysical variety and therefore make any probability of a particular outcome irrelevant *because there is no law-like behavior in these instances*. For this reason, probabilities should only function as a heuristic at the level of ER and not as a metaphysical description.

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[36] When a photon is fired through a slit, the photon can spin one of two directions. One direction is labeled '1' and the other direction is labeled '0' (see *Figure 5*). Photons are then fired at the slit and the spin is observed at instances $T_1 - T_{16}$. Then, the concordant $base_2$ sequence is recorded (e.g. 0011 1111 0111 1010), which is then converted to a $base_{16}$ number (e.g. 3F7A), which can then form a string of random numbers in $base_{10}$ (e.g. 16250). While '16250' may be the random number generated, it represents the actual observation of 'T_1=0, T_2=0, T_3=1, T_4=1 …'.

[37] Even if there is some probability that subsequent to d_1 (e.g. release of a particle in decay) another decay event d_2 will happen within a particular time frame subsequent to d_1, then we need to caveat exactly what we mean by 'metaphysically indeterminate'. This was addressed in our definition of bounded expression. But it also is the focus of Silverman's study concerning radioactive decay where he is making different quantitative comparisons of radioactive release intervals to determine if there is any pattern set by prior decay events. M. P. Silverman, Wayne Strange, Chris Silverman, and T. C. Lipscombe "Tests for randomness of spontaneous quantum decay" *Physical Review A*, Vol. 61, 042106-9.

[38] In order for Carbon-14 to have a half-life, there must be some particular rate that is accomplished that can be observed longitudinally. If this is correct, then decay is bounded, even if it is metaphysically indeterminate.

This is the crux in endorsing a belief in *indeterminacy*. For in our justification of no law-like causes, we must admit that a metaphysically indeterminate outcome has no probability. This is because probability is an affirmation of some observable expression being described based upon the physical law that underwrites the observation. Even very low correlations are correlations nonetheless. And for a quantum event to be metaphysically random, we would have to believe in 'no probability' based on metaphysical indeterminacy.[39]

For the purpose of this thesis, we need to be able to distinguish any account of metaphysical indeterminacy apart from the aforementioned example of arbitrary number strings from π. After we were aware of the full context of the number string (source: π), none of us would say that the number itself is random, but rather it exhibits random expressions via number sequences because of the absence of some probabilistic structure. By saying there is no 'probable structure', we mean that there is no probability we could assign to the chances that a particular number will come up next in the sequence of numbers. This is an apt description of epistemological randomness.

In looking at physical cases that might be attributed to MR, we must be able to distinguish those physical incidences from the example of π above. If our description of randomness is because we are observing a quantum behavior at times T_1 - $T_{1,000,000,000}$ and observe no law-like behavior, then how is this different from the number string in π?

[39] What are the observational implications of such a view? In radioactive decay, we must be willing to accommodate observations that look determined as another instance of MR. If there is zero probability of a particular time between decay, then we must be willing to allow for the possibility of a 100 year sequence where the decay intervals are '3 hours *like clockwork*'. Or we must be equally willing to account for observations of photon spins appearing determinate at times. The problem is apparent. Whether we want to affirm a causal pattern or MR, we can justify our belief of either based on highly patterned or indiscernible outcomes.

Looking again at the decay of Pu_{94} in Saint Louis, the rate of decay has no inherent law-like structure and we attribute that randomness to some internal quality of Pu_{94}. Our ascription of MR cannot be solely based on plutonium decay observations d_1 - $d_{1,000,000,000}$ because that is exactly how we mistakenly attributed *internal indeterminacy* to the billion digit sequence from π.

Because we cannot appeal to any justification for *indeterminacy outside of a series of observations* that have no structure, then we cannot affirm quantum indeterminacy with any more confidence that we could π's indeterminacy.

