REDUCTIVE IDENTITIES: AN EMPIRICAL FUNDAMENTALIST APPROACH

DOUGLAS KUTACH

ABSTRACT. I sketch a philosophical program called 'Empirical Fundamentalism,' whose signature feature is the extensive use of a distinction between fundamental and derivative reality. Within the framework of Empirical Fundamentalism, derivative reality is treated as an abstraction from fundamental reality. I show how one can understand reduction and supervenience in terms of abstraction, and then I apply the introduced machinery to understand the relation between water and H_2O, mental states and brain states, and so on. The conclusion is that such relations can be understood either as metaphysical contingencies or as necessary type-identities.

1. EMPIRICAL FUNDAMENTALISM

The following is a brief introduction to a philosophical program, Empirical Fundamentalism, and its application to the question of how to understand the identification of water with H_2O and similar claims. Empirical Fundamentalism constitutes a general philosophical system, and it can only be defended through an extensive examination of its numerous implications for a broad array of philosophical issues because such frameworks are justified in terms of their utility, not their veracity. Providing an adequate argument that its approach to philosophical problems is superior to extant alternatives would require a multi-volume treatment. Consequently, for brevity, much of the defense of the underlying assumptions of Empirical Fundamentalism is provided elsewhere. All I can present here is a single test case, an illustration of how Empirical Fundamentalism allows us to make sense of reductive identities in a flexible way that avoids ontological profligacy. This justification fits within a broader argument for Empirical Fundamentalism: that it is able to solve many traditionally intractable philosophical problems by translating them into a debate about the character of fundamental reality. To the extent that we can answer or at least bracket the question of how

Date: March 20, 2011.

This research was produced with the support of the National Endowment for the Humanities through a Summer Seminar stipend. I received very helpful comments from John Heil, Robert Rupert, Kevin Morris, Jaegwon Kim, and two anonymous referees from *Philosophia Naturalis*.

fundamental reality is structured, the remaining philosophical debate must concern what is non-fundamental, and such debates (within the framework of Empirical Fundamentalism) are often definitional quibbles that can be solved on pragmatic grounds.

Empirical Fundamentalism is built on two philosophical pillars: empiricism and fundamentalism. The fundamentalism part, as I will soon elaborate, is a metaphysical framework that employs a certain conception of the difference between fundamental and derivative reality in order to resolve philosophical disputes. Empirical Fundamentalism declares that the distinction between fundamental and derivative should be the central focus of metaphysics. There is a long history of similar distinctions: the classic reality and appearance dichotomy, Boyle's and Locke's primary and secondary qualities, Sellars' scientific and manifest image, as well as the familiar distinction between objective and subjective. The Empirical Fundamentalist judges such distinctions to be suboptimal for understanding reality and instead seeks to enthrone the fundamental/derivative distinction as the new monarch of metaphysics.

The version of empiricism invoked by Empirical Fundamentalism adopts a thoroughly naturalistic approach to fundamental reality. It involves, first of all, a flexible conception of what should count as empirically accessible: taking for granted (at least initially) a common sense approach towards observability and then refining the scope of the empirical wherever needed. Empirical Fundamentalism is not committed to an extreme phenomenalist form of empiricism but is empirical in the same way that practicing scientists see themselves as providing theories of empirical phenomena.

Second, Empirical Fundamentalism operationalizes its conception of fundamental reality through the hypothesis that our best guess about the components of fundamental reality comes by way of a global abduction. Fundamental reality, insofar as we can know it, is taken to match that model of fundamental reality which best accounts for all empirical phenomena. Underdetermination, of course, sets limits on the precision such an inferential technique can deliver, and Empirical Fundamentalism is compatible with the hypothesis that fundamental reality corresponds to a class of models that are empirically adequate and are equivalent with regard to their consequences for empirical phenomena so that the problematic inference from empirical adequacy to truth is somewhat mitigated.

Third, Empirical Fundamentalism is committed to empirical analysis as its method of conceptual analysis. Conceptual analysis is necessary for providing linkage between our conception of reality and reality itself. As discussed in Kutach (2010, 2011), empirical analysis differs from orthodox conceptual analysis primarily by rejecting the dogma that a conceptual

analysis is deficient if it conflicts with common sense intuitions or a priori truths. Instead, empirical analysis adopts the well-entrenched scientific approach towards conceptual architecture by optimizing concepts in whatever ways enhance understanding rather than insisting that metaphysical pronouncements are inferior when they mismatch naive preconceptions.

Having noted the role of empiricism, I will concentrate hereafter on the fundamentalism part of Empirical Fundamentalism.

My application of Empirical Fundamentalism to reductive identities can be interpreted as a competitor to the more familiar approach advocated by Frank Jackson (1998). Although I share the goal of clarifying a target vision of reality where the aspects of the world described by fundamental physics constitute most (if not all) of a supervenience base for all reality, there are key respects in which our conception of the target differs. The points of disagreement, I suspect, stem primarily from a difference in perspective regarding the prominence that language and psychology should have in such an account. I think most contemporary approaches towards metaphysics have been hampered by the persistent influence of the century-old linguistic turn in philosophy, including its various incarnations in logical positivism, ordinary language philosophy, and the Canberra Plan. My account, by contrast, attempts to engineer metaphysical concepts without hewing closely to linguistic or cognitive structures and without adhering to theories of reference or truth or intentionality that are adapted to the study of human language and thought. Instead, I will attempt to formulate the familiar reductive picture of reality using conceptual structures more closely resembling those used in physics.

I will initiate discussion of the details by clarifying the distinction between fundamental and derivative that plays the starring role in Empirical Fundamentalism. Then, using the example of kinetic energy as a derivative quantity in classical mechanics, I will clarify how derivative existents can bear a certain reductive relation to fundamental reality. Along the way, I will provide three brief suggestive arguments for Empirical Fundamentalism: that it provides a useful model of modality, that it helps to illuminate the disutility of many a priori arguments, and that it helps to explain away many metaphysical disputes. Finally, I will construct some additional theoretical machinery to help formulate a model of derivative properties. Two ways of defining derivative properties—what I will later describe as an unfocused way and a focus-fuzzed way—allow us to make sense of how the relation between water and H_2O can constitute a type identity.

2. Fundamental and Derivative Reality

Most people, I think, have some intuitive grasp of the difference between fundamental and derivative. In order to direct the reader's attention towards the particular form of the distinction employed in Empirical Fundamentalism, I will list a few guiding principles and then describe how we can think of kinetic energy as a derivative property that reduces (in a sense I will eventually clarify) to fundamental attributes like mass and relative speed. (An attribute is a property or relation, broadly construed.)

Perhaps the easiest way to get a grip on the fundamental and derivative is to start by thinking about reality in a rather naive way. Just consider everything that exists, including all objects, properties, relations, substances and whatever else you think needs to be included. The totality of existents, including all their relations with each other is what we call 'reality.' Then, we can think of reality as subdivided into exactly two parts, fundamental and derivative. 'Fundamental' and 'derivative' are at this point placeholders for a distinction that one can elaborate by filling in with a description of the conceptual role that 'fundamental' plays. On a first pass, it is convenient to operate under the regimentation that every existent is either definitely fundamental or definitely derivative and that these are mutually exclusive categories. Afterwards, one can take up the project of characterizing how the boundary between the fundamental and derivative and between the existent and non-existent could be indeterminate.

The following principles capture several constitutive features of fundamentality.

(1) Fundamental reality is as determinate as reality ever gets.
(2) Fundamental reality is consistent.
(3) The way things are fundamentally is the way things *really* are.
(4) Fundamental reality is the only real basis for how things stand derivatively.

A fifth principle one could entertain is that relatively little of reality is fundamental. Certainly, many prominent speculations about fundamental reality assert that it consists of a relatively sparse structure. Perhaps fundamental reality is just some atoms bouncing around in the void. Perhaps it is merely a single conscious being with temporally ordered mental states. By and large, sparse theories of fundamental reality make for more interesting metaphysical hypotheses, but it is best to avoid incorporating a desire for a parsimonious model of fundamental reality as a constraint on what it is for something to be fundamental. Instead, it is better to think of this principle as a truth that makes it especially useful to employ the distinction between fundamental and derivative.

