On Natural Kind Terms

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Abstract

This dissertation concerns natural kinds and natural kind terms. It presents Kuhn's, Putnam's, Kripke's theories of natural kind terms and my criticisms to these theories. I propose that knowledge about a kind, scientific or not, allow people to know its term and to use the term to refer to the kind. Possible candidates to account for why kind terms stand for their kinds are not just scientific stipulation or paradigms but also knowledge.

Chapter one begins with a discussion on Putnam's, Kripke's, and Kuhn's accounts of natural kinds. Putnam explains natural kinds in terms of indexical examples and sameness relations; Kripke asserts that a natural kind includes natural existents with the same essence; and Kuhn holds that scientific paradigms determine their kinds. I formulate two definitions that are relevant to these accounts, in particular, one related to Putnam's and Kripke's and the other to Kuhn's. There are, however, some issues with Putnam's and Kripke's accounts. In their accounts, there are kinds without obvious representative indexicals and kinds can be assigned new essences with scientific progress. These issues call into question their assertion of the rigidity of natural kind terms. Although Kuhn
offers a more comprehensive account for natural kinds, he does not explain how
natural kind terms can be used in non-scientific discussions.

I propose that a natural kind is a collection of natural existents that
resemble one another in certain respect or respects, and these resemblances can
generate knowledge about the existents as a kind. Based on this notion of natural
kinds, I hope to provide an inclusive theory for natural kind terms, one which
considers the fact that they are used in scientific and non-scientific discussions. I
discuss three natural kind terms: ‘neutron,’ ‘whale,’ and ‘water.’ The case of
‘neutron’ illustrates Kripke’s and Putnam’s accounts of natural kinds and kind
terms—they hold that a particular science determines the essence of a kind and
referents for its term. The case of ‘whale’ illustrates Kuhn’s view, which
maintains that different scientific accounts can provide different
comprehensions of a kind and use the kind term to express different concepts.

However, the case of ‘water’ reveals an aspect that none of the three
philosophers notice—non-scientific knowledge can also help people know a kind
and know referents of the kind term. The case of ‘water’ shows that natural kinds
and kind terms can be understood in non-scientific contexts.
In chapter two, I present Kuhn’s theory of natural kind terms—different paradigms can provide different concepts for a kind term because the paradigms may address the kind differently. Thus, a kind term needs to be understood with respect to a particular paradigm. However, Kuhn’s account does not note that some kinds and their terms are precedent to scientific theories and paradigms. Languages used by isolated tribes where there are no scientific practices contain kind terms such as ‘water.’ A five-year-old without any scientific education acquires kind terms such as ‘dog’ and ‘banana.’ Natural kind terms are used in scientific and non-scientific discussions.

In chapter three, I discuss Putnam’s Twin Earth argument and his account of reference. I agree with the idea defended by the Twin Earth argument that psychological states in the narrow sense do not determine the extension of a kind term, however, the argument itself is problematic. First of all, ‘determining the extension of a kind term’ is ambiguous. When it means ‘delineating the contour of a kind term,’ the defended claim is either not interesting (intension along does not delineate the contour of a kind term) or not true (intension does not play any role in delineating the contour of a kind term). When it means
'referring an example of a kind,' the argument is irrelevant. (The duplicates do refer to examples of water. It is irrelevant whether they refer to the examples of H₂O or XYZ.) Second, the story of scientists' arriving the Twin Earth indicates that the assertion of the rigidity of 'water' and the claim that intension does not determine its extension are not compatible. Third, by modus tollens, the situation that the extension of 'water' includes XZY—a negation of the situation that the extension of 'water' is H₂O—results from the claim that the intension of 'water' does not determine its extension. That is, Putnam's intended claim—intension of a kind term does not determine its extension—could be inferred by denying his own assertion from the Twin Earth scenario. Finally, there are no cases of two extensions of a kind term—there are only cases of multiple constituents in the extension.

Chapter four begins with Kripke's discussion of descriptivism. The descriptivist claims that names are abbreviated definite descriptions. Kripke suggests three arguments against descriptivism, and he suggests that names and kind terms are instead rigid designators. He argues that contingent properties have no influence on the identities of natural kinds. There are essential
properties of natural kinds, and they make natural kind terms rigid. Things with the same essential properties belong to the same kinds in all possible worlds.

The kind terms are thus rigid because they refer to whatever have the essential properties in all possible worlds.

However, the claim that kind terms are rigid is based on an inappropriate assumption that science determines the ultimate essences of kinds. There have been many modifications throughout the history of science, and science has assigned different essences to the same kind in different historical periods. For example, in Greek times, ‘aether’ referred to the fifth element. In the 19th century, ‘aether’ referred to a mass-free medium that fills up the universe. Nowadays we don’t believe that aether exists. Moreover, Kripke’s argument for the rigidity of kind terms is circular. In particular, Kripke supposes that gold is something that has the atomic number 79; then, he claims that ‘gold’ refers to gold; finally, he claims that ‘gold’ refers to whatever has the atomic number 79. But, given his premise that gold has the essence of having 79 protons, ‘gold’ is constructed to refer to things with that essence rigidly. Finally, some kinds are themselves scientific models; it is not appropriate to claim essences of them.
This dissertation proposes a new approach to the issue of natural kind terms. It offers a semantic externalist view without asserting the rigidity of kind terms. The reference of a kind term and the connection between a kind term and its kind can be based on knowledge about the kind. By understanding natural kind terms in terms of knowledge of their kinds, which can be generated by everyday life activities and be irrelevant to scientific accounts of the kinds, the fact that natural kind terms can be used and understood within and outside the context of science is explained. Knowledge of kinds offers a more inclusive context for kind terms.
Introduction

1.

What natural kind terms are can be answered straightforwardly: they are terms that stand for natural kinds. Natural kind terms are used to express understanding of natural kinds and to refer to them. Accounts of natural kinds are therefore crucial to the topic of natural kind terms. Philosophers have different views regarding natural kind terms. For example, Saul Kripke and Hilary Putnam claim that they are rigid designators, and Thomas Kuhn holds that they need to be understood with respect to a particular scientific paradigm. However, these philosophers assume that they can ground their theories of natural kind terms without providing a definition of ‘natural kind.’ Kripke states that a natural kind comprises natural existents with the same essence and Putnam states that a natural kind includes natural existents bearing a sameness relation. Their accounts of natural kinds can be roughly summarized as the assertion that modern science dictates the essence of, or the sameness relation among, natural existents and the essence, or the sameness relation, determines the kind to which existents belong. This assertion is ambiguous in explaining
what natural kinds are. For there are no scientific definitions of ‘essence’ and
science may attribute new essences to kinds as it progresses.

Although Thomas Kuhn offers a more comprehensive account for natural
types, he does not note that natural kind terms are used in non-scientific
discussions. For Kuhn, paradigms are responsible for determining natural kinds
because they provide specific ways of understanding and categorizing their
classes. Thus, natural kind terms need to be understood with respect to a
particular paradigm, for different paradigms may address their kinds differently.

However, this view does not note that some natural kind terms are also part of
the vocabulary of everyday life and are thus used in ordinary, non-scientific
discussions.

I hope to provide a more inclusive account for natural kind terms that is
based on an appropriate definition of ‘natural kind.’ The three philosophers
listed above address natural kind terms in light of modern science or paradigms.

However, natural kind terms are not only used in scientific discussions or texts;
some of them are also everyday words.

Theories of natural kind terms lead to three important philosophical views.
Saul Kripke’s proposal that there are *a posteriori* necessary judgments,¹ Hilary Putnam’s semantic externalism,² and Thomas Kuhn’s claim about incommensurability³ between scientific theories, have been regarded as three of the major contributions in 20th century philosophy, generating a rich literature in the philosophy of science and the philosophy of language. Though seemingly only loosely related, these three views share a significant commonality: differing theories of natural kind terms are part of the arguments that lead to these views.

However, these views are not grounded in well constructed arguments because

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¹ *A posteriori* necessary judgments are necessary judgments in that their discoveries are through empirical investigations. For example, scientists discovered that gold is Au-79 by carrying out empirical scientific investigations. They might not have discovered this fact about gold. Thus, the judgment that gold is Au-79 is an *a posteriori* or contingent judgment. However, regardless of how they discovered this fact, it is necessary that gold has the atomic number 79. Thus, the judgment is a necessary one. See Saul Kripke, *Naming and Necessity*, Harvard University Press, Cambridge, 1980, pp. 99-101.

² According to Putnam, the traditional view of meaning is that meanings depend solely on what is in the subject’s head or the subject’s physical boundary; private mental states determine the extensions of the subject’s terms. Arguing against the traditional view, Putnam proposes a semantic externalist account, which holds that the determinations of the meanings of kind terms involve external environments and scientific research. Hilary Putnam discusses different theories of meaning in "Is Semantics Possible?" *Metaphilosophy*, Vol. 1, No. 3, 1970, pp. 187-201.

³ Kuhn introduces his term of ‘incommensurability.’ He writes that “Twenty years have passed since Paul Feyerabend and I first used in print a term we had borrowed from mathematics to describe the relationship between successive scientific theories. ‘Incommensurability’ was the term; each of us was led to it by problems we had encountered in interpreting scientific texts...Each of us was centrally concerned to show that the meanings of scientific terms and concepts – ‘force’ and ‘mass’, for example, or ‘element’ and ‘compound’ – often changed with the theory in which they were deployed. And each of us claimed that when such changes occurred, it was impossible to define all the terms of one theory in the vocabulary of the other.” See Thomas Kuhn, "Commensurability, Comparability, Communicability," *PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association*, Vol. 1982, volume two, 1982, pp. 669.

Gattei also notes that "Kuhn...explained incommensurability in terms of (a sort of) mutual untranslatability of two theories as a consequence of the lack of some (relatively) neutral observation language. Untranslatability is the primary notion required to understand incommensurability." See Stefano Gattei, *Thomas Kuhn’s ‘Linguistic Turn’ and the Legacy of Logical Empiricism: Incommensurability, Rationality and the Search for Truth*, Ashgate Publishing, Burlington 2008, pp. 139.
the philosophers’ treatments of natural kinds, which their theories of natural kind terms are based upon, are oversimplified. I shall give a brief introduction of the three views and explain how these views are relevant to theories of natural kind terms in the following section.

2.

Kripke develops his philosophical account on proper names as an objection to descriptivism, which claims that proper names are abbreviated definite descriptions. A descriptivist claims that a definite description such as ‘the president of the United Stated in 2016’ uniquely picks out a particular individual; the name ‘Barack Obama’ also picks out that individual. Since they both pick out the same individual, they refer to the same thing. A descriptivist would claim that ‘Barack Obama’ is abbreviated definite descriptions that uniquely pick out Barack Obama. However, Kripke argues that proper names are not abbreviated definite descriptions; instead, they are rigid designators.

Kripke argues that the definite description ‘the president of the United Stated in 2016’ could have picked out Mitt Romney, if Barack Obama had lost the presidential campaign. But ‘Barack Obama’ refers to Barack Obama regardless of
whoever is the president. In fact, Obama could have chosen another life journey and had another career, but in every possible situation, ‘Barack Obama’ picks out Obama, given that ‘Barack Obama’ names Barack Obama. A proper name stands for its object in any given situation. The object maintains its name throughout its existence. Even though Barack Obama had been given a different name, the nature of proper name that it stands for its object regardless of any possible situations remains. The name of Barack Obama stands for him throughout his entire life. Thus, Kripke suggests that proper names, such as ‘Barack Obama,’ are rigid designators.

Kripke explains the notion of rigid designator. He writes ‘What’s the difference between asking whether it’s necessary that 9 is greater than 7 or whether it’s necessary that the number of planets is greater than 7? ...the number of planets might have been different from what it in fact is. It does not make any sense, though, to say that nine might have been different from what it in fact is.’4 Thus, Kripke concludes, ‘9’ is a rigid designator whereas ‘the number of planets’ is not. Because ‘9’ refers to 9 in all possible situations, whereas ‘the number of planets’ could be different and thus refers to different numbers in

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different possible worlds. Kripke writes that 'Let's call something a rigid designator if in every possible world it designates the same object, a nonrigid or accidental designator if that is not the case.'\textsuperscript{5} Since proper names refer to the same object in all possible situations, they are rigid designators.

Kripke believes that not only are proper names rigid designators, but so are natural kind terms. He claims that essences of natural things render rigidity of their terms. He writes "Gold apparently has the atomic number 79...Given that gold does have the atomic number 79, could something be gold without having the atomic number 79? Let us suppose the scientists have investigated the nature of gold and have found that it is part of the very nature of this substance, so to speak, that it has the atomic number 79."\textsuperscript{6} Kripke claims that on the one hand we cannot imagine gold without attributing the atomic number 79 to gold; on the other hand we cannot imagine something with the atomic number 79 without its being gold. Thus, Kripke holds that 'gold' refers to whatever has the atomic number 79 in every possible world. Thus, 'gold' is rigid. Similarly, since water is H\textsubscript{2}O in every possible world, 'water' refers to H\textsubscript{2}O rigidly; so do other

\footnotesize\textsuperscript{5} Ibid., pp. 48. 
\footnotesize\textsuperscript{6} Ibid., pp. 123-124.
natural kind terms.

The claim of rigidity of natural kind terms has a surprising theoretical consequence, namely, that there are a posteriori necessary judgments. The proposal of a posteriori necessary judgments has been a highly influential contribution to philosophy. David Hume claims that the distinction between a priori analytic and a posteriori synthetic is exclusive and exhaustive—there are only two types of judgments, i.e., a priori analytic and a posteriori synthetic; judgments that are analytic are a priori and those that are synthetic are a posteriori. Hume believes that there are neither synthetic a priori judgments nor a posteriori analytic judgments. However, Immanuel Kant recognizes a third type of judgments type of judgments, i.e., synthetic a priori judgments. Kant argues that judgments such as the total angles of a triangle is three is a priori analytic—it does not require any empirical investigation to know the total (three) since it is part of the verbal meaning of ‘triangle’; however, that the square of the hypotenuse (the side opposite the right angle in a right triangle) equals the sum of the squares of the two sides of the right angle in the right triangle was an

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discovery on the part of Pythagoras, a synthetic truth and yet necessary a priori.

Though Kant challenges Hume's claim of the exclusiveness and exhaustiveness on the distinction between a priori/analytic and a posteriori/synthetic—he points out that certain a priori judgments are synthetic—Kant agrees with Hume on the distinction between a priori/necessary and a posteriori/contingent. They believe that there are neither a priori contingent nor a posteriori necessary judgments. The recognition of synthetic a priori necessary judgments convinces many philosophers, but Kripke reflects on the exclusiveness of the distinction between a priori/necessary and a posteriori/contingent and proposes a new type of judgments, i.e., a posteriori necessary judgments.

According to Kripke, a natural kind term is rigid because it refers to natural things with the same essential feature in every possible world. For example, 'gold' refers to Au-79 rigidly and gold is Au-79 in every possible situation. Therefore, that gold is Au-79 is a necessary truth. However, the discovery of this truthfulness is a posteriori and contingent; scientists need empirical researches to discover this truth. They may never discover this truth and this discovery is contingent. Therefore, Kripke concludes that that gold is Au-79 is posteriori
necessary judgments.\textsuperscript{8}

Putnam also reaches the conclusion of rigidity of natural kind terms by his Twin Earth argument. Putnam disputes what he calls the traditional view of meaning,\textsuperscript{9} which holds that the meaning of a term is determined by a psychological state in a certain narrow sense—the ‘in the head’ sense. In order to argue against the traditional view of meaning, Putnam designs the Twin Earth argument\textsuperscript{10} to show that a person’s narrow psychological state, which depends only on the intrinsic properties of a person, does not determine the extension of her terms. In the Twin Earth argument, Putnam supposes that there is a Twin Earth where everything is just like Earth except for water. The stuff called ‘water’ has a chemical structure XYZ in Twin Earth while on Earth ‘water’ is H\textsubscript{2}O. XYZ has all the superficial features that H\textsubscript{2}O has. They both are odorless, tasteless and transparent liquids. People on Twin Earth drink XYZ, use XYZ for cooking, and rivers and oceans are filled with XYZ. People on Twin Earth also call XYZ ‘water.’