Paradox of Justification for Indeterminacy

> The author of a recently published budget of paradoxes is at great pains to prove the truism that any sequence of digits satisfactory for use in random sampling on a very long sequence of trials will contain stretches which are not suitable for use on samples with a fairly small number of members. This he takes to show up 'the ultimate self-contradiction' of the concept. *At most it shows that the concept of random sequence is not of any use*.[40]

Although Ian Hacking is not in full support of Brown's final analysis, the point remains poignant for him and metaphysical indeterminacy as well. In any long series of metaphysically indeterminate sequences, we would 'expect' to see outcomes that look structured. Concerning metaphysical indeterminacy, we could likewise state the paradox of justifying indeterminacy as this:

1. If indeterminacy is justified by appeal to the absence of structure in observation.
2. And if metaphysically indeterminate events have no probability of structured or unstructured observations,
3. And if one must simultaneously believe that metaphysical indeterminacy could express highly unstructured and structured observations.

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[40] Italics mine. Ian Hacking (*Logic of Statistical Inference*, 132) referring to G. Spencer Brown. *Probability and Scientific Inference* (London, 1957), 57.

4. Then observations from metaphysically indeterminate events meant to justify a belief in indeterminacy can simultaneously justify a belief in ~indeterminacy.

Indeterminacy could express a whole range of observable events, from the appearance of deep structure[41] to its total absence of structure. We are effectively saying that in justifying indeterminacy we will not be able to falsify our justification. Karl Popper's renowned dictum applies here where he says, "A theory which is not refutable by any conceivable event is non-scientific."[42]

In effect, the irrefutable belief in the internal indeterminacy of an entity seems to require that one ignore any possible appearance of structure in the entity's behavior, even if that behavior is precisely what led one to believe in its indeterminacy. The belief in metaphysical indeterminacy may even require a belief to be ultimately indefeasible. For if one comes to the conclusion that a number string or observed quantum phenomena were indeterminate, any evidence of the opposite requires a belief commitment beyond the observations themselves.

For instance, imagine that we observe ten billion instances of photons fired through slits and still cannot come up with a probability for an 'up' or 'down' spin the next time a photon is fired through the slit. This would be considered a reasonable justification for claiming that although the outcome must be either 'up' or 'down', there is no physical law that appears to determine either way. Thus, we would say that photon spin here is irreducibly probabilistic in that it must spin either 'up or down', but indeterminate in that there is no regulating principle that causes it to spin either 'up' or 'down' on this particular instance.

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[41] See Appendix C for examples of deep structure in observations.

Now let us imagine that after ten billion ‘indeterminate’ observations of spin, we now see a very particular pattern over the next one billion observations.[43] Here is the paradox in effect. If there is no probability of a particular outcome because there is no law-like behavior underlying the quantum expression, then there is no reason to justify a change in our initial belief (indeterminacy) to a belief in law-like behavior (~indeterminacy).

If we remove the probability of any particular behavior, as metaphysical indeterminacy requires, then we must be willing to explain physical observations on the order of millions of contiguous 1’s, for instance, as a case of indeterminacy.[44] We must be willing to regard those observed discrete outcomes as somehow affirming indeterminacy, even though one billion structured observations would also justify a belief in a physical law of some sort, especially if viewed independent of the prior ten billion observations.

If metaphysical indeterminacy means that there is absolutely no regulation to the sequence, then any observation of structure in the sequence must be illusory.[45] But if we are to take indeterminacy seriously, we must recognize that the very thing that appears to us as a mark of structure must simultaneously be considered as justification toward a belief in indeterminacy. To this, Popper would advocate that we deny indeterminacy

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[42] Karl Popper, “Conjectures and Refutations”, (London: Routledge and Keagan Paul, 1963), pp. 33-39; from Theodore Schick, ed., *Readings in the Philosophy of Science* (Mountain View, CA: Mayfield Publishing Company, 2000), pp. 9-13.

[43] One can ‘take their pick’ as to what counts for a particular pattern. But we could agree on some discernable structure in the observation that is indisputably ‘structured’. Again, See Appendix C for possible observable structured patterns.