Some other prominent hypotheses about fundamental reality are also best excluded from the conception of fundamentality. For one, fundamentality is often associated with a so-called fundamental *level*, which suggests something like the Putnam-Oppenheim-Kemelny (1958) layer cake model of the unity of science where there are different theoretical levels—for example, ecological, biological, chemical—each of which (they hope) reduces to the level directly beneath it. On the Empirical Fundamentalist conception of reality, the ontological distinction between fundamental and derivative reality is inherently binary and rules out the possibility of multiple levels that bear to each other the same kind of relation that holds between fundamental and derivative. To avoid confusion, I advise not thinking of fundamental and derivative reality as levels.

Fundamentality is also sometimes associated with smallness and in particular the empirical hypothesis that as one focuses at ever smaller distance scales, one reaches some scale beyond which reality has no interesting further structure. This is another thesis best separated from fundamentality because ceteris paribus it is better to insulate the features that motivate a notion of the fundamental from the implementation details. The same goes for requirements that what is fundamental be metaphysically simple or be composed of only localizable property-instances; it is better to allow that fundamental entities can have complexity, can consist of parts, and can be non-local.

I will now attempt to specify the constitutive features of fundamentality in terms of the example of kinetic energy in classical mechanics, which will serve as a model of reduction.

3. The Kinetic Energy Example

The theory of classical mechanics is a scheme for modeling how material bodies move in accordance with force laws. I will focus on a specific interpretation of classical mechanics, N, whose purpose is to clarify ontological commitments. Other interpretations of classical mechanics exist, but it is not my aim here to settle disputes in the philosophy of physics or to represent classical mechanics as it was understood by its inventors.

The ingredients of N include (by stipulation) a classical spacetime inhabited by corpuscles bearing intrinsic properties like mass and charge. A corpuscle is a point particle; it has an identity through time and occupies a single point of space at any given moment, so that its history over any span of time is a smooth time-like path in spacetime. Corpuscles in classical mechanics bounce around according to exceptionless laws where each corpuscle's acceleration is a relatively simple mathematical function of fundamental attributes, for example the inverse-square law of gravity and some

sort of short-range repulsive interaction. In summary, N posits the following structures: a Galilean spacetime, corpuscles with charge and mass properties, a distance relation between any two corpuscles at any given time, a relative speed relation between any two corpuscles at any given time, and a dynamical law governing how these fundamental attributes evolve over time. A model of N consists of the laws as well as a full arrangement of the allowed entities and attributes throughout spacetime.

Though we know N is an incorrect theory, it is convenient to consider how we ought to think about reality under the pretense that the actual world perfectly matches one of N's models. Having adopted N as a surrogate for a complete correct theory of fundamental reality, we can distinguish between fundamental and derivative. The corpuscles and spacetime are fundamental entities, their relative distances and speeds are fundamental relations, their masses and charges are fundamental properties, and the cited laws governing them are fundamental laws. Noises, patience, and asset forfeitures, by contrast, are not fundamental because they do not appear as elements in the model nor do the laws of the simple theory make any special use of them. Because noises, patience, and asset forfeitures exist and are non-fundamental, they are derivative existents.

In more generality, we can think of fundamental reality as a system of magnitudes and their structural relations, including laws that constrain the complete layout of magnitudes. Once we have adopted some particular specification of these magnitudes and structures as a complete specification of fundamental reality, we can construe derivative existents simply as existents that are not part of fundamental reality, quantities and attributes and entities that are unspecified. Unfortunately, ordinary language and much of extant philosophical terminology is too imprecise or contested to communicate clearly the kind of ontological distinction posited by Empirical Fundamentalism, so a bit of elaboration is required on the topic of derivative reality.

I advise adoption of the following sufficient condition: a quantity is derivative if its magnitude requires the specification of quantities that are not a part of fundamental reality. By definition, the kinetic energy of any given corpuscle is one-half its mass times its speed squared, $\frac{1}{2}mv^2$. But there is nothing in N that defines a given corpuscle's absolute speed; a corpuscle's speed is defined only relative to other corpuscles. However, if we choose some reference frame and stipulate that it counts as the standard for being at rest, we can say that a corpuscle's speed is its speed relative to this rest frame. Then, because we can associate a unique speed with each corpuscle, there will be a particular value for the corpuscle's kinetic energy. The kinetic energy of a corpuscle is an example of a derivative quantity because there is nothing in any model of N that corresponds to a unique

correct value for the kinetic energy unless we augment the model with a parameter that doesn't correspond to anything in fundamental reality, namely this stipulation of what counts as at rest. Once we make a choice of rest, the fundamental magnitudes fix the kinetic energy of every corpuscle. The total kinetic energy is also thereby fixed because it is just the sum of the individual kinetic energies.

Whenever a parameter used for describing reality does not have a unique correct assignment given how fundamental reality is structured, let us say that it is *fundamentally arbitrary*. A choice of rest is an example of a parameter that is fundamentally arbitrary. More generally, reference frames and coordinate systems are fundamentally arbitrary.

There are several justifications for treating kinetic energy as derivative rather than fundamental. For one, we already have fundamental laws in classical mechanics governing the motions of particles, and if there were some brute (fundamental) fact about precisely how much kinetic energy existed, it would play no essential role in the temporal development of the physics. (It is possible to formulate classical mechanics so that energy plays a starring role in the temporal development, but N grants kinetic energy no special status.) Another reason to think of kinetic energy as derivative is that if there were a brute (fundamental) fact about the precise quantity of kinetic energy in the world, we would have no epistemic access to its value. A third reason is that there is no scientific account of anything that would be defective in any way if we treated kinetic energy as derivative, nor would any scientific account be improved by treating it as fundamental. These kinds of considerations are standard in scientific practice and provide a practical grip on why we construe some quantities as fundamental and others as derivative. If we try to allocate various attributes to the categories of fundamental and derivative using the methods of science, we have good reasons for keeping the fundamental ontology fairly restricted. Ceteris paribus, a sparser theory of fundamental reality can provide more reductive explanations, posit fewer epistemically inaccessible facts, posit fewer quantities that fail to integrate well with the rest of the fundamental quantities, etc. Although these criteria are not sacred, it is reasonable to treat kinetic energy as metaphysically derivative, and the discussion from here on will do so.

4. Fundamentality

In this section, I will use the kinetic energy example to clarify the constitutive principles defining the notion of fundamentality that serves as the foundation of Empirical Fundamentalism.

(1) The principle that the way things are fundamentally is as determinate as reality ever gets is illustrated well by the kinetic energy example. The derivative is at least as indeterminate as the fundamental in the sense that we had to supplement the fundamental attributes of N with a fundamentally arbitrary parameter in order to get a definite value for the kinetic energy. Put simply, no specific amount of kinetic energy is fixed by fundamental reality even though all the fundamental attributes are absolutely precisely defined. (This principle does not rule out the possibility that fundamental reality includes some sort of ontic vagueness.)

(2) To say that fundamental reality is consistent is to say it obeys a metaphysical correlate of the law of non-contradiction.[1] Derivative reality, by contrast, is subject to a more permissive scheme of managed inconsistency where certain inconsistencies can be tolerated if there is a suitable scheme for blocking any troublesome logical implications. Because the details of how we should understand this second principle do not bear directly on the topic of reduction, I will forgo any further discussion of it here.

(3) The principle that the way things are fundamentally is the way things *really* are is intended to express the relationship between fundamental reality and ontology. I will attempt to describe the ontological difference between fundamental in several ways in order to mitigate some of the confusion that is generated by the variety of interpretations that could be given to the terms 'real' and 'exists.'

(a) Empirical Fundamentalism instructs us to think of the actual world as fundamental reality. The actual world does not consist of everything that is the case. It is not equivalent to the totality of propositions that are true of the actual world, nor does it consist of all states of affairs or all facts. Instead, the actual world is just the one fundamental reality and does not include any derivative existents as components or parts or constituents.

To explore this hypothesis in more detail, it helps to examine the Empirical Fundamentalist's conception of possible worlds:

> A metaphysically possible world is a logically possible fundamental reality.

