

# Metaphysical Problems of Physics

## Lecture 5

### Kinds, Natural and Unnatural

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## 1 *Précis* of Issues

In this lecture, we will discuss themes addressed by Beebe (2013) and Curiel (2016).

1. What is the connection between Kripke-Putnam semantics ('KPS'), in particular rigidity of reference, and essentialism about natural kinds ('NKE')?
2. Is either view viable in light of the structure of scientific knowledge?

## 2 Standard View of Rigidity and the Necessary *A Posteriori*

The standard definition (Putnam 1975, p. 231) for the idea of rigid designation

a designator [is *rigid*] (in a given sentence) if (in that sentence) it refers to the same individual [or kind] in every possible world in which the designator designates.

And this leads naturally (so orthodoxy holds) to Kripke (1980, lecture 1, p. 43):

The question of essential properties so-called is supposed to be equivalent (and it is equivalent) to the question of 'identity across possible worlds'.

Why? I think: because there are only two other ways to fix trans-world identity:

1. satisfaction of same description<sup>1</sup>
2. brute iteration of stipulative associations
  - a. stuff  $\phi_A$  in possible world  $A$  is the same as stuff  $\phi$  in the actual world
  - b. stuff  $\phi_B$  in possible world  $B$  is the same as stuff  $\phi$  in the actual world
  - c. ...

Kripke has arguments against descriptivism. I don't think he even imagines considering iterativism.<sup>2</sup>

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1. It is not a serious misrepresentation to identify the counterpart theory of Lewis (1968, 1983b, 1986) as such an account.

2. It is worth remarking that scientists studying the melting of the permafrost, and the subsequent release of greenhouse gases, are building models iterative models very much like what I describe in §5.3 ("Earth Is Silicates, Calcites, Carbonates and Nitrates") of Curiel (2016), and having success replicating, if not predicting, observed behavior of complex material systems such as frozen peat, clay, water, organic material, all deeply immixed. See the work of Sergei Zimov and his collaborators, *e.g.*, Mann et al. (2012). Since I wrote that paper long before I became aware of work such as Zimov's, I can only conclude that I am prescient.

The most important claim, championed by both Kripke and Putnam, is that *science* is to be the ultimate arbiter of what counts as “essential properties” (or “essential microstructure”). I understand why Putnam held this (in 1975 he was a realist trying to banish the threat of Kuhnian relativism), but I have no idea why Kripke held this.

**The “necessary *a posteriori*”:** a proposition which, if true, holds of metaphysical necessity, but which is such that its truth can be known only by *a posteriori* investigation (*i.e.*, one that cannot be accomplished by the use of “pure reason alone”, so generally including an empirical or pragmatic component). For many if not most philosophers these days, it is not a serious misapprehension to take “metaphysically necessary” to mean “holding in all possible worlds”. The canonical example: “water is H<sub>2</sub>O”.

### 3 A Metaphysician Looks at Natural Kinds: Synopsis of “How to Carve across the Joints in Nature without Abandoning Kripke-Putnam Semantics”

**Thesis:** KPS and NKE are independent of each other.

**NKE:**

1. which natural kinds exist is a fully mind- and theory-independent matter
2. natural kinds have intrinsic essences
3. natural kinds have a hierarchical structure (“the hierarchy thesis”)

Beebe thinks—by explicit advertisement (p. 141)—that she is providing a precise disambiguation of NKE, a clear statement of what it amounts to. I find this hard to swallow—“intrinsic essence” is a clear, precise, unambiguous idea? I put such concerns aside for the sake of trying to be as charitable in reconstruction as possible.

**Summary of argument** p. 143:

If we are to hold that for every natural kind there is some necessary *a posteriori* theoretical identity that specifies the essence of the kind, then, we must leave vernacular kind terms and their associated categories (substance, animal, and so on) behind. But once we are in the business of deferring to the classificatory framework(s) of the relevant science, I shall argue, the ‘essentialism’ we are left with is—in the absence of further, independent metaphysical requirements on natural-kind essences that have nothing to do with KP—an extremely weak thesis that falls a very long way short of natural kind essentialism.