[44] It does not require just contiguous 1’s either. We can choose whatever pattern we like: e.g. a series of contiguous prime numbers up to ‘26951!+1’ or a novemdecillion-digit number sequence that alternates 1 and 0.

[45] I will deal with the problem of the ‘illusion of patterned distributions’ and its opposite ‘the illusion of random distributions’ in Appendix A.

because, “Confirmations should count only if they are the result of risky predictions….”[46] That is to say that confirmations that support both one’s belief in determinacy and indeterminacy as it is defined here cannot be risky. According to Popper, this also makes indeterminacy ‘non-scientific’. This is not an absolute defeater for *indeterminacy* as a metaphysic. But it does make the belief in a metaphysical indeterminacy a hard pill to swallow, if not paradoxical.

Finally, although we can find no reason to exclude observations of structure from justifications for *indeterminacy*, this will not be the primary argument against affirming metaphysical *indeterminacy*. The reason for the above discussion then is to highlight the paradox of relying solely on the outcomes of observed quantum phenomena in order to justify their indeterminacy. It still remains unclear what rationalization could be advanced as to why observations of sophisticated structure, if they were to be observed, could be excised from the argument for metaphysical indeterminacy.

THE JUSTIFICATION FOR METAPHYSICAL RANDOMNESS

In reality, the claim of internal indeterminacy *is* supported by observations in high orders of magnitude that demonstrate no structure or illusions of structure in the *expression* of quantum mechanics. With radioactive decay, *the time between decay events* appears metaphysically *indeterminate*. What is the justification? When time difference is observed at decay events d_1 - $d_{1,000,000,000}$, no discernible structure emerges from the observations. The justification for affirming *indeterminacy* in the number sequence from

[46] Karl Popper, “Conjectures and Refutations”, 33-39.

π was due to our observations of n_1 - $n_{1,000,000,000}$ and the quantum observations of decay at d_1 - $d_{1,000,000,000}$ ***now act as the same justification for indeterminacy.***

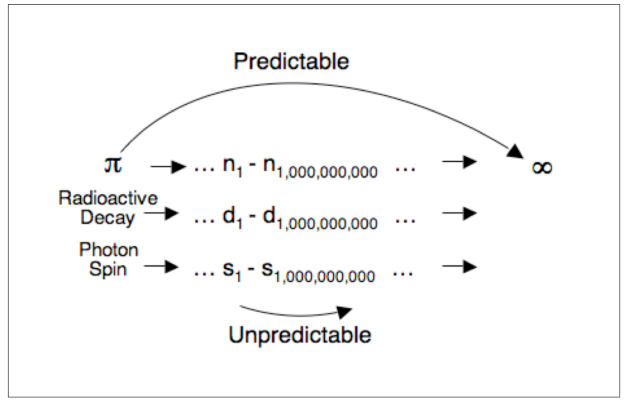

Figure 4

The implication follows directly. If the false attribution of *indeterminacy* is solely based on an analysis of a number sequence removed from its larger context, then how can MR guard against the same mistake that we made with numbers from π?[47]

The difficulties should now be apparent in attempting to represent an event where one could affirm an entity's *internal indeterminacy* through a justification based solely on observations; *even observations of billions of instances and even if it were the actual metaphysical state of affairs*. The problem is not that we merely need more data or that a threshold needs to be established for *indeterminacy*. Rather, an infinite amount of observations would not yield any justification that could be distinguished from the false attribution of indeterminacy with the number sequence from π. Although they provide us the superior case for MR, we must then reject radioactive decay and other similar quantum phenomena as metaphysically random because we cannot establish that they meet the indeterminacy criterion.

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[47] One could make the argument that the regularity of the world above the quantum granularity argues *in and of itself* for a generic 'predictability arc' over the photon spin observations s_1 - $s_{1,000,000,000}$. But this is not the tack taken in the present argument to show a clear arc of predictability where the observational arc can also clearly exhibit epistemological indeterminacy.