The function of the word 'logically' here is merely to signify that the operative notion of possibility is entirely unrestricted. Incoherent or inconsistent specifications of a fundamental reality will fail to refer to any possible worlds, but any coherent, consistent description of how fundamental reality could be will correspond to a metaphysically possible world. An important qualification to this principle is that if a description W of a possible fundamental reality is based on how the one actual fundamental reality is structured—for example, a possible world just like the actual world but

[1] Tahko (2009) defends such a version of the law of non-contradiction.

twice as big—then there will exist a metaphysically possible world corresponding to W only if the actual world is suitable for such an alteration. It is arguably coherent to double the size of the universe when you disregard the relevant physics, but if the true structure of fundamental does not permit a sensible doubling, there will be no corresponding possible world. This feature suffices to block the general inference from conceivability to possibility. In particular, natural kind terms and words like 'zombie' incorporate an implicit reference to actuality that makes them untrustworthy predicates for describing a genuine possible world.

It is beneficial that in Empirical Fundamentalism, the set of metaphysically possible worlds is not a proper subset of the set of all possible worlds. If a possibility is cogent enough to count as a world at all, it is a metaphysically possible world. Having possible worlds that are not metaphysically possible would make it unclear how we could ever gain rational access to the boundary between metaphysical possibilities and metaphysical impossibilities. We have a workable though imperfect practical grip on the difference between nomological possibilities and nomological impossibilities by way of our standards for evaluating scientific theories. But if there were some dispute about whether a certain conceivable but nomologically impossible world is metaphysically possible, how would we be able to decide rationally? As discussed by Leeds (2001, p. 172–173), empirical evidence would be of dubious value because the world under consideration is nomologically impossible. Conceptual and logical resources would be of dubious value because by hypothesis the boundary we seek is a further division among possibilities that are already accepted as coherent and logically possible. I have no conclusive argument that such a model of metaphysical possibility is unworkable, but it is a mark in favor of the model of metaphysical possibility employed in Empirical Fundamentalism that it does not suffer from this liability.

For an illustration of how to individuate possible worlds and thus an illustration of what a world consists of, consider the following two possible worlds. Let w be a model of N that is superficially just like the actual world. As detailed previously, w consists of a Galilean spacetime with a bunch of infinitely long corpuscle world lines with mass properties, charge properties, distance and relative speed relations between every pair of corpuscles at every moment and a fundamental law that governs how the state at one time evolves over time. It contains nothing else. Let w^- be just like w except with all the relative speeds excluded. The mere fact that w differs from w^- solely in virtue of w's including the relative speeds suffices for w and w^- to count as distinct possible worlds. Notice that because w^- has the same spacetime structure and the same fundamental distance relations between every pair of corpuscles at any given time, the fundamental attributes of

w^- entail the relative speeds at all times. That is, w^- has all the resources needed to specify w and no information that goes beyond what is specified in w. The only difference between them is that relative speeds are fundamental in w but are derivative in w^-. This example illustrates that there is no closure principle associated with being fundamental. The fact that all relative speeds in are logically implied by the structural relations of w^- is not sufficient to count these relative speeds as fundamental.

One of the central motivations for defining a metaphysically possible world as a logically possible fundamental reality is to ensure that the relation between fundamental and derivative is not part of actuality. Some competitors to Empirical Fundamentalism build the relation between fundamental and derivative into the structure of the actual world. In such models, what is fundamental and what is derivative are both components of actuality and what distinguishes them is some metaphysical relation that is also a component of the actual world. For example, one might postulate that some parts of actuality are linked to one another by the grounded-by relation (Audi 2007). Or one might say that some parts bear a relation of ontological priority (Cameron 2008, Paseau 2009) to other parts. One could postulate in-virtue-of relations or realization relations as metaphysically robust elements of the actual world. Empirical Fundamentalism opposes all such devices for characterizing the relation between fundamental and derivative and instead holds the following: (1) The actual world and all of its parts are fundamental, and nothing else is fundamental. (2) Derivative existents and any relation they bear to fundamental existents are not part of the actual world. Truthful statements about derivative existents (and any linguistic or cognitive references to them) are vindicated not because there is something in actuality that precisely corresponds to them but because of the utility of certain ways of abstracting away from fundamental reality.

(b) Existence in Empirical Fundamentalism can be understood in terms of a tripartite distinction between fundamental existence, derivative existence and non-existence. Our ordinary talk of 'real' tracks the difference between existence (whether fundamental or derivative) versus non-existence. By contrast, debates about realism and anti-realism, according to Empirical Fundamentalism, ought to track the difference between fundamental existence versus derivative existence or non-existence. I will now briefly sketch how this tripartite distinction allows the Empirical Fundamentalist to dissolve a debate concerning the metaphysical status of colors. I hypothesize that similar dissolutions can be provided for many other philosophical squabbles. Further examples of this sort would bolster the case for Empirical Fundamentalism.

Consider whether colors exist. C. L. Hardin (1988, pp. 111-112) argues for a version of color eliminativism, a denial of the existence of colors. He

does so on the grounds that no existent plays the constitutive role of color well enough to deserve the label. The platitudes characterizing what it is for color to exist include principles that are in tension with one another, for example that the surface colors of objects exist regardless of whether any creatures have visual abilities and that orange is more similar to red and yellow than it is to blue and green. Most other philosophers of color disagree by claiming that colors exist.

This disagreement can be adjudicated by first recognizing some common ground. Almost everyone in this debate agrees that there is good scientific reason to believe that color is not a fundamental attribute.[2] If that is correct, then the debate only concerns whether colors should count as derivative existents rather than non-existents.

According to Empirical Fundamentalism, to put it one way, a possible existent X is a derivative existent if and only if X is not fundamental and fundamental reality is such that reference to X is handy and not too misleading. To put it another way, X is derivative if and only if X is not fundamental and X is a useful abstraction from fundamental reality. Much more deserves to be said about derivative existence, but I have deliberately phrased these necessary and sufficient conditions in a non-technical (and arguably sloppy) manner because it is a tenet of Empirical Fundamentalism that the distinction between existence and non-existence has little metaphysical significance and that there is no need for a metaphysical scheme to clarify a precise boundary between derivative existence and non-existence. Although it may strike the traditional metaphysician as heresy to declare that there is no deep difference between that which exists and that which does not, the Empirical Fundamentalist embraces the role of iconoclast by claiming that the important ontological difference lies instead between that which exists fundamentally and that which does not.

Applying this to our mundane attributions of color, we are justified in setting aside philosophical niceties and using a very lax standard whereby color exists merely in virtue of fundamental reality being such that our talk of color is useful for getting along in the world. Because the platitudes that constitute our conception of color prove to be useful rules of thumb—objects are usually perceived as near enough the same color by most people in most relevant circumstances and so on—we should not be too picky about the coherence of such principles and just accept the utility of the color platitudes as reason enough to accept that color exists. When discussing color in the context of metaphysical debate, however, it is permissible to adopt stricter standards. The boundary between derivative existence and

[2] I count Cornman (1975) and Campbell (1993) as dissenters on this point.

non-existence is meant to track any raising or lowering of our standards for how well the actual world vindicates the constitutive platitudes for color.

So the dispute over the existence of colors becomes, in the Empirical Fundamentalist framework, a merely pragmatic squabble about how strictly the various platitudes concerning color should be interpreted in order for colors to exist derivatively. Under lax standards, color exists derivatively because 'color' is a handy and not too misleading term. Under very tight standards, Hardin is arguably correct that color does not exist because there is no simple non-trivial way to abstract away from fundamental reality to arrive at a single quantity that simultaneously satisfies all the platitudes constitutive of color.

(c) Derivative existence is the kind of existence that is adequate for securing the legitimacy of cognitive or linguistic reference whereas fundamental existence is the kind of existence needed for ontological significance. For example, it is irrational to believe that Eve owns a coat that does not exist, but it is perfectly reasonable to believe that Eve owns a non-fundamental coat.

This difference between existence and fundamental existence can play an important role in debunking many a priori arguments that attempt to establish what fundamental reality must be like (beyond what is analytic or true by stipulation). The Cartesian cogito, for example, can be re-imagined as an argument from the premise, "Any thought with the content 'thinking does not exist' is necessarily an existent whose content is false," to the conclusion, "Thought exists." Such an argument can be attacked from a number of directions, but its key deficiency from the perspective of Empirical Fundamentalism is that even if the argument were considered successful in establishing its conclusion, it would only demonstrate that thought exists, not that thought exists fundamentally. Thus, this argument does not motivate the hypothesis that thought is an attribute of an enduring soul, nor does it make any progress in attacking physicalism or the more narrow claim that all thought exists in virtue of the behavior of appropriate brains in appropriate physical environments.