Twin Earth is just as Earth except the chemical structure of the liquid called ‘water.’ When a person on Twin Earth utters ‘water,’ she refers to XYZ; the other

\begin{itemize}
  \item Ibid., pp. 139-143.
\end{itemize}
on Earth utters ‘water,’ she refers to H_2O. Thus, ‘water’ has two extensions—the extension of ‘water’ on Earth is H_2O and on Twin Earth is XYZ.

Putnam further supposes that in 1750, when modern chemistry had not yet developed, there are two human duplicates who are cell to cell identical with each other on Twin Earth and on Earth. Since the duplicates are identical to each other and since their surroundings are identical too, they have the same mental history and thus they have the same intension of ‘water.’ However, the intension of ‘water’ has two extensions, one is XYZ and the other is H_2O. Therefore, Putnam concludes that what is in the head does not determine the extension of ‘water.’ For the duplicates have the same intrinsic properties and they have the same intension of ‘water,’ but the intension of ‘water’ has two extensions. Semantic externalism, the view that the reference of a term does not depend on intrinsic relational properties of a person, emerges from the Twin Earth argument, if the argument is successful.

In addition, Putnam provides an account of semantic externalism. He introduces two ideas to flesh out his view: indexicality and linguistic labor. Putnam explains the notion of indexicality in the following way: “words like
‘water’ have an unnoticed indexical component: ‘water’ is the stuff that bears a
certain similarity relation to the water around here.”11 Putnam understands

‘water’ as a term indexically refers to substances that bear the sameness relation
to water in this actual world, i.e., the substances H2O. The notion of linguistic
labor12 is that in a linguistic community different people have different linguistic
responsibilities: journalists popularize terms, scientists determine the
extensions of terms, and teachers instruct students on terms. Putnam writes

“Consider our community as a ‘factory:’ in this ‘factory’ some people have the
‘job’ of wearing gold wedding rings, other people have the ‘job’ of selling gold
wedding rings, still other people have the job of telling whether or not something
is really gold...everyone to whom gold is important for any reason has to acquire
the word ‘gold’; but he does not have to acquire the method of recognizing if
something is or is not gold.”13 A group of experts of gold determines to what
‘gold’ refers—the linguistic labor of the experts determines the extension of
‘gold,’ and thus determines the referents of ‘gold.’ According to Putnam, the
intension of ‘gold’ does not determine the extension of ‘gold.’ To what ‘gold’

11 Ibid., pp. 152.
12 Ibid., pp. 144-145.
13 Ibid., pp. 144-145.
refers is determined by linguistic labors, which is a theory of semantic externalism. Putnam concludes with the rigidity of a kind term, such that it has the same referents in all possible worlds. He writes 'It should be clear, however, that Kripke's doctrine that natural-kind words are rigid designators and our doctrine that they are indexical are but two ways of making the same point.'  

To sum up, Putnam holds that the reference of a kind term is based on the sameness relation that holds between the members of a kind. When a kind term is introduced, it refers to an individual or a specific set of individuals, as well as to whatever bears the sameness relation with that individual or individuals. This is indexical because on the introduction of a kind term, the sameness relation is indexed to whatever particular sample is referred to in the context of baptism. A kind term indexically represents that sample baptized through the sameness relation defined by the scientific linguistic labor in the linguistic community in the actual world.

The sameness relation (and hence kind term) is defined by the linguistic labor being done in the linguistic community in which the kind term appears.

Experts in the kind (usually scientists) possess the ways to recognize the

14 Ibid., pp. 152.
individuals belonging to the kind, and thus they are responsible for determining
the sameness relation among the members of the kind. The sameness relation
determines the extension of the term, and the experts in the kind determine the
referents of the term. However, Putnam does not explain what would occur if a
linguistic community were to get the sameness relation wrong. He seems to
assume that the kinds defined by a scientific community, which constitutes a part
of some linguistic communities’ overall linguistic labor, are real and reliable.

Kuhn draws facts and examples from his background in the physical
sciences and history to construct his theory of scientific revolution, which makes
the theory more palpable and convincing. The notion of scientific revolution is a
significant contribution in the philosophy of science. Kuhn observes that
different scientific theories dominate different historical periods—it happens
throughout the history of science that a new theory replaces its predecessor. He
also notices that a scientific theory encounters anomalies, which often puzzles
scientists and lead them to construct new theories in order to rectify the
situation. New theories often view the same physical events with fresh
perspectives. When a new theory is considered to correctly explain the
anomalies or solve the problems, this new theory is accepted and the previous, now outdated, one is abandoned. Kuhn calls the prevailing scientific theory that is accepted as true in its time a paradigm and the acceptance of a new theory a paradigm shift.

According to Kuhn, when Newtonian physics, say, was accepted and Aristotelian dynamics was abandoned, a paradigm shift happened in physics. Kuhn writes "‘paradigms,’ a term that relates closely to ‘normal science.’ By choosing it, I mean to suggest that some accepted examples of actual scientific practice—examples which include law, theory, application, and instrumentation together—provide models from which spring particular coherent traditions of scientific research. These are the traditions which the historian describes under such rubrics as ‘Ptolemaic astronomy’ (or ‘Copernican’), ‘Aristotelian dynamics’ (or ‘Newtonian’)." A paradigm provides scientists a particular research methodology. It can roughly be understood as (at least) a set of methods, theories with theoretical terms, standards and concepts. Two significant consequences result from the view that the history of science is divided up into

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relatively incommensurable scientific paradigms. The first is that scientific
development is nonlinear, in the sense that there is no single best path forward
for scientific development to have taken in the past or that it will take in the
future. The second is that the history of science can correctly be seen as a series
of revolutions that upended whatever paradigm was dominant at those various
times.

Kuhn also observes that Newton’s laws of motion cannot be expressed in
Aristotelian terminology. This observation leads him to the notion of
incommensurability. Gattei writes ‘Kuhn ... explained incommensurability in
terms of (a sort of) mutual untranslatability of two theories as a consequence of
the lack of some (relatively) neutral observation language. Untranslatability is
the primary notion required to understand incommensurability.’\(^{16}\) A paradigm,
with its new taxonomy, introduces unexpected understandings of the kinds or
different arrangements of natural existents, which results in the kind terms
referring to a new group of things. For example, ‘mammal’ includes whales, dogs
and cats in Linnaean taxonomy; however, ‘live-bearing tetrapod’ includes dogs

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and cats but excludes whales in Aristotelian taxonomy. Whales belong to
different kinds in different taxonomies of paradigms. This causes kind terms,
such as ‘mammal’ and ‘live-bearing tetrapod,’ to refer to different things.
‘Mammal’ refers to whales, dogs and cats; ‘live-bearing tetrapod’ refers to dogs,
and cats. Kind terms express different concepts of their kinds with respect to
different paradigms. ‘Whale’ in Linnaean taxonomy means a kind of mammal but
it means a kind of cetacea in Aristotelian taxonomy.

A paradigm also provides a conceptual scheme through which people
conceive reality in a certain perspective. For example, people within the
Aristotelian paradigm believed that water was a certain element; people
receiving an education in modern chemistry assert that water is a certain
compound. Because different paradigms address natural kinds differently, Kuhn
maintains that natural kind terms need to be understood with respect to a
paradigm.

Kuhn’s theory has had a great impact in the philosophy of science; it calls
attention to paradigm shifts in the history of science. A consequence of the
theory of paradigm shift is the notion of incommensurability. As in the
aforementioned examples, ‘water’ and ‘whale’ express different concepts with respect to different paradigms, and it is a mistake to translate ‘water’ and ‘whale,’ as they appear in ancient texts, directly into ‘water’ and ‘whale’ in the modern sense. Kuhn holds that it is inappropriate to “define all the terms of one theory in the vocabulary of the other.”\footnote{Thomas Kuhn, “Commensurability, Comparability, Communicability,” \textit{PSA: Proceedings of the Biennial Meeting of the Philosophy of Science Association}, Vol. 1982, volume two, 1982, pp. 669.} That the natural kind terms of different paradigms have different meanings can exemplify the notion of incommensurability.

In their accounts, Kuhn, Putnam, and Kripke bring new insights to philosophy. Kuhn conceptualizes dominant scientific theories as paradigms, which contain a scheme of concepts that enable people to conceive reality in a certain way. He shows how people within different paradigms conceive their reality differently. Putnam questions the traditional view of meaning, which treats meaning as a concept that is determined by a private mental state. He provides the insight that the meaning of a kind term is a product of linguistic labor working on a natural individual thing. People thus have a fresh way to conceive meaning—it is not something inside the head but an entity generated
by the interactions of a linguistic community and environments. Putnam introduces a new topic in the philosophy of language, namely, a semantic externalist theory of meaning. Kripke challenges Kant’s claim about the exclusive and exhaustive distinction between \textit{a priori} necessary and \textit{a posteriori} contingency. Kripke's proposal of \textit{a posteriori} necessary has important implications in epistemology and metaphysics. For \textit{a posteriori} is an epistemic concept whereas necessary is a metaphysical one. Philosophers, following Kant, believe that topics of \textit{a posteriori} contingency belong to epistemology, whereas subjects of \textit{a priori} necessary belong to metaphysics. But Kripke's proposal of \textit{a posteriori} necessary opens a new horizon in both epistemology and metaphysics. In the next section, however, I shall explain that the three views are in tension with each other and they don’t maintain altogether.

3.

Putnam’s claims that a natural kind term is rigid and that the reference of the term is determined by linguistic labor are not, when taken together, true. If the sameness relation determining natural kinds is a product of linguistic labor in a linguistic community, a kind term cannot refer to the same group of things in
all possible situations. This is because the linguistic labor might have grouped
the individual things in other ways, and thus the kind term might have referred
to a group of different things. In fact, for example, ‘water’ refers to H₂O and its
isotopes only after the isotopes were found. Thus, ‘water’ does not refer to H₂O
and its isotopes in different historical periods. That is, ‘water’ is not a rigid
designator because it does not refer to the same group of things in all possible
situations. Putnam believes that the sameness relation on which kindness rests
is reliable, but often our natural kind categories include disparate individuals.
Though these individuals may share some resemblances, the selection of the
features defining the kindness is dependent on unpredictable human linguistic
labor.

A natural kind category may contain a wide variety of individuals with
radically different properties. For example, the kind dog contains Chow Chow
and Chihuahua; it is difficult to claim that the kindness of dog is based on the
sameness relation among the individual things comprising the kind. Even if one
claims that Chow Chow and Chihuahua share the same genetic code or ancestral
features, the selection of the features applied to the sameness relation, and
which is therefore regarded as the essences or the identities of the kind, is not
predetermined. Take water, for instance: if liquidity is selected as the identifying
feature of the sameness relation among constituents of the kind water, water
would include the liquids in rivers, creeks, and raindrops; if the chemical
structure \( H_2O \) is chosen as the defining feature of the sameness relation, the kind
water would include steam, ice, and liquid water; if \( H_2O \) and its isotopes are
chosen to define the sameness relation among members of the kind water, water
would comprise the three states of \( H_2O \) as well as different forms of heavy water.

Although the determining of the essence of a kind involves observations of
its samples, accounts about other relevant kinds, a scientific theory about the
kind, and so on, when essence of the kind is determined by linguistic labor, it is
not predetermined by nature itself. The kind term can refer to different groups of
things when scientists select different features to define the sameness relation
among members of the kind. This is in conflict with Putnam's assertion that kind
terms are rigid: for a kind term to be rigid, it needs to refer to the same group of
things in all possible situations. When the kind-ness is a product of human
linguistic labor, and when the labor can determine the extension of a kind term
to be heterogeneous or otherwise constituted, the term is not a rigid designator.

Moreover, Kripke’s account and Kuhn’s account are not compatible. Kripke believes that scientific developments are linear: science approaches an understanding of ultimate reality step by step, and it offers a more and more comprehensively truthful account with every development. Though this seems intuitive, Kuhn’s analysis points out that in the history of science, as mentioned above, scientific development is nonlinear. The substance water is conceived differently in the four-element paradigm and in the paradigm of modern chemistry. The former considers it a simple element that comprises the Earth along with other elements, and the latter considers it a compound with different isotopes and so forth. According to Kuhn, scientists do not approach the ultimate understanding of water step by step; the four-element paradigm and the paradigm of modern chemistry share little developmental continuity. Scientific progress is consisted of linear and nonlinear developments. Therefore, according to Kuhn, Kripke’s assumption—that science approaches the ultimate reality and the essences of kinds in a linear way—is not solid, which calls into question his account of the rigidity of kind terms.
On the other hand, though Kuhn’s account fits the facts in the history of science better—in particular that paradigm shifts and scientific developments are not linear—it does not exclude a possible theoretical consequence, which Kuhn would not endorse, that random theory choice can cause a paradigm shift.

Kuhn discusses criteria for theory choice in order to avoid this consequence:

the evaluation of criteria for theory choice requires the prior specification of the goals to be achieved by that choice. Now suppose...that the scientist’s aim in selecting theories is to maximize efficiency in what I have elsewhere called “puzzle-solving.” Theories are, on this view, to be evaluated in terms of such considerations as their effectiveness in matching predictions with the results of experiment and observation.\textsuperscript{18}

He also proposes a list of criteria for theory choice:

the rationality of the standard list of criteria for evaluating scientific belief is obvious. Accuracy, precision, scope, simplicity, fruitfulness, consistency, and so on, simply are the criteria which, puzzle solvers must weigh in deciding whether or not a given puzzle about the match between phenomena and

belief has been solved. Except that they need not all be satisfied at once, they are the "defining" characteristics of the solved puzzle. It is for maximizing the precision with which, and the range within which, they apply that scientists are rewarded. To select a law or theory which exemplified them less fully than an existing competitor would be self-defeating, and self-defeating action is the surest index of irrationality.\textsuperscript{19}

However, scientists can weigh those criteria differently. This leads to some sort of scientific relativism, which holds that there is no universal criterion in favor of one scientific theory over other rivaling scientific theories since there are multiple standards for theory choice. Although a scientific relativist would not maintain his preference between theories, modern chemistry, for instance, does provide more genuine knowledge of water than the four-element theory.

Scientific and technological developments make scientific relativism an unfavorable position to maintain. These considerations suggest that a more robust treatment of theory choice needs to be an important supplement to

Kuhn’s account of paradigm shifts.

Kuhn, Putnam, and Kripke are three major figures in 20\textsuperscript{th} century analytic philosophy, but one cannot maintain the aforementioned accounts altogether. In particular, Putnam’s claims are not, when taken together, true, and Kripke’s and Kuhn’s are not compatible with each other. Putnam’s claim about the rigidity of kind terms and his claim about linguistic labor determining the meanings of kind terms do not hold together. For the rigidity of a kind term makes the term refer to a group of same things in all possible worlds, but human linguistic labor could have defined the kind otherwise, and thus the kind term might have referred to a group of different things. Kuhn’s notion of scientific revolution, which implies a nonlinear scientific development, and Kripke’s assumption of a linear scientific development, by which he accounts for the rigidity of kind terms, are not compatible. Moreover, according to Kuhn, kind terms are not rigid since they may have different extensions in different paradigms, while Putnam and Kripke both uphold the rigidity of kind terms—which means that they have the same extensions in all possible worlds. On one hand, Kuhn’s claim of kind terms is supported by many facts from the history of science, though his theory of
paradigm shift has a possible theoretical consequence that many people find unfavorable, namely, scientific relativism. On the other hand, the proposal of a

*a posteriori* necessary judgments, which is regarded as an important philosophical contribution, does not hold without affirming the rigidity of kind terms.

So far I have presented views in the recent history of analytic philosophy that are in tension with each other, rooted in their different treatments of natural kind terms—in particular, the rigidity of kind terms suggested by Kripke and Putnam and taxonomy deciding the meanings of kind terms suggested by Kuhn. The topic of natural kind terms is thus critical because the understanding of kind terms leads to the acceptance or the refusal of the proposal of *a posteriori*
necessary, the assertion of the rigidity of kind terms in a semantic externalist account of meaning, and the notion of scientific paradigms, which are three major achievements in 20th century analytical philosophy.

