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'Ο θεὸς ἀριθμητίζει'
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Mario Gómez-Torrente. 2020. *Roads to Reference*. Oxford: Oxford University Press

Don't be fooled. There is more to this slender volume on specialized topics in meta-semantics than first appears. On one level, it is a careful and insightful investigation of how related classes of words--demonstratives, proper names, Arabic numerals, common nouns for natural kinds plus nouns and adjectives for sensory kinds — get, and retain, their referents/meanings. As such, it is highly significant for contemporary philosophy of language. But that's not all. Because its insights about language are tied to realities we use language to represent, it has powerful implications for the metaphysics and epistemology of mathematics, of natural kinds, and of sensory qualities. Defending the first wave of philosophical anti-descriptivism led by Kripke, Putnam, and Kaplan, Gomez-Torrente secures the foundations of their work, rebuts attacks by causal descriptivists about reference fixing, and responds to eliminativists about natural kinds and sensory qualities. The result is second-wave anti-descriptivism, extending the philosophical significance of the first.

Gomez-Torrente reconstructs reference fixing for ordinary proper names, arising initially from name-introductions involving referential intentions that are sometimes perceptual, sometimes descriptive, and often mixed. Next comes reference-transmission and uptake generated by similarly mixed referential intentions involving elements of perception, memory, and description. Although successful transmission is the norm, sometimes the original referent is lost and/or replaced by a new one. These practices generate widespread regularities that provide sufficient conditions for a use of a name to refer to an object and sufficient conditions for it to fail to refer. Although these meta-semantic facts are responsible for all cases of determinate reference and determinate reference failure, they leave some cases indeterminate. Since this is all we have, no individually sufficient and disjunctively necessary reference-fixing conditions are forthcoming.

Next consider general terms for natural kinds. These too have semantic properties resulting from meta-semantic practices of introduction and transmission. Again, referential intentions involve a mix of description, perception, and memory. As before, the practices sometimes preserve reference and sometimes don't. Here, the referent is a kind, acquaintance with which is via its instances. How do we move from such instances to a unique kind worth tracking? We typically imagine the kind as a hidden property that explains commonplace characteristics in what we pretheoretically take to be its instances. We presume there is a single, non-obvious, but discoverable and unified causal explanation of the characteristics of instances of the unique relevant *substance* (water, gold), *natural phenomenon* (heat), or *species* (turkey). This is what led many to suggest that water is H_2O, gold is the element *AU,* heat is mean molecular kinetic energy, and turkeys are a species of bird with a specific genotype. However, as recent sophisticated objections have shown, this precise scientific specificity is problematic.

Is water really H_2O*?* Perhaps not. Surely, there are too many impurities in ordinary water to count as H_2O. There are also too many possible instances of H_2O with different structures, too many varieties of H_2O with different spins of the protons in the hydrogen

atoms, and too many isotopic variations of H_2O for it to be a unified scientific kind. For example, paradigmatic water samples contain mostly one isotopic variant of H_2O, with small amounts of the less common isotope (plus impurities). From the perspective of fundamental physics, the isotopic variations are different kinds, neither of which is identical with H_2O. Because our ordinary referential intentions governing 'water' fail to choose among them, either our story of reference-fixing is wrong, or no precise scientific kind is water. This has led critics to a false dilemma. Either our theory of reference-fixing is incorrect, or 'water' fails to refer. Ditto for other natural kind terms. Since there is no widely recognized alternative reference-fixing theory, massive eliminativism threatens.

Gomez-Torrente's response begins with a meticulous account of reference-fixing for common nouns standing for *substances*, *species*, and *natural phenomena*, in the ordinary (non-specialized) senses of these terms. Nouns like 'water', 'tiger', and 'heat' are names for kinds of those types; like proper names, they are governed by sufficient conditions for reference and sufficient conditions for reference failure. Thus, we get cases of determinate reference to kinds plus cases of determinate reference failure. Since no individually sufficient and disjunctively necessary conditions for reference are forthcoming, it is sometimes indeterminate whether a use of a term refers to a kind. With this in mind, consider H_2O and its various precise, determinately non-identical subtypes S. For each S it is determinately true of H_2O that some of its instances are entirely of type S (and some are not), but it is indeterminate whether some instances of *water* are entirely of type S. *Hence, water is neither determinately H_2O nor determinately not H_2O.*