It is easy to apply the same analysis to refute many other a priori arguments that attempt to establish conclusions about how fundamental reality is structured. Such demonstrations, I believe, count in favor of the tripartite distinction between fundamental, derivative, and non-existent.

(4) The fourth constitutive principle of fundamentality is that fundamental reality is the only real basis for how things stand derivatively. It is intended to serve as something very close to a claim that derivative reality supervenes on fundamental reality. I hesitate to claim that it is a bona fide supervenience claim because supervenience claims are often understood in terms of entailment, and it proves critical for the scheme I am proposing to

avoid implying that fundamental reality *by itself* completely fixes the character of derivative reality. In order to clarify how derivative reality depends on fundamental reality, I will first introduce a new kind of reduction, and second show how it vindicates claims of supervenience, and third discuss how the supervenience-like relation between the derivative and fundamental can hold generally, even without an explicit reduction.

It is important to note although this fourth principle partly constitutes what it means to play the role of fundamental reality, it also presupposes the ontological distinction provided by principle (3).

Empirical Fundamentalism employs a proprietary notion of reduction called 'abstreduction.'[3] Abstreduction is a form of reduction that operates by explicitly representing derivative existents as abstractions from fundamental reality. In order to illustrate abstreduction, I will draw attention to a critical feature of the kinetic energy example. Remember that in order to derive any specific value for the amount of kinetic energy in a system, one needs the fundamentally arbitrary choice of rest. A complete specification of the fundamental attributes of classical mechanics does not by itself suffice for any particular value of kinetic energy. So, how things are situated fundamentally does not fix how much kinetic energy there is. Yet, given any choice of rest, every detail about the distribution of kinetic energy is fixed. So, there exists a complete conditional characterization of kinetic energy, a complete set of conditionals of the form, "If choice of rest R is made and the state of fundamental reality at time t is $S(t)$, the total kinetic energy is $K(R, S(t))$." By saying, "Fundamental reality is the only real basis for how things stand derivatively," I intend to communicate that the only thing besides fundamental reality that bears on how things stand derivatively are choices about how to abstract away from fundamental reality, choices that do not count as constituents of actuality.

Any parameter-dependent entailment from fundamental to derivative constitutes an *abstreduction*. In general, a derivative quantity q *abstreduces* to fundamental reality if and only if there exists a (possibly empty) set of fundamentally arbitrary parameters such that specifying those parameters is sufficient (in conjunction with a specification of fundamental reality) for q. Abstreduction having been defined so broadly, any non-fundamental quantity can abstreduce to fundamental reality merely by contriving an ad hoc parameter, but non-trivial cases of abstreduction are those where the employed parameter is reasonably general, such as a choice of coordinate system, a choice of spacetime region, or a collection of possible fundamental property-instances, and where the resulting derivative quantity has some utility.

[3]See Kutach (2011) for a case study applying abstreduction to the concept of causation.

One can observe that abstreduction supports a form of supervenience by considering two possible arrangements of particles, a_1 and a_2. A reasonable supervenience claim is that a difference in the kinetic energy of a_1 and a_2 implies that a_1 and a_2 differ fundamentally, especially with regard to the number of corpuscles, their masses, or relative speeds. Because it does not make sense to compare the (derivative) kinetic energy of a_1 and a_2 without a choice of rest for each arrangement and because that choice is fundamentally arbitrary, a difference in the kinetic energy of a_1 and a_2 could result either from a_1 and a_2 being different fundamentally or from their having different standards of rest. In some cases, there are resources available such that a choice of rest for one arrangement will fix a choice of rest for the other, but in full generality, the only way to ensure that the fundamentally identical a_1 and a_2 are identical insofar as derivative quantities like kinetic energy are concerned is to impose a stipulation that (for the purposes of evaluating supervenience) when two arrangements are identical fundamentally, any conventions employed for abstracting away from one must be applied to the other. That suffices to ensure that whenever a derivative quantity abstreduces to fundamental reality, it supervenes on fundamental reality.

Explicit abstreductions may not be available for every derivative existent, and yet it may still be reasonable to believe that supervenience holds. For example, physicalists maintain that whether a certain government is communist supervenes on the complete physical history and laws of the actual world. Although no one is able to supply an explicit set of parameters that (together with the totality of fundamental physics) implies what is communist and what is not, we can still reasonably maintain that if two possible worlds that obey physicalism are physically the same, then whatever principles we use to evaluate the status of a given government as communist need to be applied to both worlds equally. And that is enough to ensure that both worlds agree on which existents are communist.

One of the benefits of construing supervenience in this way is that supervenience by itself is inadequate for accurately characterizing the kind of relationship that arguably holds between kinetic energy and the masses and relative speeds of fundamental corpuscles. For one thing, A's supervening on B is in general compatible with a lack of any asymmetry in the relation between A and B. Abstreduction, however, presupposes an essential ontological asymmetry because abstreduction by definition only exists between a derivative quantity and fundamental reality (or some part of fundamental reality), and it is part of the Empirical Fundamentalist framework that fundamental existents are ontologically privileged over derivative existents. Thus, the sort of supervenience that holds in virtue of abstraction is inherently asymmetrical.

Another shortcoming of supervenience as a tool for representing how kinetic energy depends on the fundamental attributes is that supervenience does not help to represent that arbitrarily small changes in the fundamental arrangement of particles results in arbitrarily small changes in the kinetic energy. In the literature on the mind-body problem, this deficiency of supervenience was identified by Kim (1993) as the "lone ammonium molecule" problem. Supervenience alone, Kim noted, does not prevent the hypothetical addition of a single ammonium molecule to one of Saturn's rings from making a radical difference to Earthly mental states. Although we might have good scientific reasons to question this particular claim of counterfactual independence, the important lesson to draw from Kim's observation is that it is a mark of a good physicalist account of mentality that mental quantities vary in accordance with physical quantities in a way that is at least consistent with the background beliefs that make physicalism plausible. It is possible to concoct any number of crazy functions to represent how the severity of someone's pain depends on the arrangement of all the atoms in the universe. Some of these functions have a person's degree of pain varying greatly as distant atoms are shifted slightly in ways that make a negligibly small difference to the functional behavior of the person's brain. Even though such a pain-function would be compatible with the supervenience of the mental on the physical, it would undermine the reasonableness of our judgments about how much pain other people feel. The supervenience of the mental on the physical ought to fit neatly into a broader (if only dimly seen) account of how mental states vary as a function of physical states. Abstreduction helps to provide such a fit because the resulting supervenience is a consequence of a broader account of how derivative magnitudes vary as a function of fundamental magnitudes (holding fixed all fundamentally arbitrary parameters).

5. Reductive Identities

At this point, enough of the central tenets of Empirical Fundamentalism have been sketched to permit the formulation of a scheme for how water relates to H_2O. In order to fill in the details, a fragment of a theory of reference is required so that the terms 'water' and 'H_2O' can be related to reality. My goal here is to construct a model rich enough to make sense of commonly held opinions about how 'water' is to be understood, especially Putnam's (1975) observation that if we were to discover a substance XYZ somewhere else in the universe that behaves like water but is chemically very much unlike H_2O, it would not count as water. The model I will be constructing says in effect that there are two ways someone could interpret 'water.' One

kind of intension corresponds to what I call an *unfocused* derivative property, where anything that behaves superficially like water counts as water. The other kind of intension corresponds to what I call a *focus-fuzzed* derivative property, where only the stuff sufficiently similar to local instances of watery stuff counts as water. What Putnam in effect pointed out is that, contingently, our implicit concept of water more closely matches the second kind of intension. My conclusion is that in principle we can say anything we need to say about water in either the unfocused or the focus-fuzzed way. In the unfocused way, water is not the same as H_2O. In the focus-fuzzed way, they can be equated. Nature itself does not privilege one construal over the other; that we employ the focus-fuzzed construal is a result of its convenience and historical accident.