4.

Theories of natural kind terms should be constructed alongside accounts of natural kinds since natural kind terms are terms for natural kinds. Without a
definition of ‘natural kind,’ one may not know what terms are natural kind terms.
This dissertation provides a definition of ‘natural kind,’ upon which I base my account of natural kind terms. I offer a more inclusive account of natural kind terms since it addresses the fact that natural kind terms are used in scientific and non-scientific discussions. Natural kinds are not merely scientific objects; some of them are also daily-life essentials. I argue that, by investing in examples of kind terms, such as ‘neutron,’ ‘whale,’ and ‘water,’ Kuhn offers a more plausible theory of natural kind terms than Putnam's and Kripke's theories, which endorse the rigidity of kind terms. According to Kuhn, kind terms are understood with respect to paradigms since paradigms may provide different accounts for natural kinds. Following this line of thought, however, knowledge about kinds can also allow people to know their terms. If my account is convincing, it shall provide a semantic externalist theory of meaning without asserting the rigidity of kind terms, and it shall also provide kind terms a broader context than just science—kind terms could be properly situated as both scientific terms and everyday life terms, that is, in the context of knowledge of kinds happening inside and outside scientific practices.

My account of natural kind terms presents a fresh viewpoint on the account
of semantic externalism and the proposal of *a posteriori* necessary judgments.

Possible candidates to account for why kind terms stand for their kinds are not just scientific stipulation or paradigms but also knowledge. By understanding natural kind terms in terms of knowledge, which can be generated by everyday life activities and be irrelevant to scientific accounts of their kinds, the usage of natural kind terms within and outside the context of science is explained.

Moreover, this account would allow for a semantic externalist theory of meaning that does not need to assert the rigidity of kind terms. Finally, even without the assertion of the rigidity of kind terms, the proposal of *a posteriori* necessary judgment could be maintained within a certain theoretic framework. To illustrate, the judgment that gold is Au-79 in the framework of modern chemistry is necessary, though in other scientific theories it may not. These are some examples of research topics that may follow from my account, and which may be pursued in the future.

The arrangement of the dissertation is as follows. In chapter one, I discuss three definitions of ‘natural kind’ and three examples of natural kind terms: ‘neutron,’ ‘whale,’ and ‘water.’ The case of ‘neutron’ illustrates Kripke and
Putnam’s idea of natural kinds and natural kind terms—they hold that modern science determines referents for kind terms rigidly. The case of ‘whale’ indicates that a kind term needs to be understood with respect to a certain paradigm, which is an example of Kuhn’s view of natural kinds and their terms. The case of ‘water’ shows that both scientific knowledge and non-scientific knowledge allow people to recognize natural kinds, and some kind terms can be understood and used in non-scientific discussions.

Discussions and criticisms of Thomas Kuhn’s account of natural kind terms is presented in chapter two, which includes an introduction of his treatment of kind terms, especially how he connects kind terms to his account of scientific paradigms. In the chapter, I also offer my criticisms of his account. I especially interrogate how he situates kind terms within the context of science and overlooks the fact that kind terms are also used in non-scientific discussions.

Hilary Putnam’s account is presented in chapter three, which includes an introduction of his Twin Earth argument, his account of the references of kind terms, and my criticisms of his account. Putnam uses the Twin Earth scenario to argue that meanings are not in the head; however, the argument is problematic.
For examples, first of all, his phrase ‘determining extension’ is ambiguous.

Second, if he allows XYZ to be included in the extension of ‘water,’ he could easily get the result that intension does not determine extension by modus tollens.

Finally, a kind term cannot have two or more extensions; what it can have is two or more constituents in its extension.

Chapter four deals with Saul Kripke’s account, which includes an introduction to his notion of rigidity, his argument for the rigidity of kind terms, and my criticisms for his account. For example, the argument is based on an assumption that does not fit the facts of the history of science—the assumption that science describes the ultimate essences of kinds, upon which the argument for the rigidity of kind terms is based. There are also counterexamples to the claim about the rigidity of kind terms—for example, the extensions of ‘mammal’ and ‘fish’ changed constituents; and there may be more isotopes of gold to be discovered and included in the extension ‘gold.’

Chapter five is a summary of the dissertation, and Kripke’s three arguments against descriptivism are modified into arguments against my account, to which I then reply in this chapter.
Chapter One: Natural Kind Terms and Knowledge of Kinds

This chapter begins with a discussion on Putnam’s, Kripke’s, and Kuhn’s accounts of natural kinds. Putnam explains natural kinds in terms of indexical examples and sameness relations; Kripke asserts that a natural kind is natural existents with the same essence; and Kuhn holds that scientific paradigms determine their kinds. I formulate two definitions that are relevant to these accounts, in particular, one related to Putnam’s and Kripke’s and the other to Kuhn’s. There are, however, some issues with Putnam’s and Kripke’s accounts. In their accounts, there are kinds without representative indexicals and kinds can be assigned new essences with scientific progress. These issues call into question their assertion of the rigidity of natural kind terms. Although Kuhn offers a more comprehensive account for natural kinds, he does not explain how natural kind terms can be used in non-scientific discussions.

I present a third definition of ‘natural kinds’ that explains natural kinds in terms of resemblances that people recognize among natural existents. Based on this definition, I hope to provide an inclusive theory for natural kind terms, one which considers the fact that they are used in scientific and non-scientific
discussions. I discuss three natural kind terms: ‘neutron,’ ‘whale,’ and ‘water.’

The case of ‘neutron’ illustrates Kripke’s and Putnam’s accounts of natural kinds and kind terms—they hold that a particular science determines the essence of a kind and referents for its term. The case of ‘whale’ illustrates Kuhn’s view, which maintains that different scientific accounts provide different comprehensions of the kind and use its term to express different concepts. However, the case of ‘water’ reveals an aspect that none of the three philosophers notice—non-scientific knowledge can also help people know a kind and know referents of the kind term. The case of ‘water’ shows that natural kinds and kind terms can be understood in non-scientific contexts.

In the end of this chapter, there are some remarks concerning references of natural kind terms. I discuss different cases in which knowledge of a kind generated by everyday life, by scientific theories, or by both, allows people to know what its term stands for, and to use the term to refer to the kind. I also clarify the relationship between the verification of an example of a kind and criteria for being referents of its term.

1. Natural kinds and natural kind terms
Human beings have a natural inclination to categorize things. What is obvious to us is that ducks resemble one another more closely than they resemble deer, and that ducks resemble swans more than they resemble deer. Without any scientific knowledge about swans, ducks, and deer, we are inclined to categorize swans and ducks together, rather than ducks and deer. Human beings notice that there are different sorts of existents in this world. Existents in this world may be so categorized: natural organisms, such as animals and plants; natural objects, such as rocks, mountains, rivers, valleys, and planets; natural materials, such as water, clay, dirt, sand, and air; natural events, such as explosions, collisions, digestion, growth, maturation, and ripening; products made by men and animals, such as cars, televisions, honeycombs, birds’ nests, and formicaries; and artificial-natural existents, such as synthesized quartz, cloned sheep, and seedless fruits.

With technological and agricultural developments, there are two types of artificial-natural existents. One type has exactly the same properties as natural existents of the same kind. Human beings produce artificial-natural objects as copies of natural existents – they have exactly the same properties of the natural
objects in their kinds, such as synthesized quartz, and cloned sheep. Scientists do not categorize them separately; they are classified as one kind. For example, man-made diamonds and natural diamonds both belong to the kind diamond. Since they are copies of natural existents and have all the physical and chemical properties that their natural counterparts have, I regard them as belonging to a subcategory of natural existents.

The other type is offspring that are reproduced by artificial pollination, artificial insemination, or other artificial breeding techniques. Seedless fruits, cross-pollinated flowers, and other genetically modified organisms are desirable offspring that humans produce by intervening in their natural reproductive process; they are the result of artificial reproduction. Although the majority of their populations are the result of engineered reproduction, we cannot rule out the possibility that these existents can occur under natural circumstances—there may be rare examples of hybrid orchids and seedless watermelons that occur under certain natural conditions. They may be produced by nature, albeit rarely, and so they should be regarded as natural existents.

There are artificial objects such as cars, telephones, computers, and
televisions. Artificial existents depend solely on humans; unlike artificial-natural objects, they do not exist in this world if humans do not design and manufacture them. Among these different sorts of existents, it is easy to tell that organisms, objects, materials and, events—such as plants, mountains, dirt, and explosions—are natural and that artificial objects—such as cars and telephones—are not natural. Artificial objects are not natural because humans design and manufacture them. Thus, according to the same line of thought, production by animals should not be considered as natural either. Therefore, honeycombs, birds’ nests, and formicaries are not natural objects.

Based on the above discussion, I have distinguished natural existents from non-natural existents: non-natural existents include those that are not produced by nature. According to this discussion, cars, televisions, honeycombs, and formicaries do not occur in nature, and thus they are non-natural existents.

Diamonds and quartz occur in nature. Although some of them can be man-made or synthesized in a lab, they are natural existents. Orchids and watermelons occur in nature, too. Although some of them result from engineered reproduction, they are also natural existents.
According to this discussion, natural organisms, objects, materials, events, and artificial-natural existents are all natural existents. Scientists have long devoted their research to investigating natural existents. They try to discover features and governing principles of them. Botany, zoology, mineralogy, chemistry, marine biology, and many other disciplines are all scientific investigations into natural existents.

Roughly speaking, a natural kind is a group of natural existents and a natural kind term is a term that stands for the kind. However, philosophers who address the issue of natural kind terms, such as Putnam, Kripke, and Kuhn, assume that they can intuitively convey a conception of natural kinds by just giving examples, without providing a definition of ‘natural kind.’ Joseph Laporte comments on this:

Philosophers who discuss natural kind terms seldom offer any analysis of what they are supposed to be. Prominent philosophers tend just to offer examples. Their examples are supposed to help readers grasp intuitively what is intended. The most common examples of natural kind terms presented in the literature are perhaps terms for biological species and
higher taxa: ‘Tiger,’ ‘elm,’ and ‘mammal’ are all discussed extensively in the
literature. Chemical kind terms, such as ‘water’ and ‘jade,’ are also presented
as examples with great frequency.\(^{20}\)

Since there is no single commonly shared conception of natural kinds and
philosophers do not offer clear definitions of ‘natural kind,’ their accounts of
natural kinds, which their theories of natural kind terms are based upon, are not
well constructed. In particular, Putnam’s and Kripke’s accounts are unclear in
explaining natural kinds— it is unclear which kinds are natural kinds in their
work. Although Kuhn offers a more comprehensive account for natural
kinds—stating that paradigms determine natural kinds—he does not explain
how their terms can be used in non-scientific discussions.

Putnam and Kripke offer only a handful of examples of natural kinds.

Although they have certain notions that account for natural kinds—for example,
the notions of sameness relation and essence—their accounts are still
ambiguous in explaining what natural kinds are. Putnam believes that scientists,
who as part of linguistic labor in a linguistic community, determine the sameness

relation among natural existents, and the sameness relation gathers existents into a kind. Putnam writes that “the theory we have been presenting may be summarized by saying that an entity x, in an arbitrary possible world, is water if and only if it bears the relation sameL (construed as a cross-world relation) to be the stuff we call ‘water’ in the actual world” and that “words like ‘water’ have an unnoticed indexical component: ‘water’ is stuff that bears a certain similarity relation to the water around here.” From what Putnam says about the natural kind term ‘water,’ I understand that in order for existents to be a natural kind in Putnam’s view, there must be a sameness relation among constituents of the kind, which is determined by scientists. There is also an indexical example that represents constituents of the kind in this actual world and it shares the sameness relation to constituents of the kind. In the case of water, existents that are the same with an indexical example of water in this world, namely H2O, are water. Kripke believes that modern science reveals reliable truths about natural kinds. Once modern science discovers the essence of a kind, the identity of this kind is settled. Kripke writes that “Given that gold does have the atomic number

22 Ibid., pp. 152.
79, could something be gold without having the atomic number 79? Let us suppose the scientists have investigated the nature of gold and have found that it is part of the very nature of this substance, so to speak, that it has the atomic number 79.” Putnam’s and Kripke’s accounts of natural kinds can be roughly summarized as the assertion that science determines the essences of natural existents, and essences determine to which kind existents belong. Modern science dictates which existents belong to a kind and determines referents for that kind’s term.

However, their views of natural kinds raise concerns. First of all, their accounts do not clearly explain natural kinds. In Putnam’s account, scientists determine a natural kind by the sameness relation between constituents of the kind. This account does not apply to planets because there are different ways of classifying planets—there is no single classification system for all planets.

Planets can be classified as a kind according to their mass regimes, orbital regimes, or compositions. This indicates that there is no one single sameness

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24 Planets that are classified according to their compositions are, for example, Jupiter and Saturn, which are gas planets; Venus and Mars, by contrast, are terrestrial planets. See Steven J. Dick, Discovery and Classification in Astronomy: Controversy and Consensus, Cambridge University Press, 2013, pp. 245-276 and pp. 344. Planets that are classified according to their orbital regimes are, for example, a planet that is inferior to another planet if its orbit lies inside the planet’s orbit, or that is superior when its orbit is further away. See James Shipman, Jerry Wilson, Charles Higgins,
relation among members of planet-kind. Some kinds have multiple modes of
classification. This account also does not apply to kinds that are loosely defined,
such as rivers, creeks, streams, and brooks. There are no clear scientific
distinctions to separate them. Moreover, according to Putnam, members of a
natural kind can be represented by an indexical example in the kind. However,
this is difficult to apply to kinds such as mammal and carnivore because, on the
one hand, it is difficult to decide which indexical sample represents the kind
mammal and, on the other hand, members of mammal can represent other kinds
at the same time. According to Putnam, a natural kind includes existents that
share the sameness relation to an indexical example of the kind. In the case of
mammal, however, it is difficult to decide which member can be an indexical
example that represents all mammals. Bats, whales, tigers, and many other
animals are mammals; it is difficult to decide which one of them should be used
as an indexical example of mammal. Even if tigers, for instance, are regarded as a
representative member of mammal, tigers also belong to the kind carnivore.

When a tiger is an indexical example, it can represent many different kinds at the

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See also Charles H. Lineweaver and Jose A. Robles, “Towards a Classification System of
same time.

I argue that Putnam’s account excludes, or is unclear about, some kinds, such as planet, river, creek, stream, brook, carnivore, and mammal. According to Putnam, only certain kinds are natural kinds. Thus, only certain kind terms are natural kind terms. That is, Putnam’s theory of natural kind terms only applies to certain kind terms. He does not provide a comprehensive theory for terms of kinds that are commonly regarded as natural.

Kripke’s theory also raises concerns insofar as it does not apply to natural kind terms in general. First of all, according to Kripke, modern science discovers the essences of natural existents, and existents are grouped as natural kinds according to their essences. However, some kinds, such as rivers, creeks, streams, and brooks are loosely defined. Scientists do not determine essential features for each of them nor do they make clear distinctions to separate them. Second, given that the essence of water is its chemical structure, chemical structures are regarded as the essences of some kinds. Which kinds’ essences, however, should have a chemical structure assigned as their essence? The chemical structure SiO$_2$ forms quartz, sand, obsidian, and glass. It seems, however, that scientists do not
categorize them into one kind. If they each have different essences (whatever they may be) and are thus different kinds, then chemical structure is just one of their features. Chemical structure is regarded as the essence of water, but only as one of the features of quartz, sand, obsidian, and glass. The so-called essence is actually one of the fundamental features of a kind that is assumed to determine that kind. This indicates that the essence of a kind is assigned rather than discovered.

Moreover, there are no scientific definitions of ‘essence.’ The number of protons or chemical structures of existents may be regarded as the essences of some kinds, but, when deeper or more fundamental features of these kinds are discovered, these kinds may be assigned new essences. The essences assigned to these kinds today may be temporary, and they can be reassigned with scientific progress. Kripke’s account of natural kinds is based on an assumption that science will not discover deeper or more fundamental features of kinds and essences of kinds will not be reassigned. However, he provides no arguments to support this assumption.