OBJECTIONS & CONCLUSION

There are two, if not more, objections encountered to claiming that MR cannot be supported by quantum evidence. First, if the reason we see no pattern in quantum indeterminacy were actually because of MR, then this thesis would still have us reject MR. Whether the current thesis is metaphysically accurate or not, quantum indeterminacy provides one instance where it appears reasonable to be skeptical about an underlying physical law that causes the behavior. At some point, we must face what appears to be the ground floor of quanta and assess whether or not it's reasonable to accept quantum indeterminacy as an instance of MR between entities or the nature of an event.[48]

This is significant, because it is not the goal of this thesis to deny the *possibility of MR*, but to say that we have no substantial reason to assert a metaphysic that is justified through absence of evidence, especially over and above a clearly pragmatic heuristic of ER. Plainly, if MR does not give us any advantage concerning inquiry *and* contains no sufficiently extra explanatory power *and* there is no justification for it, then MR should be tabled in favor of a more economical explanation.

Second, it seems that this thesis could possibly be skeptical of any metaphysical assertion because it holds an unreasonable view of verification. One could protest this analysis in that it seems any claim we make can never be metaphysically weighty because we can always claim it is merely epistemological. What would restrain our skepticism from any discovery of science? But there are metaphysical claims that we can make and empirically support.

[48] We cannot explore here whether or not we have reached that ground floor of physics.

For instance, a claim about the predictability and fidelity of tensile stress formulae can and do faithfully map onto metaphysically observable and verifiable events.[49] The difference between this claim and the claim of MR is that there is a way to substantiate the claim that is not ultimately an epistemological appeal to our ignorance of structure. The route to justification is an appeal to demonstrative observation, not a lack of structure in observation.

The epistemological claim about how we understand tensile stress is helpful beyond epistemology; it is directly pragmatic. There *really* is a physical reality of "stress on steel" whether we want to speak as realists or anti-realists. There is some physical reality that we can observe *as a consequence of* our abstract model of physical stress. This does not appear to be the case for MR.

As we looked at *indeterminacy* in physics, we found no justification that did not either beg the question of irrefutability or the paradox of its own justification. Further, we found that the justifications offered for indeterminacy were indistinguishable from incorrect conclusions concerning the *internally determinate* expression from the number sequence in π.

If the justification for 'metaphysical randomness' cannot be distinguished from epistemological randomness, AND there is no justification for *internal indeterminacy*, AND there is no pragmatic advantage to holding a view of MR beyond ER as a heuristic, THEN 4) we cannot substantially assert anything beyond epistemological randomness as a justifiable heuristic of observable behavior.

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[49] E.g. When we say that the hardened steel in a particular shape exhibits particular aspects of strength, then we have made a metaphysical claim.

Appendix A: Randomness in Distributions & Scientific Inquiry

When the scientific enterprise observes reality, it wants to be able to tell us more than just sequences of numbers. The pursuit of scientific explication wants (anthropomorphically) to tell us what processes lay behind the distributions we observe. Even as science is sometimes said to be purely descriptive, that description often includes the possible causes for the construct expressed under observation. So first, we will look at distributions under the dichotomy of MR and ER. Then, we will consider the matter of probability that undergirds the analysis of distributions.

Michael Polanyi[50] gives this illustration of the predicament of randomness as a metaphysical construct in distributions. He tells us of the train station in Wales where a stationmaster has collected various rocks over the years. These rocks have been kicked around and find their way to the train station lawn. Over the years, the stationmaster's pile of rocks grows. She takes these rocks and creates a rock garden from them. Using the contrasting colors in the rocks, she creates a garden that says, "Welcome to Wales, from British Railways".[51]

We should note that these rocks are all from the immediate region and we could imagine them in a 'natural distribution' as well.[52] Polanyi's simply asks: What is the probability that these rocks could end up in this exact distribution (i.e. "Welcome to Wales") according to MR? We don't really need an answer for this question, but just to