Questions:

1. Is the distinction between “vernacular” and “non-vernacular” terms well posed?
2. Why is the debate posed on the basis of *terms* at all, and not, say, concepts? A classic case of the word-fetishism that infects contemporary philosophy.
3. The conclusion: KPS is in fact consistent, and does require “essentialism”, albeit of an etiolate sort.

**Crosscuttings:** the argument runs in part by identifying 3 kinds of “crosscuttings” that KPS alone does not rule out, with the consequence that it cannot entail a rich essentialism:<sup>3</sup>

**intrataxonomic** *e.g.*, “enzyme” and “protein”

**intertaxonomic** *e.g.*, species pluralism, the view that there is more than one meaningful and important concept of “species” (a *prima facie* natural kind term) in evolutionary biology, none metaphysically canonical, privileged, . . .

**interparadigm** theoretical (*i.e.*, natural kind) terms in successive paradigms are incommensurable in the Kuhnian sense

Beebe argues that all three kinds of cross-cuttings are consistent with KPS.

Thus KPS is consistent with “shallow essentialism” (p. 162):

. . . the view, not that natural kind essences are relative to context. . . , but that they are relative to the taxonomic hierarchy enshrined within a particular scientific theory.

Scientific theories, it is assumed, have well defined taxonomic hierarchies consistent with the formal structures of traditionally metaphysical natural-kind hierarchies.

## 4 A Cantankerous Old Bastard Looks at Natural Kinds: Synopsis of “Why Rigid Designation Cannot Stand on Scientific Ground”

**Thesis:** KPS and NKE are inconsistent with the structure of scientific knowledge.

### Summary of argument

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3. She mentions only to put aside a fourth crosscutting, the artificial.

1. The necessarily theory-relative character of scientific claims does not allow one to identify in an unambiguous way either “the physically important operational properties” of a kind of thing or “the essential micro-structure” of one.
2. Trans-world identity relations of the sort needed to support rigidity are inconsistent with the way that operational and scientific properties relate to each other.
3. When one pushes hard enough on the idea of how one can make sense of “natural kind” in any given theory, one finds that it all comes down to pragmatics.

## 4.1 What Is Water

Putnam (1975, p. 223)

One of the peculiarities of Twin Earth is that the liquid called ‘water’ is not  $H_2O$  but a different liquid whose chemical formula is very long and complicated. I shall abbreviate this chemical formula simply as XYZ. I shall suppose that XYZ is indistinguishable from water at normal temperatures and pressures. In particular, it tastes like water and it quenches thirst like water. Also, I shall suppose that the oceans and lakes and seas of Twin Earth contain XYZ and not water, that it rains XYZ on Twin Earth and not water, *etc.*

In other words, XYZ—or water<sub>2</sub>, as opposed to the water<sub>1</sub> we have in our world (which I will continue to designate by ‘water’ unless there is a chance of ambiguity)—must be indistinguishable from water over an extraordinarily broad spectrum of environmental conditions and states (temperatures, pressures, *etc.*), such as super-heated and under great pressure in thermal vents at the bottom of the ocean (since the oceans on Twin Earth are filled with it), very cold and rarefied as vapor at 80,000 feet (since the atmosphere of Twin Earth contains it), in the enzymatically complex and strongly buffered conditions in which organic metabolism takes place in any of tens of millions of different species of organisms (since the creatures on Twin Earth ingest it), and so on.

## 4.2 What Is $H_2O$

$H_2O$  is two H atoms and one O atom jointly arranged in a particular, stereometrically stable configuration: the water molecule. In point of fact, however, no portion of water, no matter how pure or small and no matter in what state or environment, consists of water molecules. Pure liquid water under normal conditions, for example, consists of a mixed bath of several ionic species, including not only  $H_2O$  but also  $H^+$ ,  $OH^-$  and  $H_3O^+$  among several others, to mention only the most commonly occurring, all held together by a hyper-dense, stereometrically complex network of Hydrogen bonds with extraordinarily rich characteristic symmetry patterns. In this bath, moreover, the true  $H_2O$  molecules share among themselves no canonical shape; the geometry of each constituent molecule rather depends sensitively on the composition of its immediate ionic neighborhood and the concomitant character of the node it finds itself inhabiting in the ambient, dense web of Hydrogen

bonds. (For the sake of brevity, nonetheless, I will often abbreviate reference to the molecular structure of water by using ‘ $\text{H}_2\text{O}$ ’).<sup>4</sup>