In short, according to Kripke, natural kinds are the kinds whose essences
can, in principle, be discovered by scientific research. However, there are kinds such as rivers, creeks, streams, and brooks, which are only loosely defined by modern science. It is not certain whether scientists will provide precise definitions for ‘rivers,’ ‘creeks,’ ‘streams,’ and ‘brooks.’ Thus, not all kinds that are commonly regarded as natural have been assigned precise essences by modern science. Moreover, kinds whose essences are subject to change may be, or may not be, natural kinds. There are kinds that we now assume are natural kinds, but may turn out not to be so in the future when we discover more fundamental features and reclassify them, such as with gold and water. Furthermore, since there are no scientific definitions of ‘essence,’ it is not clear which kinds have been assigned essences even though scientists may have theories for them. There are kinds that have no clear essence, which makes us uncertain about their status as natural kinds, as discussed the case of SiO₂. Because of all this, we do not know what kinds are natural kinds in Kripke’s sense of the term. Consequently, it is not clear to which terms Kripke’s theory of natural kind terms applies.

Putnam’s and Kripke’s accounts of natural kinds rely heavily on modern
science. According to their accounts, one does not know whether certain existents are a natural kind until modern science has discovered their essence or the sameness relation among these existents. However, scientists do not announce whether they have discovered the essence of a kind; rather, they report on what they have discovered about the kind's features. Therefore, it is difficult to tell which kinds have had their essences revealed and are thus natural kinds. Also, there are kinds that are loosely defined and that do not have typical examples to represent members of their kinds; these kinds may not be a natural kind in Putnam's sense of the term. Consequently, according to Putnam and Kripke, many kinds of existents that scientists study may not be natural kinds. They have not provided a comprehensive account of the ways that kinds and kind terms are important for science

For Kuhn, paradigms are responsible for determining natural kinds. He explains that scientists may provide different accounts for a natural kind in different historical periods, and thus the natural kind may be comprehended in different ways across various periods. Consequently, a natural kind term is likely to refer to a set of different things with respect to different accounts of its kind.
To illustrate, the referents of ‘water’ include isotopes of H\textsubscript{2}O only after modern chemistry had discovered those isotopes. Kuhn argues that since science often updates its theories about natural kinds, our current science is not guaranteed to offer the ultimate truth about kinds. Therefore, natural kind terms should be understood within a particular context, namely, the scientific account that determines their kinds.

Kuhn’s treatment of natural kinds makes the notion that modern science uncovers ultimate truths about kinds questionable. He argues that different scientific theories dominate different historical periods; what was verified as true gold yesterday may not be today, and what was not verified as gold in the past many be verified as such in the future. Additionally, even within a particular scientific discipline, new knowledge about kinds is continuously generated. For example, what Kripke and Putnam believe—the essence of water is the chemical structure H\textsubscript{2}O—is not true anymore; modern science has updated and changed constituents of the kind water, namely, water is H\textsubscript{2}O and its isotopes. Referents for ‘water’ will be added if more isotopes of H\textsubscript{2}O are found in the future.

Kuhn’s account provides a more comprehensive view of natural kinds than
Kripke’s and Putnam’s as his account explains that a natural kind can be
explained by different scientific theories. However, his account does not note
that collecting natural existents into kinds usually happens before a scientific
paradigm emerges. Observation, recognition, comprehension, theorization, and
theory revision of kinds are often continuous processes. People often recognize
kinds before scientists generate theories about them—people recognize rivers,
planets, water, whales, and other kinds before scientists theorize them. Thus,
natural kind terms can express recognition of the kinds in non-scientific contexts.
The fact that kind terms can express recognition of their kinds in non-scientific
contexts is important because it hints at the continuity of natural-kind
exploration. Investigations into natural existents do not begin with scientific
theories of natural kinds; pre-scientific activities should also be noted because
they are a precondition of these theories. According to Kuhn, natural kind terms
express concepts defined by accepted scientific theories of their time. However,
he does not consider whether, or explain how, these terms can be used in
ordinary, non-scientific discussions.

Although Kuhn’s account explains that natural kind terms express different
understandings or concepts of their kinds, it does not note the appearance of kind terms in ordinary daily life. I hold that an inclusive theory of natural kind terms should be able to explain the fact that natural kind terms can be meaningfully employed both in scientific and non-scientific contexts. After all, natural kind terms, such as ‘water’ and ‘gold,’ are also everyday expressions.

Though Putnam and Kripke account for natural kinds through the lens of modern science, and Kuhn does so in terms of the sciences in different historical periods, they all agree that scientists determine what a natural kind is and to what a natural kind term refers. However, their accounts do not explain the continuity of exploration, and accumulation, of knowledge regarding natural kinds. Indeed, some natural kinds, such as neutrons and protons, were recognized in a particular scientific context. In many cases, however, people first notice that certain existents can be a kind. They observe their resemblances and then conceive of them as a kind. Subsequently they produce a more comprehensive theory to explain their resemblances, and finally come up with a systematic way to integrate them with other natural kinds—for example a scientific taxonomy.
Moving forward, I shall discuss three possible definitions of ‘natural kinds.’ I will also explain how Kripke’s and Putnam’s accounts of natural kinds can be relevant to the first definition and Kuhn’s to the second. Finally, I will criticize these two definitions and propose a third one, which I believe is a more appropriate and adequate definition of ‘natural kind.’ This definition is compatible with the continuity of natural-kind exploration, reveals the commonality when a kind is addressed by different scientific systems, and applies equally to the recognition of kinds in scientific activities or in everyday life.

The first definition: a natural kind contains natural existents with an identical essence that is characteristic of that kind.

To illustrate, water, as a kind, contains substances with the essence of having the chemical structure \( \text{H}_2\text{O} \) just as gold, as a kind, contains substances with the elemental essence of \( \text{Au}-79 \). Essence is the feature that determines which substances belong to a kind; natural existents with a particular feature, or essence, belong to a particular kind. Water and gold have many features, such as certain boiling and melting temperatures, certain densities, and certain
conductivities. Having the chemical structure H₂O and being Au-79, however, are the determining features, or the essences, for natural substances that fall within the kinds of water and gold. The chemical structure H₂O and the atomic number 79 are features that determine certain individual substances to be members of a kind.

Kripke’s and Putnam’s accounts of natural kinds proceed in a similar fashion. Kripke claims that the essence of gold is its atomic structure, which has 79 protons, and thus ‘gold’ refers to Au-79 in all possible worlds. Kripke believes the essence of gold, as revealed by modern science, is a solid fact. Once scientists discover the essence of gold, the definition of ‘gold’ is given. ‘Gold’ refers to whatever has the essence that scientists assign to gold, and gold is the substance with 79 protons. Putnam has a similar line of thought. He claims that ‘water’ refers to whatever scientists verify as bearing a sameness relation to water, namely, H₂O. ‘Water’ refers to any existent that has the chemical structure H₂O.

However, this definition raises some issues. First of all, this definition does not apply to kinds that are loosely defined. For example, it is difficult to decide

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the respective essences of rivers, creeks, streams, and brooks. A natural kind can be determined in a loose way; scientists do not assign distinct essences to each of them. Moreover, a kind may have different determining features. For example, the kind planet can be classified by mass regime, orbital regime, or composition. In such a case, which feature shall be the essence of the kind planet?

Furthermore, different natural kinds may share the same fundamental features. Diamond and graphite are both formed by carbon; they are two allotropies of carbon. Also, the molecular structure of sand, quartz, obsidian, and glass are all SiO₂.

Secondly, the essence of a natural kind is not predetermined. Different scientific theories may assign different essences to a natural kind. For example, whales were categorized as cetacea, fish, and mammal in different scientific systems. Bats were not classified as mammals until the Linnaean taxonomy in the 18th century. Moreover, even within one particular scientific theory, accounts for a natural kind are subject to change. Modern chemistry, in the early 20th century, assigned to the kind water the essence of chemical structure H₂O, but it later assigned water the essence of H₂O and its isotopes when those
isotopes were discovered. Finally, a scientific framework may contain different accounts for a kind. Today’s biology has not determined the feature of pandas that makes them belong to a particular family. Some biologists hold that a giant panda belongs to the bear family, while others hold that it belongs to the raccoon family. Because of this controversy, some suggest that a panda belongs to its own panda family. In other words, the example of the panda shows how different biologists can assign an existent different essential features that allow it to belong to different families. As Beebee and Sabbarton-Leary report, LaPorte states that

natural kind essences are ‘stipulated’ rather than discovered, and so

theoretical identities such as ‘water is H₂O,’ while necessary, are not a posteriori. Investigation into the chemical constitution of water did not reveal that water is essentially H₂O; instead, it provoked a decision about what ‘water’ would refer to; in particular, the decision that D₂O or heavy water (whose molecules have deuterium, an isotope of hydrogen, as a constituent) counts as water. Use of the term ‘water’ prior to this stipulation

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was ‘open-textured’ or vague: it was indeterminate whether samples of pure D$_2$O counted as water or not.\textsuperscript{28}

The first definition accounts for natural kinds in terms of their essences. However, when faced with various fundamental features, it is a scientific decision that determines which one of them is the essence of a kind. Though it is attractive to categorize natural kinds according to their essences, natural kinds may be assigned different essences in a scientific framework or frameworks.

The second definition: a natural kind is a collection of natural existents with certain common features, which can be stated in scientific terminology that constructs formulations of relevant natural laws.

To illustrate, natural existents with a particular chemical structure or with a certain number of protons are a kind. For example, existents with the chemical structure H$_2$O are the kind water, and existents with 79 protons are the kind gold. The reason why the chemical structure of a substance or the number of protons of a substance can determine which kind the substance belongs to is because modern chemistry formulates certain natural laws in terms of chemical structure.

and atomic number. For example, formulations of the natural laws that ‘chemical reaction must meet chemical equation’ and that ‘each chemical bond of a structure must be balanced in order to reach a neutral state’ are partly constructed by the notion of chemical structure. Similarly, a neutral substance with a certain number of protons must also have an equal number of neutrons and electrons; thus, neutral gold must have 79 neutrons and 79 electrons. Also, in order to meet the mass-mole calculation, one mole of gold must be about 79 grams. These statements are partly based on the notion of atomic number. The chemical structure of substances or the number of protons in substances constructs formulations of certain natural chemical laws. The notion of chemical structure and atomic number are used to formulate certain natural laws and to determine natural kinds in modern chemistry.

This definition may satisfy people in favor of Kuhn’s theory. Kuhn notes that force was not regarded as measurable until Newtonian physics, which includes the second law of motion, where in the key notion is that force is quantifiable. Likewise, ‘H₂O’ cannot be meaningfully employed without modern chemistry, which includes an account of the chemical structure, the construction of the
periodic table, the scientific model of atoms, and so on. In this definition, natural kinds are understood with respect to a certain scientific framework.

Consequently, natural kind terms also need to be understood with respect to that framework.

This definition addresses natural kinds within scientific frameworks. Different scientific frameworks may have different formulations for natural laws, and they may have different terminologies to explain the features of natural existents. This definition allows natural kinds to be accounted for with respect to different scientific frameworks.

Although different scientific frameworks may classify a natural kind in different ways, what is classified is often a kind rather than instances of that kind. To illustrate, bats may be classified as mammals or as birds in different biological frameworks, but what is classified or reclassified is the kind bat; the frameworks do not classify individual bats into the kind bat. Individual bats do not require a scientific account to gather them into one kind. Bats are already a kind when scientists account for them.

Moreover, a consequence of this definition is that only scientifically
knowledgeable people can understand kinds, such as water, as natural kinds; ordinary people can not understand kinds as natural kinds unless they acquire scientific accounts of them. That is, when a kind is discussed in scientific contexts, it is a natural kind; but it is not so in ordinary, non-scientific contexts. Also, ‘water’ is a natural kind term only when it appears in scientific discussions and it is not so when it is used in non-scientific discussions.

Although some knowledge about some kinds is very complicated, detailed, and only known by experts of the kinds, it can be difficult to decide whether some forms of knowledge are scientific. For example, the knowledge that dogs give birth after embryonic gestation, that water has three states, or that gold has high malleability can be ascertained by mere observation. But these forms of knowledge also involve scientific accounts about those respective kinds.

Sometime, it is difficult to draw a sharp distinction between scientific and non-scientific knowledge about kinds. Moreover, I think it is more convenient to regard ‘water,’ for instance, as a natural kind term regardless of whether it is used in scientific discussions or not. For scientists can have non-scientific discussions about water and ordinary people can learn scientific information
about water through everyday conversations. It can be confusing when ‘water’ is regarded as a natural kind term in one discussion and is not in another discussion when it is not clear, in the first place, whether the discussions are scientific.

Natural kinds are not merely scientific objects; they are also objects of everyday experience. People can do scientific research into natural kinds, but they can also make non-scientific observations to investigate them. I propose regarding kinds comprised by natural existents as natural kinds whether or not they are addressed scientifically and regarding their terms as natural kind terms whether or not they are used in scientific discussions.

The previous two definitions are overdependent on science and they disregard how natural kinds appear in daily life. I hereby propose a third definition that can be relevant to scientific accounts about natural kinds and knowledge generated by daily life experiences.

The third definition: a natural kind is a collection of natural existents that resemble one another in one or more respects. When the resemblance or resemblances are regarded to be genuine knowledge about the existents,
and may generate more knowledge, the existents can be classified as a kind because of that knowledge. To understand the kind, a person must know, at least in one respect, how members of the kind resemble one another.

To illustrate: whales, bats, and leopards would not be a kind unless people notice a certain respect or respects in which they resemble one another. In fact, people notice that they all give birth after embryonic gestation. This resemblance allows them to be recognized as members of the kind mammal. Creatures of the kind mammal have many different features, but they all resemble each other insofar as they gestate their young in embryo. To take another example, deer, leopards, and tigers do not resemble one another in the respect of eating meat. Thus, they cannot be related to each other using the kind carnivore. On the contrary, whales, leopards, and tigers all eat meat. Thus they belong to the kind carnivore for they resemble one another in this respect.

Members of a natural kind can resemble one another in many ways. Take water as an example. Liquid water is universally tasteless, odorless, and transparent. These resemblances may provide enough information for people to recognize water as a kind. Instances of liquid water do not merely resemble each
other in some respects; they are indistinguishable from each other. People may also learn some fundamental resemblances from science, e.g., that water is H₂O and that H₂O appears in three states. Thus they learn that steam, ice, and snow also belong to the kind water.

When people recognize some respects in which certain existents resemble one another, they may recognize that all existents that resemble each other in this way form a kind of existents. Steam, ice, snow, and liquid water cannot be a kind unless a certain resemblance among them is recognized, i.e., that they all have the same chemical structure of H₂O. The same argument applies to mammal, carnivore, gold, and other natural kinds.

Not all knowledge of resemblance is used to group existents into kinds. On the one hand, for example, our current scientific system does not collect red existents into one kind; in particular, tomatoes, watermelon, and red bell peppers resemble one another in appearing red, but we do not collect them into one kind. However, since they are plants that contain lycopene—a phytochemical that can be found in many red vegetables and fruits—they can be gathered into one kind because of this resemblance. It is genuine knowledge
about these existents that they all contain lycopene, although we do not group
them into one kind because of this knowledge. On the other hand, resemblances
in temperature can group certain animals into kinds. For example, homeotherms—warm-blooded animals—and poikilotherms—animals whose
internal temperature varies—are natural kinds. These resemblances are true
features about these existents. These kinds can generate a lot of knowledge, for
example, that animals have different metabolic mechanisms and systems.
Although not all resemblances are used to gather existents into kinds, existents
are grouped into kinds because of their resemblance or resemblances.

Scientific knowledge is not the only source for gathering existents into kinds,
although it is a reliable one. Non-scientific knowledge also allows people to
recognize natural kinds. People recognize that bananas, apples, and water are
kinds based on the direct experiences of their daily life. People may know
nothing about how science theorizes these kinds, but they can still generate
valuable knowledge about these kinds from daily activities; for example, brown
spots on the skin of a banana indicate its ripening.