In order to present my model, I will mention concepts, intensions, and referents in order to relate the structures I define to familiar philosophical terms, but nothing in the model presupposes a prior notion of intentional content or requires that content be considered fundamental. Contents exist, of course, but I strongly suspect they are derivative like most everything else.

By formulating the indexical character of natural kind terms like 'water' in terms of fundamental reality and abstreduction, I will show how references to water can make sense in a world that is fundamentally just a bunch of physics without any fundamental water. It will thus solve the so-called location problem for water. Unlike the Jackson (1998) methodology, which requires one to locate water by showing how truths about water are *entailed* a priori from truths about fundamental reality, Empirical Fundamentalism allows one to locate water by providing an account of how the concept of water is a *useful* device for abstracting away from fundamental reality. Jackson requires that in order for an entity to be allowed in reality as a bona fide existent, it must achieve "entry by entailment." Empirical Fundamentalism only requires entry by utility.

Before discussing what reductive identities amount to, several preliminaries are needed. Let us restrict discussion to *concrete* derivative entities and ignore non-concrete entities like numbers and algorithms. For a (concrete) derivative entity to exist is for fundamental reality to include an instance of that entity. The derivative entity itself can be thought of as merely some set of possible instances. For example, we can think of a giraffe as a derivative entity by associating it with a set, G, of metaphysically possible instances, the ones we intuitively think of as ways a giraffe could be instantiated. An instance is by stipulation always fundamental. If some part of fundamental reality—say a complete specification g of all the fields and

corpuscles in some spacetime region—is a member of G, we say that *g instantiates* a giraffe (as precisified by G). Of course, what we have in mind when we think of giraffes and what we refer to when we refer to a giraffe do not perfectly match up with any particular precisification, G, but everything that needs to be said about the metaphysics of giraffes can arguably be cashed out in terms of its precisifications.

An instance can be defined formally in several ways. In order to cut to the chase, I will only present a model of instances rich enough to discuss reductive identities. So, for current purposes, let an instance be defined as an ordered pair consisting of a fundamental event and a set of fundamental laws. A fundamental event is a spacetime region together with a full specification of all the fundamental attributes throughout that region. The fundamental laws specify not only the rules for how fundamental attributes evolve over time but also specify any fundamental constants and what kinds of fundamental attributes are allowed. This model of instances can be easily extended to handle relational concepts, but my discussion will focus on its application to rather simple derivative properties like being-water or being-a-table.

A derivative property is by stipulation a set of instances. For illustration, consider the derivative property being-a-giraffe. Some of its instances are a specification of quarks and electrons and electromagnetic fields arranged giraffe-wise somewhere in a 4m cube of space lasting a tenth of a second together with a set of dynamical laws that govern the evolution of these particles and fields. Other instances instantiate the four fundamental elements—fire, water, air, and earth—in appropriate combinations to make a giraffe-ish material body that behaves like a giraffe.

There are no restrictions whatsoever on which sets of instances count as a derivative property. For example, the predicate "frog or carburetor" can be precisifed as a derivative property by specifying an appropriate set of instances, the set that includes instances of what we intuitively take to be frogs as well as instances of carburetors. I emphasize this example because philosophers commonly restrict use of the word 'property' in order to block the inference from the existence of some meaningful predicate to the existence of a corresponding property. Derivative properties, however, are ontologically innocuous, and for the sake of simplicity it is better not to impose any restrictions. Derivative properties that are gerrymandered or consist of unduly heterogeneous instances typically have little utility, so we can set them aside merely on pragmatic grounds.

In order to keep the discussion manageable, I will focus on possible worlds that have a four dimensional spacetime as their sole container for all fundamental fields and corpuscles and that have fundamental laws governing the temporal development of these fundamental attributes such that

the complete state of the world at any one time fixes objective probabilities for all later states of the world. Thus, I will be ignoring how water and tables and giraffes can exist in worlds with two dimensional time, or where physical objects are fundamentally a perceptual state of God, or anything else too outlandish. Furthermore, from here on, I will assume that fundamental reality resembles paradigm models of fundamental physics, at least so that the fundamental ontology does not include properties like being-a-giraffe.

For the simple cases under discussion, talk of derivative properties and concept intensions are interchangeable. Any precisification of the intension of the concept of a giraffe is a set of those possible instances that count as a giraffe, and that in turn just *is* (a precisification of) the derivative property being-a-giraffe.

5.1. **Unfocused Properties.** One important kind of concept is the functional concept, which can be associated with derivative properties through what I call a "test." For reasons that will soon become clear, the derivative properties associated with purely functional concepts will be a special case of what I call "unfocused properties." Our ordinary concept of a table can be construed in terms of its function in the sense that a table is anything that behaves in a table-like way. (Remember that it is not important in Empirical Fundamentalism whether thinking of tables in a purely functional way perfectly matches our intuitive concept of a table. It suffices that our concept of a table comes reasonably close to being merely functional.) In order to cash out what it means for something to behave in a table-like way, one can use the following procedure: Start with any spatial region r in a single time slice of spacetime as shown in Fig. 1, and specify some fundamental laws, L. Let e be any r-shaped fundamental event compatible with L. Then consider various possible background conditions, $\overline{B_i}$, occupying the entire space outside r. Each $\overline{B_i}$ is a set of fundamental events with a probability measure over the set to allow it to represent in a fuzzy way what could happen outside r. Now consider what we get when we graft e on to $\overline{B_i}$ by letting $\overline{C_i}$ be just like $\overline{B_i}$ except that each of $\overline{C_i}$'s members has e planted into the r-shaped hole. Thus, each $\overline{C_i}$ represents the precise event e embedded in some fuzzily characterized background field.

The laws, L, we have assumed, provide deterministic or chancy rules for how to evolve a completely specified time slice of physics towards the future. Thus, L is sufficient to propagate each $\overline{C_i}$ throughout the future, thereby establishing probabilities for any future event one chooses to consider.

In order to get an adequate characterization of table-like, one could choose a $\overline{B_1}$ that includes a human who is just about to poke the table with a finger. If some e is such that the resulting $\overline{C_1}$ fixes a very high probability for the

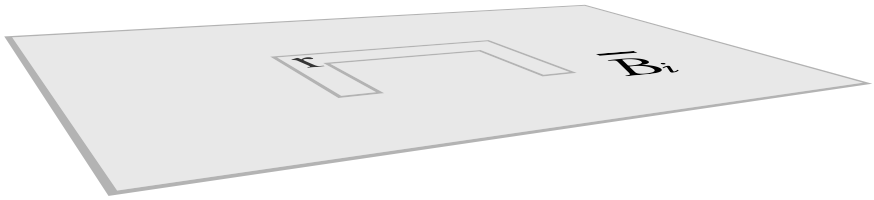

FIGURE 1. (e, L) instantiates a table at r iff e fixes suitable probabilities under L for certain future effects when e is embedded in various background conditions $\overline{B_i}$.

finger being blocked at the edge of r, then e has answered one "test question" correctly for being table-like (or more accurately, being disposed to behave like a table). One could choose a $\overline{B_2}$ that includes a human attempting to drag the contents of r across a floor. If e is such that the resulting $\overline{C_2}$ fixes a high probability for the material in r retaining its shape as it moves along with the human, then e has gotten another test question right for being table-like. One can formulate arbitrarily many such $\overline{B_i}$, each of which represents a way to probe whether the stuff in region r is likely to behave like a table in some respect. Each such test question can be formalized as an ordered triplet, $(\overline{B_i}, E, p)$, where the E is a coarse-grained description of some possible event located in a spacetime region after $\overline{B_i}$, and p is a probability range. An instance (e, L) is said to answer a test question correctly iff the $\overline{C_i}$ formed by grafting e onto $\overline{B_i}$ fixes a probability for E in the range p using the laws L. A test consists of a set of test questions together with some function that specifies whether a given instance (e, L) passes the test as a function of which test questions it answers correctly. One might stipulate that passing the test for being table-like requires an instance to answer absolutely all of the test questions correctly, or nine-tenths of them, or perhaps some weighted measure of them. If an instance (e, L) passes the test, that means that e counts as table-like (given the fundamental laws L and the chosen precisification of the functional test for being disposed to act like a table). Finally, the set of all (e, L) that count as table-like is a precisification of the property of being disposed to act like a table. Because the concept of table was interpreted as a purely functional concept, any such derivative property also counts as a precisification of being-a-table.