[50] Michael Polanyi was a Nobel Prize winning chemist turned philosopher of chemical and social sciences. See Drucilla Scott's biography of Polanyi: *Everyman Revived: The Common Sense of Michael Polanyi* (Grand Rapids, MI: Eerdmans Publishing Company, 1995).
[51] Michael Polanyi, *Personal Knowledge: Towards a Post-Critical Philosophy* (Chicago: University of Chicago Press, 1962), 163.

say that we could calculate some probability statement that might accurately reflect the probability of this describing a state of MR (say $1{:}10^2$ or $1{:}10^{203}$).[53]

Polanyi asks us to then imagine that we mixed up all these rocks so there was nothing meaningful or discernable about the arrangement of the garden.[54] Polanyi asks us again, "Now what is the probability that the rocks came to this distribution by description of MR?" The probability of both is dead equal if we want to make some metaphysical claim about how probability is metaphysically constrained to the scenario. Although we have some yearning to call the first distribution highly improbable and the second distribution less so, we have no reason for so doing.

We do not need to focus on the actual probabilities involved. Again, the reason we feel a disparity in the probabilities is not a metaphysical reason, but rather it is only epistemological disparity. We should recognize that this example applies to the whole of the scientific enterprise (not just geology).

In looking at distributions, we are looking for the probability of observing a particular phenomenon significantly greater than chance. To understand the significance of chance versus structure, we must closely examine the notion of chance, often taken to be synonymous to MR. In order to find any grounds to assert MR over and above ER, MR must explain the apparent disparity between chance and structure over and above ER. In the example of Polanyi's train station, MR does not offer such an explanation.

In dealing with matters of randomness in distributions, we see that the focus is not on the distribution itself, but rather the analysis of the distribution. Polanyi's rock

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[52] A "natural distribution", for these purposes, would be one where there is no meaningful message and no look of intentionality in the distribution itself.

[53] In order to curtail objections concerning monkeys and typewriters, we will constrain the probability to include a space and time in geologic history and the laws of physics *ceteris paribus*.

garden, among others, gives us reason to suspect that we have no metaphysical motive to assert MR or order, one over the other. There can be instances of distributions that have identical mathematical description, yet we would want to assert radically different causal chains (i.e. welcome messages appearing in rock arrangements). We must look *past* the mathematic descriptions of distribution and *to* the statistical analyses that are meant to derive structure or randomness in observation.

Much of the work done in the area of randomness comes in the form of mathematically stochastic processes and statistical analyses. After all, if we observe some phenomenon, and that phenomenon is merely a grouping of randomly interrelated occurrences (or we could say that it occurs strictly by *MR* as a nomological theory), then there is not much point observing any further.[55] The most extreme form of MR negates any hope of finding real causation and leaves us to merely find pseudo-causes, illusory causes or falsely attributed ones at best. If randomness is an actual and complete metaphysic, statistical analysis should disabuse us of our notions of "prevailing order". This, of course, is a tenet of scientific inquiry; that we can compare our distribution results to those of chance and find meaningful difference (i.e. that we can use inductive-statistical modeling). But we don't need to question the above tenet of science, because it appears to be ubiquitous in formal science. However, we ought to be least concerned with formal science, for it is least prone to get confused by the probabilities or duped by well-known human biases in interpreting observational experience. Instead, science wants to know if we are cohering the pattern of particular phenomena or if we are just seeing MR at work?

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[54] E.g. We just kicked the rocks around for two hours or scooped up the rocks and dropped them

Appendix B: Physical Randomness & The White Noise Effort

Not all claims of metaphysical randomness reduce to epistemological randomness. Some claims are meant to be actual claims about the physical state of relationships between bodies and not simply our ability to understand those relationships. There is also a concerted effort to assert physical phenomena as exemplars of MR, however, this section offers that there is no significant reason to uphold MR in most of these instances (sans the special case of indeterminacy).

The statistical analysis of all experimental science needs to be weighed both internally (re internal fidelity of results, statistical outliers, and such) and externally (re against the possibility that the cause of the results is not outside the scope of the research). It is this external analysis, contra pseudo-random results, that evinces the power of the experiment to capture the construct investigated (i.e. construct validity).