When a theory accounts for a kind, it needs to explain why certain things are
a kind. That is, it needs to explain the resemblance among the members of the kind. When different theories account for the same kind, they usually emphasize different resemblances among the members. People can also learn or recognize resemblances of natural existents in their daily activities. This allows them to see natural existents as kinds.

Notice that resemblances among members may not be equally important. Some resemblances can stem from basic knowledge of the kind and some resemblances may be so important scientifically that they cause existing kinds to be reclassified. When information about an individual member is generally true for other members of the same kind, this information can become knowledge about the kind. That is, members of the kind resemble one another in the way indicated by this information. For example, the information that water freezes at zero degrees Celsius in certain atmospheric conditions is true to all instances of water. This resemblance becomes knowledge of the kind water. Some resemblances are revealed as important scientific discoveries that can cause kinds to be reclassified. For example, the discovery that steam, liquid water, ice, and snow resemble one another in terms of chemical structure groups them into
one kind. Scientists reclassify the kind water according to the identical chemical structure of its instances. Furthermore, different scientific systems may emphasize different resemblances within a kind. For example, resemblances in anatomy are emphasized in the Linnaean taxonomy, and thus whales and bats are classified as kinds of mammal. In the Renaissance, the habitus of whales was emphasized, and thus it was classified as a kind of fish.

Classifying existents into kinds allows knowledge to be generated efficiently. As Beebee and Sabbarton-Leary put it, “Predictive (and explanatory) success has played a large role in the conception of natural kinds adopted by many philosophers of science...Many metaphysicians...hold that there must be something metaphysically or ontologically distinctive about natural as opposed to non-natural kinds.”

The fact that a particular piece of knowledge generated from a member of a kind can be applied to other members makes natural kinds important. It is an efficient way to understand natural existents when they are grouped as kinds.

Knowledge of kinds enables us to predict individual existents. For example, whales are individual natural existents. Although individual whales live and die,

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29 Ibid., pp. 2.
whales as a kind remain. Knowledge about whales as a kind can be generally true to all individual whales, including whales existing in the past and future. In order to generate knowledge efficiently, it is important to classify individuals into kinds. In the end, knowledge about whales and other marine creatures constitutes marine biology. Similarly, knowledge about the wavelengths of light, such as X-rays, microwaves, and radio waves constitutes optics. Moreover, the more science reveals fundamental resemblances in kinds, the more valuable knowledge we gain. We now know that atoms form all substances, that all cells contain DNA and RNA, and that the periodic table accommodates all elements. All valuable knowledge about the fundamental features of natural existents begins with researching resemblances in kinds. In-depth scientific research on resemblances of kinds leads to the discovery of natural existents' fundamental features.

There are some advantages to this definition of natural kinds. First of all, it includes kinds that are loosely defined, such as rivers, creeks, streams, and brooks. It also includes kinds that are ambiguously accounted for, such as pandas. Kinds do not require precise scientific definitions to be natural kinds. Also, it
includes kinds, such as carnivore, mammal, and marsupial. Habitus, modes of reproduction, or anatomical features can all be resemblances that classify existents into kinds. Second, this definition commonly holds that natural kinds are based on resemblances, even in different scientific systems. Finally, it accommodates the fact that natural kinds can be recognized both by scientific investigations and by everyday observation. People may recognize, in the first place, a kind based on resemblances observed during daily activities and, then, learn more about the kind by way of science. Scientists may notice certain resemblances among certain existents and, later, generate more detailed knowledge about them as a kind. This definition allows natural kinds to be conceived in both scientific contexts and non-scientific contexts.

Although all three of the philosophers discussed above account for natural kinds in terms of science or sciences, and claim that scientists determine the referents of natural kind terms, I argue that non-scientific knowledge also allow people to recognize kinds that satisfy philosophers’ criteria for being natural and know referents for their terms.

People can know the referents of a kind term (especially natural kind terms
used in everyday life, such as ‘water,’ ‘banana,’ and ‘broccoli’) without knowing scientific theories regarding the kind. Moreover, most people do not need science to tell them that individual bananas belongs to the kind banana. Non-scientific knowledge can also help people apprehend some natural kinds and referents for some kind terms.

People can recognize some natural kinds without any scientific training. In the linguistic community of an isolated tribe, for instance, there can be natural kind terms, such as ‘water,’ ‘wood,’ and ‘dog.’ People in such a tribe may have neither science nor a knowledge system in the modern sense; but the lack of scientific knowledge regarding kinds does not prevent them from having such natural kind terms. Recognizing natural kinds and thus having natural kind terms in a linguistic community can occur irrespective of scientific activity.

Moreover, people in modern society may acquire natural kind terms without any scientific information or training, which indicates that people can recognize natural kinds without scientific knowledge about them. A typical English speaker may acquire natural kind terms such as ‘water,’ ‘banana,’ and ‘dog’ before he has any scientific knowledge or engages in any scientific activities.
A five-year-old acquires such terms before he learns how to write, not to mention before receiving any particular scientific knowledge. Some natural kind terms are basic vocabulary that people learn from daily activities.

Kuhn holds that different paradigms provide different conceptual schemes for addressing natural kinds. Since these kinds are addressed in different ways, their terms express different concepts with respect to different paradigms. Therefore, natural kind terms need to be understood with respect to a certain paradigm. For Kuhn, natural kinds are scientific objects and he considers natural kind terms only when they appear in scientific discussions and texts. However, natural kinds, such as apple, broccoli, and banana, are daily life essentials; natural kind terms, such as, ‘water,’ ‘electricity,’ and ‘dog,’ are in the vocabulary of daily life and are used in ordinary discussions too.

Although scientists may provide a detailed and complicated theory for a kind, certain scientific knowledge of natural kinds can also be commonsense knowledge. For example, it is now common sense that water is H₂O. Sometimes it is difficult to separate commonsense knowledge from scientific knowledge about a kind. The knowledge that water is H₂O is both scientific and common sense.
There can be no distinction between scientific knowledge and commonsense knowledge about a kind. The knowledge that only some scientists have today may soon be common sense for many people. Moreover, since some natural kinds are essential to everyday life and their terms are part of everyday vocabulary, it is inappropriate to only address natural kind terms, such as ‘water,’ when they appear in a scientific context. Since ‘water’ refers to water when it appears in scientific discussions and everyday conversations, why can ‘water’ not be a natural kind term in both situations? Kuhn does not note that natural kind terms are also used in ordinary, non-scientific discussions.

It is necessary to have some knowledge about a kind to acquire its term. A person who states that gold is a kind of apple does not know what ‘gold’ means. She at least needs to have some knowledge about gold, for instance, that gold is a valuable metal, so that she is able to use ‘gold’ to refer to gold. The knowledge required in order to acquire the kind term, however, is not necessarily relevant to scientific accounts about the kind. Non-scientific knowledge about a kind can also enable people to know its term. The recognition that certain liquids are the kind water may be knowledge derived from daily activities. For example, the
recognition that the liquid in the river and the liquid from melted snow are both odorless, tasteless, and transparent may be enough for people to recognize that they are the same kind because they are indistinguishable from each other; and this recognition does not require any scientific information about the kind water.

To sum up, I argue that knowledge about a natural kind, scientific or not, allows people to know and use its term. Having knowledge about a natural kind is a precondition for understanding its term. One cannot grasp a natural kind term without any knowledge about the kind. One can use a kind term properly because one has some knowledge about the kind; and that knowledge can be irrelevant to any scientific account, training, education, or activity.

With their views of natural kinds, Putnam and Kripke assert that a natural kind term is a rigid designator—it refers to the existents with the same essence in every possible world. Because a natural kind term is rigid, different people are able to use it to refer to the same things. However, this assertion is based on an assumption that modern science reveals the ultimate essence of a kind, which makes its term refer to existents with that essence in all possible situations. But, the fact that science progresses makes it inappropriate to claim that science has
already discovered, or will soon discover, the ultimate truth or essence of things. It happens in the history of science that scientists reassign the essential feature of a kind. As in the aforementioned example of water, modern science reassigned its essence as $H_2O$ and its isotopes. Because a natural kind term can be redefined when scientists provide a new account for its kind, and reassign a new essence to its kind, it is not rigid.

In the next section, I provide three examples to show different cases of natural kind terms and knowledge of kinds. First, the case of neutrons shows that a particular scientific account about a kind enables people to know what its term stands for. Second, the case of whales shows that a kind term can be meaningfully employed in different scientific accounts. Third, the case of water shows that a kind term can be used in scientific and non-scientific discussions.

The case of neutrons shows that the scientific account of neutrons enables people to conceptualize them in certain ways: for instance, as neutral particles in a nucleus or as having similar mass to protons. These understandings of neutrons enable people to know what ‘neutron’ stands for—‘neutron’ refers to those particles that are in conformity with such concepts. That is, ‘neutron’ refers
to the existents that resemble one another in these respects.

To some extent, at least, acquiring knowledge generated by scientists about neutrons enables one to know neutrons as a kind and to understand what ‘neutron’ stands for. This example can satisfy people who believe that a kind term refers to its referents rigidly, such as Putnam and Kripke. This example presents how one particular scientific account of a kind allows people to know its term, to determine referents of its term, and to reveal significant facts about the kind.

The case of whales illustrates that different accounts about whales provide different concepts for the term ‘whale.’ People conceive of whales as a kind according to the dominant scientific account of whales in their respective times. People in ancient times may have conceived of whales as a kind of cetacea, which is based on Aristotelian education. People in modern times may conceive of whales as a kind of mammal, which is based on modern biology’s classification of whales. The case of whales illustrates Kuhn’s theory of natural kind terms. Different scientific systems provide different accounts for whales, and thus ‘whale’ expresses different concepts of whales with respect to different systems.
In this view, ‘whale’ is, and should be, understood with respect to a particular scientific system.

The case of water illustrates that knowledge about water, which comes from daily activities and not from scientific training or scientific theories, allows people to know ‘water’ in the first place. People learn the term ‘water’ from their everyday life. They do not learn ‘water’ from a scientific account of water.

Although people gradually gain greater scientific knowledge about water, they do not need scientific training to introduce them to what ‘water’ stands for. The same applies to natural kind terms of daily life such as ‘dog,’ ‘banana,’ and ‘broccoli.’

Unlike what Putnam, Kripke, and Kuhn suggest, not all natural kind terms need to be understood in scientific contexts. Without accounting for this fact, one is not offering a comprehensive theory of natural kind terms. The discussion of the case of water shows that some knowledge of kinds that is learned from daily activities enables people to use their terms and know referents of their terms. It is a fact that people do not need scientific theories to help them recognize some natural kinds and grasp these kind terms, especially with the natural kinds that
are common in daily life. People may know nothing about scientific theories about bananas, apples, and broccoli, but they can recognize them and know what ‘banana,’ ‘apple,’ and ‘broccoli’ refer to. Although people need a scientific explanation to help them understand what ‘neutron’ stands for, they can also comprehend many other natural kind terms without any help from scientific explanations of these kinds.

Kripke and Putnam assert that natural kind terms are rigid, but their theories are based on an unsupported assumption that the kinds for which modern science has discovered essences will never be reassigned. Kuhn’s account does not note that natural kind terms are used in non-scientific discussions; however, it is a fact that some natural kind terms are also part of everyday vocabulary. My account allows natural kinds to be understood in scientific and non-scientific contexts, which explains that their terms are used in scientific and non-scientific discussions, and therefore it is a more inclusive treatment for natural kinds and their terms.

2. Three cases

A. Neutron
The story of the discovery of the neutron goes roughly as follows. In 1911, the Rutherford model suggested that an atom consisted of a nucleus and any surrounding electrons. The nucleus consisted of protons that provided positive charges and most of the atom’s mass. The surrounding electrons provided negative charges that were equal to the positive charges. At this time, scientists did not yet know about the existence of the neutron.

Since those scientists regarded the proton as the only type of particle in a nucleus, the kind proton included all the substance in the nucleus, which included what was later discovered to be the neutron, and the term ‘proton’ meant the substance, which included protons and neutrons at that periods of time. This reference of ‘proton’ lasted for the next 20 years. However, since particles with the same charge were supposed to repel each other, the scientists wondered what kept protons together in a nucleus. Scientists were unable to answer this question. Also, they found that the mass of four hydrogen molecules were equal to one helium molecule. But hydrogen has only one proton, and

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30 Jade is a similar case. ‘Jade’ meant a certain kind of mineral until it was found that jade consisted of two minerals, nephrite and jadeite, in the 19th century. Now, ‘jade’ applies to both nephrite and jadeite. That is, before the 19th century ‘jade’ meant a kind of mineral, and after the 19th century ‘jade’ has meant two kinds of mineral. See John Searle, Intentionality, New York: Cambridge University Press, 1983, pp. 203.
helium has two protons. The mass of two hydrogen molecules should therefore have been equal to one helium, given that the proton provides most of the mass of the atoms.

The questions remained unanswered until 1932 when James Chadwick designed an experiment to show that the neutron existed. Chadwick let alpha particles hit beryllium, and he discovered that particles without charge were emitted. He subsequently let these particles hit paraffin wax, and, in this case, he found that protons were emitted with high speed. He concluded that the particles emitted from beryllium do not have charges and have similar masses to protons. He gave these particles the term ‘neutron.’ Thus, we were given Chadwick’s model of atom: a nucleus, which has protons and neutrons, surrounded by electron clouds.

Let me examine the discovery of the kind neutron and the invention of the term ‘neutron.’ When the neutron was about to be discovered around 1932, scientists were generating information and gathering descriptions of the neutron. Some of the descriptions and information later became the knowledge about the kind neutron. Meanwhile, the concept that ‘neutron’ expressed was constructed
by this confirmed information about the neutron. The discovery of the kind neutron was a process; so was the introducing of ‘neutron.’ In the beginning, scientists realized that there were some puzzling facts about a nucleus. These puzzling facts later inspired them to come up with new hypotheses and experiments. When the results of the experiments generated a theory that explained away the puzzling facts, the scientists were ready to accept the new theory. And finally, they were ready to assert the discovery of the new kind neutron and to acknowledge ‘neutron’ as a new natural kind term.

In many cases, the knowledge of the neutron could provide answers to the question: what does ‘neutron’ mean? When a person asks this question, the answer can be any knowledge of the kind neutron. Appropriate answers may include ‘it means a kind of nuclear particle,’ or ‘it means the particle that is located in the nucleus and has a similar mass to the proton.’ These answers are regarded as true information about the kind neutron. Inappropriate answers may include ‘it means the particle with a positive charge,’ or ‘it means the particle that forms clouds around the nucleus.’ These answer are inappropriate because the facts in them are not regarded as being true of the kind neutron, and
people do not include them in their understanding of the neutron. The knowledge of the neutron also determines referents for ‘neutron.’ ‘Neutron’ can be understood as referring to the neutral particle in a nucleus, or referring to the neutral particle with a similar mass with protons, or referring to the particle described by the knowledge of the neutron.

‘Neutron’ stood for neutrons when scientists discovered their existence and generated knowledge about them. The concept of the neutron and the usage of ‘neutron’ were both enriched when scientists discovered more knowledge about neutrons as a kind, allowing people to comprehend them. Neutrons were introduced as a kind by knowledge of neutrons, and people knew what ‘neutron’ stood for by knowledge of neutrons. This case can be an example of Kripke’s and Putnam’s accounts of natural kind terms—modern science determines that ‘neutron’ rigidly refers to neutrons.

**B. Whale**

The classifications of whales can be traced back to ancient times. According

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to an Aristotelian taxonomy, whales are classified under the category of cetacea. Aristotle's taxonomy is based on the doctrine of teleology that endorses the purposefulness of nature. As Meyer puts it "The thesis of natural teleology is a central tenet of Aristotle's natural philosophy. This is the thesis that nature acts 'for something' (heneka tinos), by which Aristotle means that the parts of natural organisms develop because of the good ends they serve." Aristotle believed that nature is hierarchical, and he ranked rational species higher than nonrational ones. Individuals and species are driven to realize their highest potential. Ayers writes "The definition of the essence of man is 'rational animal'. Rationality...is "the principle thing in a man's nature."