5.2. **Focus-Fuzzed Properties.** Concepts that are purely functional can be modeled effectively using tests that result in unfocused derivative properties, but concepts like 'water' require a more sophisticated treatment, what I call "focus-fuzzed derivative properties." The idea behind focus-fuzzing is quite simple. We start with an unfocused derivative property, water_{uf},

which corresponds to some precisification of the predicate "being disposed to act like water." Then we formulate a second derivative property, water_{f}, a so-called focused property, which contains only those members of water_{uf} that are instantiated in our local environment. The third step is to form the focus-fuzzed derivative property, water_{ff}, that includes all the members of water_{f} plus any other members that are suitably similar to the ones in water_{f}. I will now construct these three in more detail.

Stage 1: Any unfocused (derivative) property, water_{uf}, corresponding to "that which is disposed to behave like water" can be defined functionally just like the table, in terms of a test for watery behavior. Our ordinary concept of water seems to be modeled best when the stipulated test is only for the superficial behavior of water including its liquidity at room temperature, its density of roughly 1g per cc, and its translucency, but excluding its esoteric behavior such as its disposition to produce an explosive combination of gasses when an electric current is passed through it. Nothing in my account of functional properties places any restrictions on the kind of tests that can be used to define water_{uf}, so there is nothing wrong with using such a test if one wishes.

Stage 2: In the second stage, we focus water_{uf} into a new set, water_{f}, by tossing out any of its members that are not instantiated in a certain prescribed region of the actual world, say the region around Earth. This implies a restriction to the actual fundamental laws, so any members of water_{uf} whose fundamental laws differ from the fundamental laws of the actual world are automatically discarded. One could also impose further rules to discard more instances so that water_{f} represents the *predominant* local substance that behaves watery or perhaps the watery substances that have interacted appropriately with our ancestors. I will set aside these refinements for the sake of brevity, but they are not difficult to incorporate.

For further detail, we can consider two hypothetical chemicals that are instantiated as part of water_{uf}. Let us suppose there exists a chemical, XYZ, that is possible according to the actual fundamental laws and passes the chosen test for being disposed to act like water. Let us also postulate a chemical, PDQ, that does not exist in the actual world but passes the test in virtue of alien fundamental laws. So, water_{uf} includes instances (e_{XYZ}, L_a), where e_{XYZ} is an event that instantiates XYZ and L_a represents the actual fundamental laws, and it also includes members (e_{PDQ}, L_n), where e_{PDQ} is an event that instantiates PDQ and L_n represents non-actual laws that help PDQ to behave like water. The point is, water_{f} automatically excludes all members of water_{uf} that instantiate PDQ because they involve alien fundamental laws. Furthermore, if XYZ does not occur anywhere in the local region of spacetime chosen as the focus region, then all members of water_{uf}

that instantiate XYZ are excluded. So, the presence of XYZ on Twin Earth makes no difference as to what counts as an instance of water_{f}.

Stage 3: In the third stage, we fuzz water_{f}, by defining water_{ff} to include all the members of water_{f} plus any other instances that we choose to count as similar enough to the members of water_{f}. The intuitive reason for adding this fuzzing stage is that there is no reason to think that water_{f} includes absolutely every microscopic configuration of water. Water_{ff} includes all the instances one gets by taking an instance from water_{f} and shifting its electrons and quarks a bit and altering it in other microscopic ways until water_{ff} forms a set whose members we group together as being suitably similar.

There is no uniquely correct way to fuzz a set. Just like kinetic energy, where we are free to pick any standard of rest we like for purposes of convenience and scientific utility, we can fuzz a derivative property as much or as little as we like. A few general rules of thumb, though, guide the implicit conventions for fuzzing we tend to employ so that focus-fuzzing has substantial utility.

- The fuzzings that are most convenient as conceptual devices for understanding the behavior of ordinary macroscopic objects tend to be those that preserve the macroscopic character of an object but permit whatever microscopic variations are consistent with the macroscopic character. Water_{ff} should include all instances formed by taking a member of water_{f} and shifting some hydrogen nuclei to other locations near their oxygen nuclei, but water_{ff} should not include instances where each oxygen nucleus has two protons shifted out to the neighborhood of the existing hydrogen nuclei because that would in effect convert the H_2O into methane, CH_4.
- Water_{ff} should include instances that differ merely in size and shape. Even though water_{f} contains no instances of water that occupy a cubic light-year, such cubes of water should count as water_{ff}.
- When a linguistic community agrees with Putnam that XYZ is not a form of water, that reveals that the implicit standards for fuzzing in that community are such that fuzzing H_2O samples enough to include XYZ molecules counts as fuzzing too much. Any population that does count XYZ as water is not committing a metaphysical error; they just have more liberal conventions for fuzzing.
- After we have selected a test that identifies some precisification of an unfocused property, it often proves convenient to re-use that test to establish boundaries so that fuzzing cannot include any events outside that boundary. For example, if we decide to fix a borderline for water_{uf} so that samples of very muddy water with a density

greater than 1.02 g/cm^3 do not count as watery enough, then when we fuzz the resulting water$_{\mathrm{f}}$, we should exclude samples of H_2O that contain enough dirt contaminants to cross that borderline.

- In other cases, it proves useful to ignore water$_{\mathrm{uf}}$'s boundaries. For example, a cubic meter of empty space with a couple of stray H_2O molecules intuitively counts as water even though it does not behave like water superficially. Similarly for snow, ice, steam, clouds, and so on.
- It is reasonable to allow some fuzzing in the laws as well, so that the H_2O in worlds where gravity is slightly stronger still counts as water. Yet, worlds should be excluded if they have substantially different laws or substantially different kinds of fundamental attributes.

6. Water = H_2O

All the resources have now been assembled to make sense of how water can be associated with H_2O. The key observation is that we can make sense of all the empirical phenomena associated with water either by thinking of water in an unfocused way as water$_{\mathrm{uf}}$ or in a focus-fuzzed way as water$_{\mathrm{ff}}$. Even though ordinary language treats 'water' in a focus-fuzzed way, in an empirical analysis of water, there is no interesting fact of the matter as to which is water.

Consider water as water$_{\mathrm{uf}}$. All actual nearby instances of water$_{\mathrm{uf}}$ are instances of H_2O, but water cannot be equated with H_2O because XYZ and PDQ are also forms of water$_{\mathrm{uf}}$. So, there is no identity holding between composed-of-H_2O and water$_{\mathrm{uf}}$.

Consider water as water$_{\mathrm{ff}}$. All members of water$_{\mathrm{ff}}$ instantiate H_2O, and the conventions for fuzzing could reasonably be chosen so that all and only instances that count as composed-of-H_2O are included in water$_{\mathrm{ff}}$. If that choice is made, there is a identity between water$_{\mathrm{ff}}$ and composed-of-H_2O. This identity furthermore counts as a kind of type identity because derivative properties play the role of types; they are sets of possible instances.

It should be noted that the interesting metaphysical structure is not especially well illuminated by talk of identities. The derivative property water$_{\mathrm{ff}}$ can indeed be equated with the derivative property composed-of-H_2O, but this identity is largely the result of just choosing the convention for fuzzing water$_{\mathrm{f}}$ that results in an identity with composed-of-H_2O. A less permissive convention would have water$_{\mathrm{ff}}$ as a proper subset of composed-of-H_2O, and other conventions would have them overlapping but with neither one included in the other. What is not a matter of convention is that all local watery instances, water$_{\mathrm{f}}$, are instances of composed-of-H_2O. The interesting metaphysical structure underlying the natural kind, water, is partly that

the fundamental laws and fundamental kinds are such that the only stable configurations of particles that instantiate the functional kind, water_{uf}, are H_2O configurations and partly that if there are any other chemicals that behave superficially like water, they are not around here in any sufficient quantity. With an alien fundamental physics, there could be a continuum of substances or properties with no clear practical boundary between the watery stuff and the golden stuff and the feathery stuff, etc., in which case there would not be a well demarcated water kind. That is the pragmatic contingency that makes it handy to associate 'water' with water_{ff} rather than water_{uf}.