In short, the identity conditions for water are indeterminate. Some philosophers think that vague identity is incoherent. Others, like me, disagree. Although Gomez-Torrente doesn't address the debate, he notes that we presuppose vague identity conditions all the time – for cities, rivers, roads, mountains, and even people (persisting through time). Thus, he suggests, it's not surprising that natural kinds recognized in ordinary thought and talk aren't determinately identical with precise scientific kinds. This doesn't mean that science tells us nothing about them. Since we assume ordinary kinds to be hidden properties that explain similarities of their instances, science tells us a great deal. As for the objection that samples of water contain impurities, (i) trace elements of, e.g., iron, magnesium, etc. are *not* sufficient to make water samples instances of those substances (and hence not instances of a single substance), and (ii) there is nothing in our ordinary conception of a substance that requires instances of it be entirely devoid of foreign elements. Instances of water are those that are not too different from ordinary instances of H_2O, where what counts as *too different* is vague.

Next comes Kripke's extension of natural kind terms to adjectives for perceptible qualities, including colors and temperatures. Although this extension has led to plausible theories of colors as precise reflectance properties, that precision is challenged by variation in color judgments involving seemingly inconsistent predicates – C1: '*green but somewhat blue*', and C2: '*green but neither somewhat blue nor somewhat yellow*'. Agent A1 characterizes some items as instances of C1 that A2 characterizes as instances of C2. Since both are fully competent speakers with normal vision, it is hard to convict either of error. But if there is no error, then, it seems, the properties expressed by the predicates must be subjective, speaker-relative, and perhaps even and phenomenalistic.

Gomez-Torrente responds, (a) by pointing out that we get similar variation in what is judged to be warm/neither warm nor cool/cool, which surely are judgments about where something stands on a physical scale (temperature), (b) by suggesting that colors and other

sensible qualities approximate precisely defined scientific properties which, like other natural kinds, have vague boundaries, and (c) by attributing slightly varying color judgments made by equally competent and well-placed agents to idiosyncratic variations in the absorption of light by their visual systems, leading, in some cases, to slightly different objective colors seen, and predicated of objects. Realizing that this raises questions about linguistic communication, he suggests (pp. 207-8) non-publicly available Kaplan-type contextual parameters generating slightly different color contents for uses of color terms by different agents. Although that is possible, there are, I believe, other promising possibilities to be explored -I have discussed this in sections 3-4 of my "Rejecting Excluded Middle," in Oms and Zardini, eds., *The Sorties Paradox* (Cambridge: Cambridge University Press, 2018).

The final and perhaps most significant advance in the book concerns one of the deepest questions in philosophy. *What are natural numbers and how do we know about them?* Gomez-Torrente suggests they are plural cardinality properties - see Boolos, "To Be is to Be the Value of a Bound Variable (or to Be the Values of Some Variables)" *Journal of Philosophy* (1984) and my own *The World Philosophy Made* (Princeton University Press, 2019, Ch. 5) and "What do we know about numbers and propositions and how do we know it?", *Organon F* (2020). The number 3 is the property *being three in number,* which applies to the fingers x, y, and z, I am holding up, without applying to any one of them. Our knowledge of numbers begins with counting. One doesn't *first* learn what numbers are, and *then* use them to count. Rather, one learns to repeat a memorized sequence of numerals, pairing them off with things counted. One begins to *recognize numbers* and *use numerals to refer to them* when one has mastered the practice and integrated it into one's cognitive life.

For example, a child learns I am holding up three fingers from her perceptual knowledge that x, y, and z are different fingers. Having learned to count, she exhaustively pairs off, without remainder, the fingers I am holding up with the words 'one', 'two, and 'three', thereby ensuring that the fingers and numerals "have the same number" in Frege's sense. The number they share is designated by the numeral that ends the count. Having counted other trios, she recognizes that x, y, and z have something in common with other objects she has counted. Eventually, she comes to recognize the common property —*being three in number*— perceptually, without counting. Later, her ability to count is extended, becomes systematized via the operation of adding 1, and is integrated with her knowledge of Arabic numerals. At this point, her reference-fixing intentions match those of other speakers, determining, in principle, a referent for each numeral. Though these intentions contain a modest descriptive element, they don't provide purely descriptive synonyms for such numerals. What they do provide is a mastery of the generation of Arabic numerals that parallels the generation of the natural numbers. It is this, Gomez-Torrente argues, that allows competence with Arabic numerals to ensure the acquaintance with natural numbers needed to ground what Kripke insightfully called "*de re* beliefs about numbers" but was unable to successfully explain in Kripke 1992 unpublished Whitehead lecture "Logicism, Wittgenstein, and De Re Beliefs about Numbers."

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