And he explains Aristotle's natural biology with the following diagram:

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32 Aristotelian taxonomic categories are roughly as follows: viviparous quadrupeds (warm blood animal on land), oviparous quadrupeds (cold blood animal on land), birds, cetacea, fish, and so on.
The more the individual or the species realizes its potential, the more rational they are.

Teleology might be the reason that Aristotle did not include whales under the category of viviparous quadrupeds—animals with four feet that produce their offsprings in embryos and not in eggs—though he noticed that whales have lungs and breasts, which are similar to the traits of warm-blooded animals. This similarity in anatomy was not the most important consideration for Aristotle’s classification of whales.

The Renaissance scientist, Guillaume Rondelet, takes a different perspective to account for whales. He noted that a whale has a heart with four chambers, and he also compared the anatomy of a dolphin with that of a pig and a human. Though he did not propose a new taxonomy, he classified whale under the category ‘fish’ according to their habitat. Whereas Aristotle based his taxonomy
on teleology, the habitus of the whale was more salient in Rondelet’s understandings of whales.

In modern times, Peter Artedi and Carolus Linnaeus established the taxonomy that we use today in biology. Artedi’s publication *Ichthyologia* is the foundation of ichthyology. He classified marine creatures on the basis of the caudal fin, and, for the first time in the history, whales were separated from fish.

Linnaeus later integrated Artedi’s taxonomy, and created a comprehensive system for the taxonomy in biology. Linnaeus defined categories with specific characteristics. He defines mammal as a category that includes creatures that have hair, are viviparous, and produce milk. The cetacean category in Linnaeus’s taxonomy includes animals with the following characteristics: two-chamber hearts, lungs that are used for breathing, hollow ears, internal fertilization, and the production of milk. Cetacea—which includes whale and dolphin—is a subclass of mammals in Linnaeus’s taxonomy. The Linnaeus taxonomy has a hierarchical order: class, order, genus and species. A kind is named by its genus and species in Latin grammatical forms.

It is hard to say whether we know whales better than we did in ancient
times. After all, the anatomy of whales has supposedly been the same since ancient times. Nevertheless, whales are placed differently in different taxonomies. In Aristotle’s taxonomy, whales were placed under bird and above fish based on teleology. In the Renaissance, whales were placed in the category of fish. And in modern times, whales are classified as mammals.

Different theories in different times provide different accounts for whales, and this results in different knowledge of the kind whale. Regardless of these differences, however, knowledge of the whale is always highly relevant to usages of ‘whale.’ In ancient times, for example, answers to the question, “what does ‘whale’ mean,” could include that “‘whale’ means a kind of cetacea.” However, the answer that “‘whale’ means a kind of mammal” would be regarded as incorrect in ancient times by those with an Aristotelian background. Similarly, in response to the same question, the answer that “‘whale’ means a kind of marine mammal” would be regarded as incorrect during the Renaissance. During the Renaissance, people’s concept of the whale did not contain the knowledge that a whale is a mammal. Finally, in modern times, a proper answer to the question may be that “‘whale’ means a kind of marine mammal.” The answer that “‘whale’ means a
kind of fish” is regarded as incorrect. In all these different cases, the understanding of the whale, which is based on information and knowledge of the kind whale, provides answers concerning questions about ‘whale.’ The above discussion points out that knowledge of the kind whale is salient in usages of ‘whale.’

Although referents of ‘whale’ remain the same from ancient times to modern times, referents of ‘fish’ have been changed in order to delete whales from the kind fish; ‘fish’ no longer refers to whales. Different scientific systems, or paradigms, provide different understandings for the kind whale—whales were understood as a kind of cetacea in Aristotle’s taxonomy, a kind of fish in the Renaissance, and a kind of mammal in Linnaeus’ taxonomy. Knowledge of whales determines referents for relevant kind terms. This case is an example of Kuhn’s account of natural kinds and natural kind terms—natural kinds can be accounted for differently in different paradigms and thus natural kind terms need to be understood with respect to their paradigms.

C. Water

Theories of water can also be traced back to ancient times. The idea of four
elements was shared by Thales, Plato and Aristotle; each explained nature in terms of air, water, earth, and fire. They regarded water an essential element of life. The four-element understanding lasted for about two thousand years.

The belief that water was an element was abandoned around 1783.\(^36\)

Almost simultaneous but individually, Cavendish and Lavoisier suggested a new theory of water and designed experiments to show that water is not an element.

Henry Cavendish found that a certain kind of air produced water when it burned. He called it inflammable air or phlogiston. The theory of phlogiston is that flammable things contain phlogiston and that they lost phlogiston in burning.

However, when things lost phlogiston they supposedly lost some mass, as phlogiston was assumed to have mass, but scientists knew that things gain weight and mass in burning. Therefore, this puzzled the scientists who believed the phlogiston theory. In order to explain why things that lose phlogiston gained weight, some of the scientists proposed that phlogiston had negative mass, and others proposed that phlogiston was lighter than air. But the phlogiston theory had not been proven wrong. Though Cavendish believed the phlogiston theory,

and used the theory to explain his discovery of hydrogen, he was still able to show that water is a compound, rather than an element.

At almost the same time, Lavoisier proposed the combustion theory to compete with the phlogiston theory. He noticed that phosphorus and sulfur gain weight in burning. He assumed that all things must gain weight in burning, and that this must be because of the same cause. He thoroughly criticized the phlogiston theory and realized that combustion requires dephlogisticated air, rather than phlogiston. He renamed phlogiston as hydrogen and dephlogisticated air as oxygen, and explained why burning makes things gain weight. He explained that combustion is a reaction in which things are oxidized. When burning hydrogen produces water, it is actually the case that hydrogen is oxidized. Lavoisier’s theory of combustion was not just a theory of water but also a revolution in chemistry. With his theory of combustion, he predicted that all things gain weight after burning, and he explained why this is the case. As a result, the combustion theory replaced the phlogiston theory.

Harold Urey discovered another important fact of water. He found an

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isotope of hydrogen in 1931. This shows that the chemical structure of water is not just H₂O, but also ²H₂O or D₂O, also known as heavy water. In 1933 Gilbert Lewis isolated the first sample of heavy water.³⁸ Heavy water can be used in operators that generate electricity and operators that make nuclear weapons. Though heavy water is not toxic to human beings, it has different biochemical reactions than water that are harmful to humans. When humans consume too much heavy water, it may cause cell dysfunction. Heavy water also has higher boiling and freezing points than water.

Water is a special case in natural kinds. It has little variety. In ancient times, the four-element theory asserted that water is an essential component for life; in the 18th century, modern chemistry asserted that water is a kind of compound; in the 20th century, contemporary science asserted that isotopes of hydrogen and oxygen also compose water. With the development of science, information about water changes.

However, people don’t really need the information provided by the scientific theories to recognize water as a kind. Water is a necessity for everyday life, and

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³⁸ Alongside H₂O, the following are also examples of water: ²H₂O or D₂O (heavy water), HDO (semi heavy water), H₂¹⁸O and H₂¹⁷O (heavy-oxygen water), and ³H₂O (super heavy water).
there are few substances similar to it. Unlike, say, dog, which includes Chihuahua, Golden Retriever, and other examples of the kind, the kind water has only one example that people come into contact with in everyday life. That is, though water includes isotopes of H$_2$O, people don’t have access to heavy water very often; among different examples of water, average people encounter the single specific example, namely, the particular substance that everyone needs to maintain his life.

To recognize that ‘dog’ is a kind term, people need to acquire some salient information about the kind dog. But little information about water is sufficient in order to recognize ‘water’ as a kind term. To illustrate, being a furry animal is not sufficient salient information to distinguish the kind dog; many animals are furry. But, because in everyday life, we come into contact with only one example of water, being the liquid in a river or a liquid with three states of matter is good enough for people to recognize water as a kind.

Kripke, Putnam, and Kuhn all regard water as a natural kind and ‘water’ a natural kind term. However, from the above discussion, I have shown that, unlike what Kripke and Putnam claim, ‘water’ is not a rigid designator. ‘Water’ has been
defined differently in different historical periods because the kind water
contains different constitutions with respect to different accounts of water. Kuhn
maintains that a natural kind can be addressed differently by different scientific
systems; thus, natural kind terms need to be understood with respect to a
particular scientific system. Kuhn’s claim is more convincing than the claim of
rigidity of natural kind terms. But he does not note that ‘water’ is not merely
used in scientific discussions; it is also a basic word in people’s daily life. People
can generate scientific knowledge about water while discussing water in their
everyday life. Natural kind terms, such as ‘water,’ are used in both scientific and
non-scientific discussions.

The knowledge of water includes information about the utilities of water
and of the features of water. Knowledge about water generated from everyday
life and from scientific practice both allow people to know referents of ‘water.’
To illustrate, the knowledge that water is H₂O and that water has three states of
matter are information about the features of water. When one claims that ‘water’
refers to the substance with the chemical structure H₂O, or claims that ‘water’
refers to the liquid with three states of matter, one is regarded as making true
statements in everyday life conversations. Information about the utilities of water may include: the liquid that comes out from a tap or the warm liquid in a tub. The liquid from a tap or in a tub is usually water. Therefore, when one claims that ‘water’ refers to the liquid from a tap or in a tub, most people know what liquid is being mentioned—they have seen water from a tap or in a tub. Imagine a scenario in which half of all taps dispense beer and half of all taps dispense water, and suppose that half of all people have a bath with warm milk, and half have a bath with warm water. Then, in such a case, people may be confused and would not know which liquid is being discussed. In that case, taps may not run water, and people may not bathe with water. Most people know that a tap runs water, and most people bathe with water; such knowledge makes people know what ‘water’ stands for. When one states that ‘water’ refers to the liquid comes out from a tap, people in one’s linguistic community know what one means by ‘water’ because they have such knowledge.

To sum up, I argue that knowledge of the kind neutron, the kind whale, and the kind water allows people to know what ‘neutron,’ ‘whale,’ and ‘water’ stand for, and allows them to use these terms to refer to the kinds respectively. The
case of ‘neutron’ shows that the knowledge of a newly discovered kind allows an invented term to stand for the kind. Knowledge about neutrons, such as having a neutral charge, being a nuclear particle, and having similar mass to a proton, group certain particles into a kind. ‘Neutron’ refers to the kind of particles that resemble one another in the ways that are indicated by such knowledge. This case shows that modern science makes ‘neutron’ refers to a particular group of particles and nothing else. If the scientific knowledge about neutrons will never be updated or changed, ‘neutron’ is a rigid designator. However, even if ‘neutron’ is rigid, not all natural kind terms are rigid.

As shown above, ‘fish’ included whales during the Renaissance, and it does not include whales in modern times. ‘Fish’ refers to different referents in different historical periods. Additionally, ‘proton’ had meant the nuclear particle with a positive charge, and most of the nuclear mass, before the neutron was discovered. So, ‘proton’ had referred to the substance in the nucleus before the neutron was discovered; we now know that the nucleus includes both the proton and the neutron. After the neutron was discovered, ‘proton’ meant the nuclear particle that provides positive charge and almost half of the nuclear mass.
'Proton,' therefore, did not refer to the substance that includes the neutron anymore. That is, one of the referents of 'proton' was deleted. 'Proton' refers to different particles in different times, so it is not a rigid designator. Finally, before heavy water was discovered, 'water' referred to H₂O. After the discovery of the isotopes of hydrogen and oxygen, 'water' referred to H₂O, ²H₂O, ³H₂O, and HDO. That is, 'water' added more referents. Therefore, 'water' is not a rigid designator.

Different scientific systems address whales differently, and thus 'whale' should be understood with respect to different theories. Both during the Renaissance and in modern times, the knowledge of the whale includes information about the appearance, the habitus, and the anatomy of the whale. These systems, however, emphasize different information about the whale, and the respective emphasis is expressed in 'whale.' In the Renaissance, the habitus of whales was emphasized, so whales were regarded as a subclass of fish; in the Renaissance, 'whale' meant a kind of fish. In modern times, the anatomy of whales is emphasized, so whales are regarded as a kind of mammal. In modern times, 'whale' does not mean a kind of fish; it instead means a kind of mammal. The information about whales is supposed to be the same because the
appearance, the habitus, and the anatomy of whales are supposed to be the same.

But how pieces of knowledge about the kind whale are emphasized results in different understandings of whales. 'Whale' thus expresses different concepts with respect to different accounts of whales. The case of whales is an example of Kuhn's view of natural kinds—different scientific systems can have different accounts for natural kinds and their terms are understood differently with respect to different scientific systems.

Although Kuhn's treatment of kind terms is more convincing than the claim of rigidity of kind terms, he does not note that many natural kind terms can be understood without any scientific accounts for their kinds and that they can be used in ordinary, non-scientific discussions. Also, scientific knowledge about a kind can be common sense. It can be difficult to distinguish scientific knowledge from non-scientific knowledge. Natural kinds are not merely scientific objects; some of them are also daily essentials. Natural kind terms are not merely terminology that needs to be understood with respect to a certain scientific system; some of them are also basic words that people use every day.

Unlike what Kuhn maintains, some natural kind terms can be understood
without any scientific theories of their kinds. Knowledge about a kind is not necessarily triggered by science. Contacts with water generate enough triggers for people to recognize water as a kind.\footnote{Acquaintance with individual things does not necessarily generate enough triggers for people to recognize certain things as a kind. For example, people encounter insects in everyday life. But the acquaintance does not generate enough information for people to group insects into different kinds. Entomology is a theory that groups insects into kinds, and it is a profession to be an entomologist.} The liquid in the river, the liquid in the lake, and the liquid of raindrops are indistinguishable in appearance. The liquids that are used in the shower, in cooking, and in cleaning are all tasteless, odorless, and transparent. There is only one such liquid in everyday life. Therefore, it is easy to recognize that the liquids are all the same. It does not require scientific theories for people to recognize that they are the same liquid. Knowledge learned by an everyday acquaintance with water is sufficient for water to be recognized as a kind. People learn that ‘water’ stands for water by acquiring the information from contacts with water in daily activities.

3. Some remarks on references of natural kind terms

Kripke’s account of references of proper names, with which Putnam agrees, can be summarized as follows. An individual is baptized and therefore named. The individual and the name form a link. When the link is passed along by more
and more people (in other words, when more people recognize and use the name) a chain is formed in a linguistic community. This chain in the linguistic community gives the reference of the proper name. When people use the name, the name links back to the individual. The reference of the proper name is irrelevant to how people acquire the name, and is irrelevant to the knowledge that people have about the individual. Even though people don’t know to whom the name refers, the name still refers to the individual rigidly once the reference has spread in the linguistic community.

Kripke believes that his account of references of proper names also applies to natural kind terms. However, it is problematic. In most cases, proper names are for particular individual things, but natural kind terms don’t refer to individual things; rather they refer to groups of things. The account applies well to proper names, but that does not mean that it can also apply to kind terms. For example, cases such as neutron, heat, and light are cases for which there are no particular things that scientists can baptize, rather they themselves are scientific models. Kripke’s account of reference cannot be applied to such kind terms.

Even if Kripke does not intend to apply his account to terms of kinds that
have no particular instances to be baptized, science may change the reference of a kind term. For example, with developments in science, people now know that heavy water, steam, and ice are all included in the kind water. Therefore, ‘water’ refers to all of them. However, in ancient times, people had no idea about heavy water. The link between ‘water’ and water did not include heavy water. New scientific understandings added referents to ‘water’ and therefore changed the reference of ‘water.’ In modern times, the link between ‘water’ and water is not just between ‘water’ and liquid water; it also includes heavy water, steam, and ice. That is, the chain in the linguistic community today is different from what it was in ancient times.