It is often claimed that the identity between water and H_2O holds necessarily. Kripke (1971) famously argued that such relations hold necessarily in virtue of the logical character of identity. However, there is another way to look at it that does not invoke any special features of identity. Some propositions are necessary because they result from semantic devices that convert contingent truths into necessary truths. For example, one can stipulate that 'plake' designates the actual number of tangerines eaten by the reigning Dutch monarch during the year 2033 in the actual world. Suppose that by happenstance, there is exactly one reigning Dutch monarch, and she eats nine tangerines during 2033. It follows that the proposition *P*, expressed by the statement, "Plake exceeds three," is true in the actual world, w_a. When we evaluate the truth value of *P* from the perspective of some non-actual world, *w*, the definition of 'plake' requires us to find its magnitude by looking at what happens in w_a, not at what happens in *w*, whence plake's magnitude exceeds three. Thus, *P* is true in every possible world. Thus, *P* is a necessary truth despite its incorporating a description whose numerical value is contingent. Notice that there is nothing metaphysically interesting about the necessity of *P*, and it certainly does not demand that we postulate an essence of plakitude in our metaphysical scheme. The necessity arises entirely from a cheap semantic trick that has no bearing on issues of ontology or fundamental reality. Because it was built into the definition of 'plake' that contingencies in the actual world fix its intension, the extension of plake in *w* is independent of *w*'s tangerines and royalty.

The semantic trick that makes "Plake exceeds three" a necessary truth is the very same trick that makes the statement "All instances of water_{ff} are instances of H_2O" a necessary truth. Water_{f}—because it focuses on the *actual* world—fixes a precisification of water that excludes the way watery stuff is instantiated in alien worlds. Water_{ff} will presumably expand this set to include some instances that have slightly different fundamental laws, but all such instances are still included only because they are suitably similar to the actual instances of water_{f}. How people in alien worlds use the word 'water' and how they drink and what substances play a watery role in such

worlds is entirely irrelevant to what instances are included as members of water_{ff}. Once the set water_{ff} has been constructed by focus-fuzzing, it remains constant across all possible worlds. Thus, all instances of water_{ff} are *necessarily* instances of composed-of-H_2O. The inference from "In the actual world, anything that is water_{ff} contains H_2O" to "In all possible worlds, anything that is water_{ff} contains H_2O" is a semantic triviality and says nothing about the structure of fundamental reality.

7. The Mind-Brain Identity Theory

The scheme I have presented for relating water to H_2O is quite general and can be applied without alteration to the relation between the mental and the physical. It is true that the derivative property, water_{uf}, was defined functionally in terms of the probabilities that an instance would need to fix for certain effects characteristic of water when conjoined with certain background conditions. However, nothing in the scheme I presented for focus-fuzzing requires a functional characterization of the unfocused derivative property. If there are some aspects of mentality, phenomenality perhaps, that resist a purely functional characterization, so long as there is some available precisification of the mental state, for example a stipulation of what instances count as being-thirsty, one can use that as the unfocussed derivative property that serves as a starting point for focus-fuzzing.

To explore the mind-body problem in more detail, let us introduce some neologisms by saying that a component of fundamental reality is *fphysical* iff it resembles (near enough) something that is uncontroversially an entity, attribute, or law of fundamental physics. For example, all of the following are fphysical: spacetime, electromagnetic fields, corpuscles, superstrings and the eleven-dimensional arenas they inhabit, quantum mechanical configuration states, and the classical inverse-square law of gravitation. If any of the following are components of fundamental reality, they are paradigmatically non-fphysical: Cartesian souls, phenomenal states, volitions, economic stratification, angelic influence, and any fundamental laws that impart a special swerve to particles that compose the brain of a decision-making creature.

Fphysicalism is the thesis that fundamental reality is entirely fphysical. Worlds where fphysicalism holds are worlds composed of nothing non-fphysical. Fphysicalism is a version of physicalism because it implies that the only way something non-physical can exist is derivatively, by being merely an abstraction from a fphysical fundamental reality. Dualism, by contrast, is the hypothesis that fundamental reality is partly physical and partly mental.

Now consider what we should say about thirst under the assumption that fphysicalism is true. Presumably, $\text{thirst}_{\text{uf}}$ contains some instances of brains together with the actual fphysical laws. It should also contain instances of a thirsty Cartesian soul together with fundamental laws that blend the interactions of fphysical properties and fundamentally mental properties. Thus, there is no special relation between $\text{thirst}_{\text{uf}}$ and fphysicality.

But when we focus $\text{thirst}_{\text{uf}}$ to form thirst_{f}, only fphysical instances will be members of thirst_{f} because we are operating under the assumption that the actual laws and fundamental properties are all fphysical. Then, when we fuzz thirst_{f} to form $\text{thirst}_{\text{ff}}$, it is arguably reasonable to have a convention for fuzzing where we stick to at least roughly the same kind of fundamental laws and fundamental materials as the actual world, so that we are left with a $\text{thirst}_{\text{ff}}$, all of whose instances are purely fphysical. This result allows us to make sense of how thirst (and mentality generally) can be understood as a form of type identity physicalism. If fundamental reality is just a bunch of fundamental physics without any fundamental mentality, then the property we get by focus-fuzzing all metaphysically possible instances of thirst is a property all of whose instances are entirely fphysical. Again, it is trivial that this type identity, if true, counts as a necessary truth.

Of course, we originally come to the mind-body problem without knowing the true nature of fundamental reality. If our interest is in determining whether *thirst* is a physical property, then Empirical Fundamentalism tells us first to work on establishing—as best as we can—whether the better overall model of fundamental reality is one that is entirely fphysical, or one that incorporates a mixture of physical and mental components, or one that includes only mental components, or some other option. Assessing which model of fundamental reality is best involves considering which model provides the superior account of all empirical phenomena. Among other things, one would need to investigate whether the quarks and electrons in people's brains exhibit some unusual motion that is best explained by a fundamental libertarian volition. Also, one would need to consider the delicate issue of whether phenomenal happenings should count as empirical phenomena, and if so, whether phenomenalism or epiphenomenalism or mind-body parallelism would provide a better overall account of the totality of everything that is empirically accessible. These issues are all too contentious to address here, of course. What my account of focus-fuzzing does is to say that if you settle on the hypothesis that fundamental reality is entirely fphysical, then you ought to believe that (1) in the unfocused sense, mental properties are not physical properties but they are contingently everywhere physically instantiated, and (2) in the focus-fuzzed sense, mental properties are necessarily physical properties (given reasonable conventions for fuzzing).

Much more deserves to be said about the relationship between mentality and physicality, but owing to space limitations, I can only make two brief additional observations. Because the degree of fuzzing is a fundamentally arbitrary parameter, there is no deep fact of the matter as to whether some mental property—say, the property of understanding Chinese—should be focus-fuzzed into a derivative property that only includes human brains, or instead into a derivative property that is inclusive of computers, or of a guy shuffling papers around based on rules written in English, or of a galaxy-sized wooden contraption with the gross functional behavior of an ordinary Chinese speaker. According to Empirical Fundamentalism, such decisions are to be made on the basis of convenience and utility; there is no fact of the matter to be discovered as to which ones *really* understand Chinese.

This consideration suffices to insulate my account from the multiple realizability argument. The multiple realizability argument tries to attack reductive theories of mind on the ground that the target mental existent can be realized by distinct physical kinds. Multiple realizability, it must be said, is a nearly trivial claim. On any remotely plausible version of physicalism, mental existents will be multiply realizable in the sense that any mental state can be instantiated by microscopically distinct instances. It is uncontroversial that mental states are not sensitive to absolutely every last physical detail. Every distinct instance of a mental state (under physicalism) must be an instance of a distinct physical kind because every instance belongs to the kind that includes itself and nothing else, a simpleton kind.

Advocates of the multiple realizability argument have in mind a less discriminate conception of physical kinds, but within the framework provided by Empirical Fundamentalism, there is no reason to ascribe any metaphysical privilege (any fundamentality) to such kinds. Physical kinds are merely groupings (sets) of physical instances, and they can be as convoluted or gerrymandered or ad hoc as you like while still being physical kinds. A precisification of thirst may not be identifiable with a physical kind that is easy to express in English, but there is no barrier to its being identified with some convoluted set of physical instances. If there is any fact of the matter at all as to what physical instances count as an instance of (some precisification of) thirst, then that set of instances *is* the physical kind. Of course, given my account above, it would be misleading to say thirst is identical with some specific physical kind because there are numerous ways to precisify thirst as $\text{thirst}_{\text{uf}}$, and it is merely a matter of convention and pragmatics how much fuzzing to use when constructing a focus-fuzzed property, $\text{thirst}_{\text{ff}}$.