### 4.3 Outline of Twin Earth Argument

The crucial part of Putnam’s argument has the following form:

1. we have a pre-scientific usage of a term, based on pre-scientific, operational knowledge of samples of the stuff
2. the advance of science shows that (most of) the (normal) samples of the (local) stuff (in the actual world) we referred to using the pre-scientific term in fact share a hidden structure
3. we then use the hidden structure to articulate a (more precise) meaning for the term
4. it could have happened otherwise: science could have discovered no physically relevant hidden structure shared among the samples of stuff, while the fundamental theories of physics remain otherwise not intolerably different
5. thus, it makes sense to use a scientifically defined relation like  $\text{same}_L$  to compare the referents of the same term as used in two separate possible world, since the science is not intolerably different between the two worlds

This, however, is not always true. (In fact, I find it likely that it is never true.) In particular, the example of XYZ on Twin Earth violates it in several ways.

### 4.4 Quantum Mechanics Cannot be True on Twin Earth

Liquid  $\text{H}_2\text{O}$  in the aggregate (*i.e.*, in gross portions of water) has several properties unique among all known physical stuffs, among them: it ionizes both acids and bases; its density decreases on freezing; and there are several ranges of temperature and pressure in which an increase in pressure at constant temperature causes its viscosity to decrease rather than increase. All these properties in turn are directly grounded on the fact that liquid water consists of a mixed bath of several ionic species held together by a hyper-dense network of Hydrogen bonds. Not only is the hyper-dense network of Hydrogen bonds characteristic of liquid  $\text{H}_2\text{O}$  itself unique as a physical structure among all physical stuffs we know of, but it more or less follows from our best current theories that no other molecular mixture of any sort besides the mixed ionic bath of liquid water could support such

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4. See Eisenberg and Kauzmann (1969, *passim*, but esp. ch. 8, §4, pp. 246–253), and Marechal (2007, *passim*) for a more up-to-date account. For the sake of brevity, I will not cite them again in the paper, but the interested reader should consult them (and others like them) for detailed accounts of the claims I make about the physical properties of water and  $\text{H}_2\text{O}$ . I cite the Eisenberg and Kauzmann as well as the Marechal not only because it is a beautiful classic but also because of its publication date: 1969. All the scientifically substantiated facts about water I rely on in my arguments were well known in the scientific community at the time that Putnam, Kripke, *et al.*, worked the foundations of the rigid program out.

a network of such bonds. In other words, according to our best theories, not only are the seemingly unique properties of water in fact unique, but they must be in the following strong sense: if we found other stuff that shared all those properties, then quantum chemistry, and *a fortiori* quantum mechanics itself, would be wrong. At a certain point—and this is the crucial matter—, after one fixes enough operationally definable properties of the right sort of the stuff at hand, “having the same operationally definable properties” more or less *entails* “having the same microstructure” at a particular level of theory, on pain of falsifying whatever theory it is one is working with.

#### 4.5 There Is No Canonical Theory to Define $\text{same}_L$

If we choose Navier-Stokes theory to model water, then water vapor and liquid water are different natural kinds, but we cannot discuss ice or  $\text{H}_2\text{O}$ ; if we use chemistry, then it seems difficult to discuss water itself at all, and  $\text{H}_2\text{O}$  definitely does not come out as a natural kind; and in the Standard Model, almost nothing comes out as a natural kind, and in any event certainly not water or  $\text{H}_2\text{O}$ . The idea of rigid designation cannot even begin to get off the ground in this diremptive state of affairs.