Kripke’s account has another problem. According to it, ‘water’ refers to the liquid we drink and use in the shower. There are the the existent that are baptized as ‘water.’ The reference of ‘water’ forms when the link between water and ‘water’ forms a chain in the linguistic community. Likewise, the reference of ‘\text{H}_2\text{O}’ forms when scientists link ‘\text{H}_2\text{O}’ and the chemical structure of water, and pass this link to ordinary people. Kripke holds that ‘water’ and ‘\text{H}_2\text{O}’ are rigid. Thus, according to the reference of ‘water’ and ‘\text{H}_2\text{O},’ ‘water’ should refer to the
liquid we drink and use in the shower, and ‘H₂O’ should refer to the scientific model of the chemical structure of water rigidly. That is, ‘water’ refers to the liquid and nothing else, and ‘H₂O’ refers to the model and nothing else. If this is true, then the statement ‘water is H₂O’ is false. For the liquid cannot be equal to the scientific model. “The term ‘water’ refers to H₂O” is also false. For ‘water’ refers to the liquid with which we have contact and nothing else. The referent of ‘water’ does not include the chemical structure of water. In short, Kripke's account of reference and his claim that natural kind terms are rigid imply that ‘water is H₂O’ and “‘water’ refers to H₂O” are false.

Moreover, Kripke claims that ‘water is H₂O' is an *a posteriori* necessary statement. But his account of reference contradicts with this claim. Kripke explains that the discovery of the fact water is H₂O is contingent. It depends on the development of science. However, the laws of nature make it necessary that water is H₂O. Therefore, ‘water is H₂O’ is a necessary contingent statement. Thus, Kripke's claim that ‘water is H₂O’ is an *a posteriori* necessary statement contradicts his account of reference. According to his account of reference and the claim that natural kind terms are rigid, ‘water is H₂O’ should be false.
I argue that people know the reference of a natural kind term by their knowledge about the kind. In a linguistic community, communication about a natural kind is possible when most people in the community have some knowledge about the kind. One can recognize the reference of a term because one knows what the term stand for, and this is based on one’s knowledge of the kind. Because most people in a linguistic community know what a natural kind stands for, there can be the reference of the term.

A number of facts support my observation of the connection between the knowledge of a kind and its term. First, the more knowledge a person knows about a kind, the better he will apply the term. A person who knows a lot about whales should be able to tell a whale from other marine creatures. That is, he knows to what the term ‘whale’ applies. His knowledge of the kind whale allows him to apply the term ‘whale’ well. Second, the more people in a linguistic community who know a kind, the more people know the kind term, because it is unlikely to know a kind without knowing its term. Thus, the pervasiveness of the knowledge of a kind means the popularity of the kind term. Finally, different communities may have different knowledge of a kind, and this results in
different understandings expressed by the kind term.

For example, reishi and cordyceps are famous in traditional Chinese medicine and in the Chinese linguistic community. Therefore, in the Chinese language, ‘reishi’ and ‘cordyceps’ both are understood as a kind of herbal medicine. In particular, ‘reishi’ and ‘cordyceps’ both are a kind of fungi that is used in the herbal medicine. But in modern Western medicine, they are not recognized as medicines, because their medical results are not yet clinically proved. Therefore, in the English linguistic community, ‘reishi’ and ‘cordyceps’ both are understood as a kind of fungi. In English, the two terms stand for, at best, a kind of herbal supplement, and they are not terms for medicines. ‘Reishi’ and ‘cordyceps,’ therefore, are terms for herbal medicines in the Chinese language and herbal supplements in the English language. The two terms express different understandings in different linguistic communities due to the different knowledge of reishi and cordyceps.

Two people have no problem using a kind term in a dialogue because both know what the term stands for. The reference of the kind term, in the dialogue, is based on their knowledge of the kind. An author has no problem using a kind
term in an article because he supposes that the reader knows what the term stands for and he supposes that the reader has knowledge of the kind. That is, he supposes that the reader's knowledge of the kind enables the reader to know what he means by the term. A kind term can refer to its kind because enough people in the linguistic community commonly know what the term stands for.

Knowledge of a natural kind is a condition for communication about the kind; communication is a condition of reference. The reference of a kind term results because both parties in a dialogue know what the term stands for. Because they both know what the kind term stands for, they can communicate. Conversely, if one of the parties in the dialogue does not know what the term stands for, they cannot communicate. Because enough people in a linguistic community know what the term stands for, the term refers to its kind. When no one in the linguistic community knows what the term stands for, the term does not refer to anything. The reference of a kind term is based on shared knowledge of the kind in the linguistic community.

4. Some clarifications
In ‘Kripke and Putnam on natural kind terms,’40 Donnellan has raised some questions about the meaning of a kind term appearing in a historical text and about the influence of verification of the meaning of a kind term, which I shall discuss in this section. The first question I will address is whether the referents of ‘salt’ differ in Locke’s Essay concerning the Human Understanding and in modern texts. The word ‘salt’ appearing in Locke’s book has largely the same referents and is the same word as in a modern text: ‘salt’ means salt no matter in Locke’s day or in our day.

This might be true concerning the referents of ‘salt,’ but the referents of ‘water’ is a different story. As shown above, referents of ‘water’ changed in different historical periods. Thus, even though ‘salt’ has not changed its referents, the case of ‘salt’ is not generalizable to other kind terms.

Generally speaking, the referents of kind terms are determined by knowledge from particular scientific accounts about the kinds and/or knowledge from everyday acquaintance. There are three possible situations: referents of a natural kind term are determined mostly by knowledge from everyday

acquaintance, mostly by knowledge from scientific accounts, or by both. The
terms ‘salt’ may be an example of the situation involving mostly everyday
acquaintance. Scientific knowledge about salt is less pervasive than ordinary
knowledge about salt. Although the knowledge that sodium chloride is salt can
determine referents of ‘salt,’ commonsense knowledge that salt is a salty cooking
ingredient can also allow people to know what ‘salt’ stands for. The pervasive
knowledge about salt may not be coming from scientific accounts of salt.

‘Water’ is an example of the situation in which both everyday and scientific
knowledge are involved. Water is available in everyday life; alongside that
scientific knowledge about it is also well spread. Most people who have acquired
‘water’ to stand for the odorless, tasteless, drinkable liquid have the knowledge
that water has the chemical structure of H₂O. This knowledge of water is
commonly shared in the community. Knowledge about water acquired from
daily life or from scientific education both enable people to use ‘water’ to refer to
water. Both allow people to know referents of ‘water.’

Most people acquiring ‘water’ have knowledge of H₂O, and they know that
H₂O is a feature of water. However, a five-year-old acquiring ‘water’ knows
nothing about chemical structures and \( \text{H}_2\text{O} \). In such a case, the child’s understanding of water does not contain the knowledge of \( \text{H}_2\text{O} \). But his understanding of water contains other information that enables him to know what ‘water’ stands for and to use ‘water’ competently. When the child grows up and learns about water’s chemical structure, he will integrate this knowledge into the concept of water. The information about water’s chemical structure is a commonly shared knowledge; the child needs to possess the shared knowledge to communicate with other members in the linguistic community in certain contexts.

Finally, the element nihonium is an example of a situation in which scientific knowledge determines referents of ‘nihonium’. Nihonium is a newly discovered element. Scientists do not yet know much about it, let alone a typical English speaker. Meanwhile, people have no acquaintance with nihonium in everyday life, and therefore they have no way to generate knowledge about it from everyday life. Thus, the knowledge that allows ‘nihonium’ to refer to nihonium currently comes from scientific accounts alone.
Importantly, people know the referents of all three types of kind terms due to their knowledge about those kinds. The referents of ‘salt’ have not changed because knowledge of salt has not changed; it is not because ‘salt’ is a rigid designator, and its referents never change. The case of water shows that natural kind terms, such as ‘water,’ do change their referents. When knowledge of salt results in reclassification of the kind salt, the referents of ‘salt’ may change as well, just like ‘water’ did.

Donnellan has also raised the question: if a ring in Locke’s day was identified as true gold, but it did not contain the element with the atomic number 79, it is still gold? A proper treatment of this question does not give a straightforward yes or no. Rather, the following three examinations clarify the confusions inherent in this question. First, whether the ring is gold or not is a matter of scientific verification. The technology of scientific verification of gold determines whether the ring is gold or not according to the standards of the time.

Even in a case such as a jeweler misidentifying a ring as gold that does not meet the current scientific verification standards, the criteria of being referents of ‘gold’ would not be affected. The question about the criteria of being referents of

41 Ibid., pp. 98.
'gold' represents one line of inquiry, which is relevant to the knowledge of the kind gold, but whether any particular item is true gold is a separate question, which is a question of empirical verification.

Second, does 'gold' refer to the ring? The answer was yes in Locke’s day, and the answer is no in our day. The reference of 'gold' depends on the shared knowledge of gold of the time. In Locke’s day, according to verification standards for gold at the time, the ring was identified as true gold. So 'gold' referred to the ring at that time. In our day, the technology for identifying gold has advanced, and the shared knowledge of gold has changed; thus the reference of 'gold' has changed, and 'gold' no longer refers to the ring. Thus, what was verified as true gold in Locke’s day may not be identified as gold in our own time, and this change demonstrates that the reference of 'gold' does change.

Finally, although the criteria of being referents of 'gold' has nothing to do with the identification of the ring, which is just a random item to be verified, one might hold that there are some cases whose identifications are relevant to the criteria of being referents of 'gold.' If there was an ideal sample that set the criterion for identifying gold, then any information and knowledge about that
sample would have influence on the criteria to some extent, Because the
information about the sample would provide the standard for identifying gold,
the sample would thus determine what ‘gold’ refers to. However, this ideal
situation rarely happens. We have no ideal samples of gold. Instead, what we
have are different accounts about the nature of gold in different historical
periods. I doubt there is any ideal sample of a kind that sets the criterion for
identifying the kind. In any case, even if there is such a case, I think it is not
appropriate to generalize the case to other kinds and kind terms. Many kinds,
such as mammal and carnivore, have no ideal samples. In short, the question of
the scientific verification of a particular item of a kind is one thing and the
criteria of being referents of the kind term is another.

5. Conclusion

This chapter presents my claim that knowledge about a kind, whether
scientific or not, allows people to know what the term stands for and to use the
term to refer to the kind. I discussed three possible definitions of natural kinds,
presented three real cases of natural kind terms, and remarked upon references
of natural kind terms. Finally, I took up two relevant questions raised by
Donnellan. This chapter gives my account of natural kind terms against the accounts suggested by Kuhn, Putnam, and Kripke, which shall be discussed in detail in the following chapters.
Chapter Two: Thomas Kuhn on Natural Kind Terms

This chapter considers in detail Kuhn’s account of natural kind terms, in particular how he situates kind terms in relation to the theory of scientific revolutions and paradigms. He holds that natural kind terms need to be understood with respect to a particular paradigm. For different paradigms may address their kinds differently and assign different referents to their kind terms. However, I suggest that natural kind terms can be meaningfully employed without paradigms. A linguistic community can have certain terms for natural kinds without any systematic knowledge about those kinds or any scientific practice in the modern sense; one can also understand certain natural kind terms without any scientific knowledge. That is, unlike what Kuhn suggests, some natural kind terms can be understood independent of a scientific paradigm. I also discuss some anomalies that indicate that certain kind terms can be understood independent of their paradigm.

1. The scientific revolution and natural kind terms

Kuhn draws facts and examples from his background in the physical sciences and history to construct his theory of scientific revolution, which makes
the theory more palpable and convincing. The notion of scientific revolution is a significant contribution in the philosophy of science.

Kuhn observes that a new scientific theory replaces its predecessor and the two theories often share little continuity. The replacement of theories happens throughout the history of science. This indicates that the progress of science is not totally linear, and Kuhn names this replacement a paradigm shift. A paradigm shift is what happens in a scientific revolution.

Kuhn distinguishes two phases in the history of science: normal science and revolutionary science. During periods of normal science, scientists accumulate knowledge based on the principles and disciplines of a particular scientific theory. The progress of this phase can be described as linear—scientists develop this particular scientific theory and make it more comprehensive. But there will come a time that revolutionary science challenges the prevailing theory. During this period of time, the progress of a given scientific theory is interrupted. Scientists find that the theory encounters anomalies that it is unable to explain or that the theory encounters problems that it is unable to solve. These anomalies or problems puzzle scientists and often lead them to construct new
theories in order to rectify the situation. When a new theory is considered to correctly explain the anomalies or solve the problems, this new theory is accepted as a new paradigm by scientists and the previous, now outdated, one is abandoned. Kuhn calls this acceptance of a new theory a paradigm shift.

Kuhn calls a scientific theory accepted in a given historical period a paradigm. He writes:

I shall henceforth refer to as ‘paradigms,’ a term that relates to ‘normal’ science. By choosing it, I mean to suggest that some accepted examples of actual scientific practice—examples which include law, theory, application, and instrumentation together—provide models from which spring particular coherent traditions of scientific research. These are the traditions which the historian describes under such rubrics as ‘Ptolemaic astronomy’ (or ‘Copernican’), ‘Aristotelian dynamics’ (or ‘Newtonian’), ‘corpuscular optics’ (or ‘wave optics’), and so on.42

A paradigm is the prevailing theory that is accepted as true in its time. A paradigm often includes a loose set of principles, premises, particular

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observational points of view, conceptual systems, and so on. Kuhn explains that Ptolemaic astronomy, Copernican astronomy, Aristotelian dynamics, and Newtonian physics are all paradigms of their time.

Take astronomy, for example: Ptolemaic astronomy regarded Earth as the center of the cosmos and the sun circled around Earth. However, according to this theory, other heavenly bodies needed to be in retrograde motion in order to explain actual observational data of the heavenly bodies. Copernicus proposed the idea that the sun was at the center of the cosmos and that Earth circles around the sun. This idea allowed heavenly bodies to move in a simple rotation around the sun, which was a more simplified picture of the cosmos. Ptolemy and Copernicus generated different theories of astronomy out of the same observational data of the cosmos. When scientists abandoned Ptolemaic astronomy and accepted Copernican astronomy, they embraced a brand new understanding of the cosmos. The old paradigm of Ptolemaic astronomy was replaced by the new Copernican paradigm. Thus, Kuhn concludes that this paradigm shift is a revolution in astronomy since it creates a brand new view of the cosmos.
To sum up, Kuhn finds that scientific developments are not continuous; there are revolutions in the history of science. When the scientific community regards a theory as correct, it becomes the dominant paradigm of the time. A scientific revolution occurs when a new paradigm is adopted. The new paradigm may be the theory that stands above its competitors and it may inherent little from the old paradigm, making it truly revolutionary.

Following this approach to the topic of scientific revolution, Kuhn suggests that the reference of a natural kind term is decided by a paradigm. When a new theory is accepted as the new paradigm, its taxonomy is accepted too. This new taxonomy creates novel categories, classes, and kinds, and thus individual things are variously classified into kinds through it. Also, the new paradigm consists of a new conceptual system. This emergent paradigm provides people with a fresh understanding of its subject. For example, the Copernican paradigm reframed people's understanding of the cosmos in contrast to the old Ptolemaic paradigm. In the case of whales, which I have discussed in chapter one, people throughout history differently conceive of the animal as a kind according to their

contemporary theories. The emergent paradigm, with its new taxonomy, provides their kind terms with new concepts because it either introduces unexpected understandings of the kinds or different arrangements of natural existents, which results in the kind terms referring to a new group of things.

The theory of paradigm shift has consequences for the account of natural kind terms. First, kind terms can characterize scientific revolutions. The new paradigm provides existing terms with fresh concepts and produces new terms to characterize the theory. Kuhn presents an example of paradigm shift by tracing the changing concepts expressed by terms like ‘mass,’ ‘weight,’ and ‘force’ in Aristotelian physics and Newtonian physics, respectively.44 By revealing the modulations in the concepts expressed by this set of terms, he shows a revolution in physics.

To introduce the notion of paradigm shift effectively, Kuhn uses ‘force’ as an illustration. To acquire the term ‘force’ under the paradigm of Newtonian physics, a student would need to know that that force is quantifiable and can be measured by a spring balance, which is laid out by Newton's third law and

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Hooke’s theory: i.e., the force pressing the spring equals the force of the spring pressing back, and the force can be calculated by an equation describing the extension and the stiffness of the spring. This notion of the quantity of force made no appearance before Newton’s theory, and thus it provides a new concept for ‘force’ that accompanies the knowledge that force is quantifiable. The concept expressed by ‘force’ in different paradigms, therefore, cannot be the same.