8. A Brief Justification

The preceding discussion, I hope, explains how one can make sense of reductive identities, but it is fair to ask why it should count as a good way, or at least as a better way than existing alternatives. As I noted in the introduction, any attempt to evaluate the relative merits of the Empirical Fundamentalist program as a whole is too vast a project to take up here, but within the general guidelines established by Empirical Fundamentalism, there are some advantages to the approach I have taken that can be briefly noted beyond the three suggestive arguments given in section 4.

The primary merit of my account of how water relates to H_2O has been that it treats water and H_2O and their relation as derivative. Rather than having to complicate a model of fundamental reality that already includes a bunch of fundamental physics by having additional components to stand as a referent for 'water' and a referent for 'H_2O' and further relations to connect them appropriately to each other and to the fundamental physics, I have left all these out of the actual world. This more parsimonious model of the structure of the actual world counts as a benefit according to the standard scientific practice of treating an ontologically sparse model as ceteris paribus preferable.

The advantage of a parsimonious account of reductive identities would be worth little if other philosophical issues required tables, giraffes, and water to be treated as ontologically on a par with electrons and spacetime. So, an important factor in the value of the model is whether it relies on any concepts or constructs that require a more heavily populated fundamental reality, for example treating ordinary objects and their causal relations as fundamental. To that end, I intentionally formulated the individuation of various properties without the concept of causation. Instead, I employed the concept of a fundamental law, which is similar to causation in that fundamental laws govern how events at one time are related to events at another, but it is not encumbered with all the baggage that comes along with causation as it is normally understood. This means that my account is in a position to avoid some of the potential pitfalls that challenge other accounts. Models of realization along the lines of Melnyk (2001) or Shoemaker (2007), for example, reckon ordinary attributes—being-water, being-a-table, and so on—in terms of their causal roles or powers or profiles. Given the notoriously contentious issue of figuring out what causation amounts to, there is at least the potential for such causal-role accounts to be saddled with a bloated ontology.

Another benefit is that the extensive conventionality (or fundamental arbitrariness) built into my account of terms like 'water' helps to explain several familiar aspects of natural kinds. If we bracket issues concerning

fundamental kinds and focus solely on derivative kinds, then it is relatively easy for the focus-fuzzing conception of natural kinds to make sense of why the category 'natural kind' exists on a continuum. On the one end, there are clear-cut derivative natural kinds like water and gold, and on the other end there are clear cut derivative artificial kinds like games and tables. The difference can be drawn as follows. A (derivative) natural kind is a category such that it is reasonable to conduct a scientific investigation of its hidden nature. For example, it is prima facie reasonable to investigate the properties of diamonds to see if they share a common hidden nature with coal. By contrast, it is prima facie silly to conduct a scientific investigation of chess to see if it shares a common hidden nature with football. The focus-fuzzing model of natural kinds can make sense of this distinction in terms of our implicit knowledge of our default conventions for fuzzing. Without much reflection, we can recognize that focus-fuzzing the property being-chess is going to result in a set of instances that is far more dependent on our conventions for fuzzing than on the details of how chess matches are locally instantiated. There may be many surprising commonalities among chess and football, but these will inevitably turn out to be uninteresting historical contingencies, such as the hard-to-predict commonality that they are both disliked by Laura Monroe of West Bromwich. Without much reflection, though, we can also recognize that focus-fuzzing that which is disposed to behave like water may well result in some surprising properties that play a prominent role in science.

The focus-fuzzing model of natural kinds also helps to explain derivative kinds that lie between the natural and artificial extremes. For example, biological kinds are located somewhere near the natural end, because before we engage in much zoology, it is plausible that focus-fuzzing the set of instances that behave like a koala, panda, or grizzly will result in a set whose members share some hidden factors. But once we have a more thorough understanding of all the underlying genetics, their commonalities and differences will appear more like historical contingencies. That is, knowing the vastness of the space of nomologically possible biological diversity, it is plausible that koalas, pandas, and grizzlies exist on a phenotypic continuum and that it is largely just historical happenstance (grounded in the constraints imposed by evolutionary factors) that accounts for the limited range of phenotypic mixtures of koalas, pandas, and grizzlies. Furthermore, current technology makes it difficult to create a continuum of in-between animals. By contrast, it is not largely historical happenstance or technological limitations that make it difficult to discover or manufacture an element that lies halfway between carbon and nitrogen. My remarks here accord with Russell's (1956) and Quine's (1969) observation that as sciences mature, they tend to obviate their natural kinds. A more extensive discussion would

point out that mixture kinds like air and clay also lie between the natural and artificial extremes for obvious reasons, and that some artificial kinds like the dollar bill kind have a focus-fuzzing character, but one whose only hidden structure is its various anti-counterfeiting attributes and its historical origins. The benefit of thinking of derivative kinds in terms of focus-fuzzing is that it allows us to make sense of why it is reasonable to think of the world as having natural kinds, but without requiring any deep fact of the matter as to whether planets or eskimos or hurricanes are genuine natural kinds. It thereby avoids some unnecessary ontological clutter.

References

[1] Audi, P. (2007). *Beyond Causal Theories of Mind*. PhD. Dissertation. Princeton.

[2] Cameron, R. (2008). "Turtles all the Way Down: Regress, Priority, and Fundamentality," *The Philosophical Quarterly* 58 (230), 1–14.

[3] Campbell, J. (1993). "A Simple View of Colour," in *Reality, Representation and Projection*. J. Haldane and C. Wright, eds. Oxford: Oxford University Press.

[4] Cornman, J. W. (1975). *Perception, Common Sense, and Science*. New Haven, CT: Yale University Press.

[5] Hardin, C. L. (1988). *Colour for Philosophers*. Indianapolis: Hackett.

[6] Jackson, F. (1998). *From Metaphysics to Ethics: A Defence of Conceptual Analysis*. Oxford: Oxford University Press.

[7] Kim, J. (1993). *Mind and Supervenience*. Cambridge: Cambridge University Press.

[8] Kripke, S. (1971) "Identity and Necessity," in M. K. Munitz (ed.) *Identity and Individuation*. New York: New York University Press.

[9] Kutach, D. (2010). "Empirical Analyses of Causation," in *New Waves in Metaphysics*. A. Hazlett, ed. Hampshire, UK: Palgrave Macmillan.

[10] Kutach, D. (2011). *Causation and Its Basis in Fundamental Physics*.

[11] Leeds, S. (2001). "Possibility: Physical and Metaphysical," in *Physicalism and Its Discontents*. C. Gillett and B. Loewer, eds. Cambridge: Cambridge University Press.

[12] Melnyk, A. (2001). *A Physicalist Manifesto*. Cambridge: Cambridge University Press.

[13] Oppenheim, P. and Putnam, H. (1958). "Unity of Science as a Working Hypothesis," in *Minnesota Studies in the Philosophy of Science, II*, 3–36.

[14] Paseau, A. (2009). "Defining Ultimate Ontological Basis and the Fundamental Layer," *The Philosophical Quarterly*, 1–7.

[15] Putnam, H. (1975). "The Meaning of 'Meaning'," in K. Gunderson (ed.) *Language, Mind and Knowledge*, Minnesota Studies in the Philosophy of Science, VII. Minneapolis: University of Minnesota Press.

[16] Quine, Q. V. (1969). "Natural Kinds," in Rescher (ed.) *Essays in Honor of Carl G. Hempel: A Tribute on the Occasion of His Sixty-Fifth Birthday*. Dordrecht: D. Reidel.

[17] Russell, B. (1956). *Human Knowledge: Its Scope and Limits.* Allen.

[18] Shoemaker, S. (2007). *Physical Realization*. Oxford: Oxford University Press.

[19] Tahko, T. (2009). "The Law of Non-Contradiction as a Metaphysical Principle," *Australian Journal of Logic* 7, 32–47.

Box 1918, Brown University, Providence RI 02912, 1 (401) 863-3242, Douglas_Kutach@brown.edu