#### 4.6 The Scientific Tahāfut al-Falāsifa; Or, The Perfidy of Examples

Philosophers have a tendency to deploy simple examples putatively based on science without bothering to verify whether or not our best science actually supports the use to which they want to put the examples. Casual deployment of thought experiments is a dangerous game. It takes a lot of knowledge to construct a conceit as grandiose as Twin Earth that is not a pure fairy tale.

The analogy to fairy tales is instructive. A fairy tale may help us understand what picture a people has of the world, of their relations to it, and of their relations to and with one another, with a particular eye to the distraction and education of the young; it can teach us nothing about the nature of the world itself or about the sorts of knowledge we may or may not be able to secure about the world, divorced from our own psychological, cultural and social predilections.

Kripke (1980, p. 44, his emphases): “‘Possible worlds’ are *stipulated*, not *discovered* by powerful telescopes.” *Argumentum ex italico*. Also (p. 49), “Generally things aren’t ‘found out’ about a counterfactual situation, [*sic*] they are stipulated.” But that’s crap. We *do* discover them, using the telescopes our theories and other empirical knowledge provide us. *Fictional* worlds are stipulated, not possible ones. Philosophers must justify their so-called possible worlds.

## 5 Invitation to a Short Essay

I invite you to write me a short discussion (no more than 2 pages, *i.e.*, no more than 1000 words) on any issue discussed in any of this week’s readings. You can raise further questions, propose answers or interpretations, or whatever seems of most interest to you. If you get it to me by the

start of next lecture (11. May), then I will return it to you with my comments the following week.

## References

- Beebe, Helen. 2013. “How to Carve across the Joints in Nature without Abandoning Kripke-Putnam Semantics”. Chapter 7 in *Metaphysics and Science*, edited by Stephen Mumford and Matthew Tugby, 141–163. Oxford: Oxford University Press. doi:[10.1093/acprof:oso/9780199674527.003.0007](https://doi.org/10.1093/acprof:oso/9780199674527.003.0007).
- Curiel, Erik. 2016. “Why Rigid Designation Cannot Stand on Scientific Ground”. Unpublished manuscript. Draft available at <http://strangebeautiful.com/papers/curiel-against-rigidity.pdf>.
- Eisenberg, D., and W. Kauzmann. 1969. *The Structure and Properties of Water*. New York: Oxford University Press.
- Gunderson, Keith, editor. 1975. *Language, Mind and Knowledge*. Minnesota Studies in Philosophy of Science, VII. Minneapolis: University of Minnesota Press. Freely available online: <https://cla.umn.edu/mcps/publications/minnesota-studies-philosophy-science>.
- Kripke, Saul A. 1980. *Naming and Necessity*. Cambridge, MA: Harvard University Press.
- Lewis, David. 1968. “Counterpart Theory and Quantified Modal Logic”. In Lewis 1983a, chapter 3.
- . 1983a. *Philosophical Papers*. Volume 1. Oxford: Oxford University Press. doi:[10.1093/0195032047.001.0001](https://doi.org/10.1093/0195032047.001.0001).
- . 1983b. “Postscripts to “Counterpart Theory and Quantified Modal Logic””. In Lewis 1983a, chapter 3.
- . 1986. *On the Plurality of Worlds*. Oxford: Basil Blackwell.
- Mann, P. J., A. Davydova, N. Zimov, R. G. M. Spencer, S. Davydov, E. Bulygina, S. Zimov, and R. M. Holmes. 2012. “Controls on the Composition and Lability of Dissolved Organic Matter in Siberia’s Kolyma River Basin”. *Journal of Geophysical Research: Biogeosciences* 117 (G1). doi:[10.1029/2011JG001798](https://doi.org/10.1029/2011JG001798).
- Marechal, Y. 2007. *The Hydrogen Bond and the Water Molecule: The Physics and Chemistry of Water, Aqueous and Bio-Media*. Amsterdam: Elsevier Science.
- Putnam, Hilary. 1975. “The Meaning of ‘Meaning’”. Chapter 12 in *Mind, Language and Reality: Philosophical Papers, Volume 2*, 215–271. Cambridge: Cambridge University Press. First published in Gunderson (1975), ch. 3, 131–193.