It appears, then, that the pseudo-random number generators should be of the highest quality (i.e. highest level of randomness). For if statistical analyses of observed phenomena cannot give substantial reason to believe in a particular explanatory construct over and above the belief that these phenomena occurred at random, then the whole of scientific discovery is epistemologically for naught.

But is this the case? We should say here that *most* random number generators cannot generate metaphysically random numbers.[56] Most random number generators

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[55] Even trying to define MR in terms of nomological theory is problematic because MR is fundamentally a total violation of law-like behavior.

[56] We will tentatively acquiesce to say ‘most' at this point until it can be more fully demonstrated that no random number generator outputs metaphysically random numbers. Indeterminacy exhibited by quantum random number generators produce number sequences based on indeterminate outcomes. For this thesis, we will have to consider indeterminacy as a separate concern.

fashion number sequences that are caused by formulae. It is just that the formulation is sufficiently occult and/or complex *to us*, that we believe it to be least affected by anything going on in a specific experiment.

Of course, the same is true of slot machines and cryptology as well. They rely on the least amount of direct relation between the generation of these pseudo-random numbers and the derived results from experimentation. So that if I am observing slot machine outcomes that synchronize with any other activity, then we begin to suspect a "secret cause". Oppositely, if I am comparing my statistical results from observation against 'random number sequences' and detect some covariance and/or synchronization between the sequences, then I suspect some "secret cause" to be at work in the generation of the number sequences.

As computational powers grew, so did the ability to *see through* pseudo-random numbers to their underlying formulae. Simultaneous efforts were made on several fronts to find sources of numbers that might derive from MR, not pseudo-randomly generated.[57]

The major foray to find MR in the physical realm is what we will call the White Noise Effort. This effort presumes that if the physical reality that surrounds us is fundamentally random at some granularity, then *that* reality is where we should look for sources of randomness. Formulae, no matter how sophisticated, will always produce deterministically caused numbers. While these efforts are rooted in observing randomness as a metaphysic, the question for this thesis is whether or not they function *as a form of* MR or as a *belief about MR* and thereby reduce into an epistemological view of randomness?

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[57] Deborah J. Bennett, *Randomness* (Cambridge, MA: Harvard University Press, 1998), 138-9.

The White Noise Effort[58] is meant to be a conglomerating term based on a simple idea: find some naturalistic source of entropy and quantify it. Then take these quantifications and use them as a 'seed' to which some recursive formulae can be applied in order to yield random numbers.[59] If we find things that have no 'natural correlation' then they should co-vary randomly, or without any affective metaphysical relationship (from the purview of statistical analyses). For instance, if we were studying rates of violent crime in Eastern seaboard states, we could find some other number source by measuring some other phenomenon that co-varies randomly. We could measure rainfall amounts on a particular ridge of the Bitter Root Mountains in Montana. There should be no correlation between these two quantifications.[60]

This must be done very carefully, even for moderate results. We could quantify ice cream sales, for instance, and use those numbers as 'background noise' to our selected area of study: violent crime. This would be an example of poor choice of 'background noise' for it appears that ice cream sales and rates of violent crime co-vary in a specific relationship.

When ice cream sales rise, so too does the rate of violent crime. This classic example of *spurious variables* in experimentation exaggerates the problem of the white noise effort.[61] There was an open question as to whether white noise was an actual source of MR, but as its use has continued, it is fairly clear that white noise comes in specific patterns that cannot be guaranteed to co-vary randomly with any other observable

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[58] This is my coinage.

[59] Deborah J. Bennett, *Randomness,* 142.

[60] Ian Hacking cites an incidence of this kind of attempt with the RAND machine. *Logic of Statistical Inference*, 129-30.

[61] The spurious variable between ice cream sales and violent crime is temperature. The increase of temperature co-varies with ice cream sales and violent crime for many direct and indirect reasons.

phenomenon.[62] Whether it is the stated presumption of the White Noise Effort that it observes MR or not, it is an assumption that often remains unstated and that many would share prior to any explicit knowledge of their results [63]

The end result of studying white noise at the granularity of classical physics is: practical heuristic. Background noise derived from the cosmos can be pragmatically applied with some success. For instance, signal-to-noise ratios are a common application of background noise used as a metric to determine the intended pattern. Indeed, this is the spinal column of all electrical signal transmission in the 21st century. However, the pragmatic pay off of the white noise effort at the cosmological spectrum does not give way to the acceptance of white noise as an instance of MR. It has been generally observed that whatever the source of "noise", there is always some discernable pattern.[64] And thus, the White Noise Effort is not actually an instance of MR at all. Further, white noise also reduces to an instance of ER.

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[62] An objector could insist that we use something completely unpredictable (e.g. number of sneezes in zip code 63143 on a given day × ratio of public school students to stray dogs captured ÷ the factorial of temperature on the radiator of a given truck). Again, if the frame conditions are known, then it is still recursive and deterministic.

[63] In the texts consulted concerning mathematic application of the possibility of random function, there is no hint of a discussion about what underlies the mathematic principle. This may leave the reader to assume that the functions resemble natural processes, especially being directly tied to physical sources of white noise. Takeyuki Hida & Si Si., *An innovation approach to random fields : application of white noise theory* (River Edge, NJ : World Scientific, 2004). Even further, Harvard University Press devotes an entire text to the subject of 'randomness' and yet there is no discussion of metaphysical bonds or the notion of randomness and the physical world. Although the text is fully adequate in describing epistemological approaches to randomness, its approach to the physical realm is wholly deficient. Deborah J. Bennett, *Randomness* (Cambridge, MA: Harvard University Press, 1998).

[64] As archetypal examples, we can see instances where *white noise* exhibits structure and where noise evokes structure. First, *random* noise of charges in metal oxides exhibits observable pattern. F. Crupi (et al), "Noise as a Probe of the Charge Transport Mechanisms Through Thin Oxides in MOS Structures," *Fluctuation & Noise Letters*; June 2001, Vol. 1 Issue 2, p 61. Second, studies have found that 'random' noise created patterned behavior upon the nervous system of fish and other creatures with statistical significance. David F. Russell (et al), "Noise Effects on the Electrosense-Mediated Feeding Behavior of Small Paddlefish," *Fluctuation & Noise Letters*, Vol. 1, No. 2 (2001), pp 71-86.

Because the earlier forms of white noise were typically a direct or abstracted reflection of the cosmic level of physics, and physics above the quantum spectrum are found to be quite regular and predictable, the effort to find cases of metaphysical randomness shifted to the irregular and unpredictable scope of quantum mechanics. With the growth of cryptography and statistical analysis in the 21st century, the need for a *purer* source of randomness was constantly propelled toward quantum random number generators.

Appendix C: Possible Number Sequences

Chiastic Sequence Observed: $T_{1\text{-}103}$

‘1’	‘2’	‘3’	‘4’	‘5’	‘6’	‘7’	‘8’	‘9’
$T_{1\text{-}20}$	$T_{21\text{-}35}$	$T_{36\text{-}45}$	$T_{46\text{-}50}$	$T_{51\text{-}52}$	$T_{53\text{-}58}$	$T_{59\text{-}68}$	$T_{69\text{-}83}$	$T_{84\text{-}103}$

Chiastic Structure:

11111111111111111111
222222222222222
3333333333
44444
5
5
66666
7777777777
888888888888888
99999999999999999999

Embedded ‘7’ Sequence Observed: $T_{1,2,3\ldots}$

579277653777589977778594257777748643677777703139551777777736966053377777
77735222509077777777721668229607777777777363952421384777777777704955396
9992777777777777…

Embedded ‘7’ Structure:
57
9277
653777
58997777
85942577777
486436777777
03139557777777
369660537777777
352225090777777777
21668229607777777777
363952421387777777777
04955396999277777777777…

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