Kuhn writes that “An important clue to problems in reading Aristotle’s physics is provided by the discovery that the term translated ‘motion’ in his text refers not simply to change of position but all changes characterized by two end points.”45 A paradigm provides a conceptual system. In order to acquire terms belonging to one particular system, a student needs to receive some specific training, which allows her to know this paradigm and therefore to know the concepts expressed by natural kind terms of this paradigm. In the examples of Newtonian physics and Aristotelian physics, Kuhn notes that the student needs to receive different educations in order to acquire terms belonging to different physical paradigms. Students receiving a strictly Newtonian education could not understand Aristotelian terminology.

45 Ibid., pp. 299.
As an example, let's consider a natural kind term in chemistry, 'air,' to see how different concepts expressed by a kind term can indicate paradigm shifts. In ancient times, those with Aristotelian educations regarded 'air' as a simple element. A scientist with such an education could discover flammable air, but given his Aristotelian concept of air, he might consider the discovery to be air with flammable powder, or simply an anomaly. He would not claim that it was another kind of air or that it was a compound. However, after the 19th century, the term 'air' no longer meant a simple element. Modern chemistry instead considers air to be a mixture of many elements and compounds. \( \text{H}_2, \text{CO}, \text{and CH}_4 \) are all examples of flammable gases. This scientific revolution was accompanied by an alteration of the concept expressed by the natural kind term 'air.' Tracing the alteration of the term shows a paradigm shift in chemistry. Kuhn for his part, considers the natural kind of water; he writes:

\( \text{H}_2\text{O} \) can exist in all three states of aggregation—solid, liquid and gaseous—and it is therefore not the same as water, at least not as picked out by the term ‘water’ in 1750... Not until the 1780s, in an episode long known as the ‘Chemical Revolution,’ was the taxonomy of chemistry transformed so
that a chemical species might exist in all three states of aggregation.

Thereafter, the distinction between solid, liquid, and gases became physical, not chemical... This is not to suggest that modern science is incapable of picking out the stuff that people in 1750 (and most people still) label 'water.' That term refers to liquid $\text{H}_2\text{O}$. It should be described not simply as $\text{H}_2\text{O}$ but as close-packed $\text{H}_2\text{O}$ particles in rapid relative motion.\textsuperscript{46}

Kuhn shows that the chemical revolution changed what 'water' refers to—from liquid water to three states of aggregation for $\text{H}_2\text{O}$. Therefore, this shows that the new chemical paradigm provides a new context for relative natural kind terms.

Second, Kuhn holds that kind terms are acquired alongside their paradigms. Different paradigms usually provide different accounts for their kinds, and thus allow people to apprehend natural kind terms in certain perspectives, as in the above-mentioned examples of 'force,' 'water,' and 'air.' Therefore, to acquire specific concepts expressed by kind terms, the terms must be learned alongside the paradigm. Kuhn explains that 'weight,' 'mass,' and 'force' are terms that express different concepts in Newton’s theory and in Aristotle’s theory. They are old terms with new contents for students with Aristotelian educations. Students

\textsuperscript{46} Ibid., pp. 312.
are not able to acquire the new concepts expressed by the terms ‘weight,’ ‘mass,’ and ‘force’ without some basic comprehension of Newton’s theory; the terms are not acquired in isolation from the Newtonian paradigm. Similarly, to conceive of ‘air’ as a mixture of different elements and compounds, students must acquire the term in the context provided by the paradigm of modern chemistry. On the other hand, to understand ‘air’ as a simple element, students need to learn it in the context provided by Aristotelian theory.

In other words, Kuhn holds that kind terms can be properly understood only with respect to a certain paradigm. Kuhn writes that “With occasional exceptions, words do not have meanings individually, but only through their associations with other words within a semantic field. If the use of an individual term changes, then the use of the terms associated with it normally changes as well.” \(^{47}\) A paradigm provides the context to its kind terms. The concept expressed by ‘H\(_2\)O’ is webbed within the paradigm of modern chemistry; ‘H\(_2\)O’ cannot be meaningfully employed without an account of the chemical structure, the construction of the periodic table, the scientific model of atoms, and so on.

Kuhn notes that redubbing happens throughout the history of science, and

\(^{47}\) Ibid., pp. 301.
redubbing makes it inappropriate to translate natural kind terms, as they appear in the text of one paradigm, directly into the text of another. For instance, ‘water’ expresses different understandings of water and stands for different existents in different paradigms. Liquid water was dubbed as ‘water’ in ancient times. ‘Water’ is redubbed by modern chemistry—it refers to H$_2$O, which has three states of aggregation, namely, solid, liquid and gaseous. Thus, it is a mistake to translate ‘water,’ as it appears in ancient texts, directly into ‘water’ in the modern sense. ‘Water’ means a kind of element only in the ancient paradigm, and ‘water’ means a kind of compound only in modern chemistry. The ancient scientific paradigm renders ‘water’ to mean a kind of element; the paradigm in modern times renders ‘water’ to mean a kind of compound. ’Water’ expresses a specific concept about water in a specific paradigm. The concept expressed by a kind term in a particular paradigm cannot be equated to the concept expressed by the same term in another paradigm.

Kuhn concludes, ‘the development of the chemical lexicon in which H$_2$O is embedded required an almost total readjustment in the samples used to introduce the basic chemical kinds. No workable form of chemistry could have
survived the change that placed liquid water in the same category as ice and
steam but continued elsewhere to regard the divisions between states of
aggregation as chemically fundamental.48 Natural kind terms relate to one
another in their paradigm. Single change in the meaning of a term cannot happen
because the terms are connected all together. In order to make 'H2O'
meaningfully employed, a conceptual system that includes a comprehensive
understanding of other related kinds is required.

Finally, Kuhn holds that a paradigm is a worldview generated by a particular
scientific theory, and people need to receive a particular education in order to
inherit that paradigm. Therefore, people within different paradigms conceive of
their reality differently, which can cause difficulties in communication. Through
the lens of their paradigm, people learn how to comprehend physical facts in
certain ways. For example, those educated within the Ptolemaic system believed
that the Earth was at the center of the universe, while those educated within the
Copernican system believed that the Sun is the center of the universe. Different
scientific paradigms provide different explanations for the same facts about the
same sky. People who comprehend the facts of the sky differently would have

48 Ibid., pp.314.
difficulty communicating with each other about the sky. Barker, Chen, and Andersen summarize Kuhn’s accounts of paradigm, taxonomy, and natural kind terms: “Due to addition, deletion, and rearrangement of kind terms, a holistic redistribution of referents occurred. Because of the referent redistribution, many terms in the new taxonomy could not be translated into the old ones, or the other way around. Consequently, it becomes possible but not inevitable that communication between followers of the two systems will be impeded.”

Kuhn’s theory is a post-Darwinian Kantianism; he called himself “a Kantian with movable categories.” He attributes paradigms and their taxonomies to the conceptual forms through which reality is conceived. According to Kuhn, a paradigm provides a conceptual scheme that we use to differentiate existents in the world. It provides explanations that legitimate its taxonomy or taxonomies. These forms are not observable entities, but they are how we make sense of reality.

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52 Irzik and Grunberg discuss this view and its problems, see Gurol Irzik and Teo Grunberg, “Whorfian Variations on Kantian Themes: Kuhn’s Linguistic Turn,” Studies in History and Philosophy of Science, Vol. 29, No. 2, pp. 207-221.
To sum up, Kuhn holds, following these consequences, that a paradigm or taxonomy of a paradigm provides the context for natural kind terms; the terms are meaningfully employed only within that context. The redubbing of kind terms, which happens in paradigm shifts, implies that particular concepts expressed by natural kind terms hold only within a specific paradigm, for the concepts do not remain the same in different paradigms. The claim that people with different paradigms conceive reality differently implies that effective communication happens when people share the same paradigm because they share the same conceptual scheme through which reality is conceived. Since a paradigm provides a specific way to conceive of their kinds and assigns referents to their kind terms, it creates a context within which people can communicate effectively because they are in the same context.

For Kuhn, natural kind terms are based on paradigms because they provide specific ways to address and understand natural kinds. The term ‘dog’ implies background information. A wolf may look similar to a police dog, but the two do not belong to the same kind. To differentiate the kind wolf and the kind dog.

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requires information about the two kinds and knowledge of the taxonomy that
differentiates them. One needs to possess some basic information about dogs to
grasp what ‘dog’ stands for in the paradigm. In comparison, one does not require
much background information to grasp the reference of the proper name
‘Michael.’ Grasping the reference of ‘Michael’ simply necessitates an introduction
to someone by that name.\textsuperscript{54} As long as one grasps the connection between the
name and the person, one knows to which ‘Michael’ refers. However, according
to Kuhn, to grasp the concept expressed by ‘dog,’ one needs to possess the
conceptual system within which ‘dog’ is webbed. In short, unlike a proper name,
a natural kind term implies a system of knowledge and concepts, which is
provided by a paradigm.

2. \textbf{Criticisms of the bond between natural kind terms and science}

A Kuhnian position holds that a paradigm includes a taxonomy or a set of
taxonomies that constitute interconnected concepts and ways of ordering
experiences. Among the various taxonomies of different paradigms, reality is
ordered differently, and thus experienced differently. Howard, quoting Kuhn,

\textsuperscript{54} Note that the introduction could happen in many possible ways. It is not necessarily \textit{a de re}
introduction.
writes that “when paradigms change, the world itself changes with them’ and that in the transition between paradigms a ‘whole conceptual web’ had to be ‘shifted and laid down again on nature whole.””\textsuperscript{55}

The claim holds that a taxonomy of a paradigm is the categories that enable us to see reality as an ordered whole. Natural kind terms are constituents of a paradigm’s taxonomy: they allow the linguistic community to share the same conceptual scheme, and thus to experience the same ordered reality. Kuhn writes that “like the Kantian categories, the lexicon supplies preconditions of possible experience.”\textsuperscript{56} However, the fact that people from pre-scientific tribes—with no comprehension of science or accompanying paradigms—experience reality in a ordered way and have kind terms, provides an objection to this claim.

Natural kind terms appear in linguistic communities that have no science. Though it is intuitively true for people nowadays that kind terms are understood in terms of scientific accounts of their kinds because science has a long history dealing with them and therefore it intimately relates to them, kind terms appear


in linguistic communities whether they have a comprehension of science or not.

Some natural kinds, such as water, rice, or banana, are necessities for everyday life; this makes the use of kind terms necessary in any language. Thus kind terms undoubtedly appear even in communities so undeveloped that they have no written language nor any scientific practice.

The trajectory of scientific development varies across cultures. Generally speaking, most communities first understand reality through the lens of mythology and religious teachings. Gradually, the accumulation of observations and past experiences helps communities to develop scientific understanding of particular subjects. For example, almost all communities around the world develop some form of their own medicine, some of which are very different from today's western medicine. Ancient Egypt had a highly developed understanding of geometry; the Mayan civilization had a uniquely specialized calendar. Some communities never develop their own scientific theories and sustain primitive lifestyles, such as the isolated tribes of Papua New Guinea. Other communities develop sciences so mature that they have an in-depth understanding of everything from insects to the cosmos.
However, the usage of some natural kind terms is not dependent on a paradigm. Regardless of whether a linguistic community develops sciences, it still possesses some kind terms. Kind terms are not just used in scientific discussions; some of them are also the lexicon of everyday life. A tribe will have a term for water even if its members have no scientific understanding of water nor a paradigmatic taxonomy in which to include it. However, the term for water should enjoy the status of being a natural kind term. The term is not deprived of being a natural kind term because the tribe lacks a taxonomy classifying water or a scientific theory of water. Contrary to Kuhn, I would claim that the term can still stand for water and express a concept of water, which the tribe generates from daily life, despite the fact that no paradigm gives an account for water.

Indeed, some natural kind terms need to be understood with respect to a particular paradigm, especially theoretical terms. Terms, such as ‘mammal,’ ‘carnivore,’ and ‘homeotherm’ are terms that belong to taxonomy of today’s biological paradigm. But some kind terms can be meaningfully employed without a paradigm. For example, ‘water’ could mean something we drink every day. The connection between the term ‘water’ and physical water could have nothing to
do with science. When a linguistic community does not develop science, and thus
the concepts expressed by the kind terms that appear in the community have
nothing to do with science, the terms should still stand for their kinds and people
could still use them to refer to their kinds. A paradigm is not a condition for
people's knowing and using natural kind terms.

Moreover, in "On Learning Physics," Kuhn discusses how students acquire
Newtonian terminology. 'Force,' 'mass,' and 'weight' cannot be acquired without
some basic training in Newton's physics, while 'quantity' or 'magnitude' should
already be acquired as a preliminary before the student learns the set of
Newtonian terminology. What he intends to show is that "the differences
between the old laws and the new are reflected by the terms acquired with
them... Translations involving terms introduced with the altered laws are
impossible." Kuhn holds that some terms are crucial and fundamental to their
theory, and so they need to be acquired with the theory. Incommensurability
applies to these fundamental terms.

However, though this account is appealing, acquiring the term 'force' is not
necessarily accompanied by acquiring Newton's physics. 'Force' is a common

term used in everyday life. A person could use the word ‘force’ without knowing
Newton’s physics. Similarly, a child could learn the term ‘mammal’ without
knowing the complex modern biological taxonomy that defines it. Newtonian
physics and modern biological taxonomy are not requirements for acquiring the
terms ‘force’ and ‘mammal.’ People can know what ‘force’ means from their
everyday life and can use the term in everyday communications. ‘Mammal’ can
be acquired by acquiring knowledge of animals belonging to the kind mammal,
rather than acquiring the modern biological paradigm.

Susan Gelman and Ellen Markman discuss how young children acquire kind
terms and concepts of natural kinds.58 Children might generate the idea that
certain individual things are a kind by appearances induction or learning
categorical information. They could learn a kind solely by a narrative, e.g., telling
a bedtime story; solely by appearances, for example, showing pictures without
giving any information; or by both. It is not often that, when teaching the term
‘force’ to a child, one instructs them in Newtonian physics.

According to Kuhn, science (in a sense that includes all the paradigms in

58 Susan Gelman and Ellen Markman, ‘Young children’s instructions from natural kinds: the role
different historical periods) should be the most inclusive context for most
natural kind terms; natural kind terms are understood and acquired with respect
to scientific paradigms. But one can acquire many kind terms without learning
science. It is not rare for a five-year-old to know nothing about the paradigm of
chemistry and the paradigm of biology yet still acquire the terms ‘water,’ ‘apple,’
and ‘dog.’ Similarly, a child can acquire the term ‘bat’ without learning ‘bird’ or
‘mammal,’ which are crucial to the classification of bat in Linnaean taxonomy. In
short, one can manage to acquire a term without knowing its paradigm.

To acquire kind terms, one needs to acquire some information about the
kind, but the information is not necessarily its taxonomy or its paradigm—the
information can be non-scientific. We acquire ‘force’ and ‘air’ when we know
nothing about physics and chemistry. It is thus not a given that kind terms
should be acquired together with a paradigm, nor that kind terms are
understood with respect to a paradigm. On the contrary, it is often the case that
people acquire many natural kind terms in order to grasp the taxonomy of the
paradigm. For example, in order to know for what ‘mammal’ stands, it is often

59 For more detailed discussions, see S.A. Gelman, The essential child: origins of essentialism in
the case that one needs to previously know some kinds that are classified as mammal. When one is not familiar with examples of mammals, it would be difficult for one to know to what ‘mammal’ refers. Some kind terms, such as ‘water,’ ‘banana’ and ‘broccoli,’ are acquired directly from daily life, not from the sciences; they can be acquired without a paradigm and its taxonomy or, in other words, without a scientific theory.

Finally, terms for anomalies of a paradigm serve as problematic cases to Kuhn’s claim that natural kind terms need to be understood and acquired with respect to its paradigm. This claim assumes that a paradigm provides information for its kinds. People group and comprehend individual things as kinds according to the information provided by the paradigm; kind terms thus stand for and express certain concepts of their kinds with respect to the paradigm. To illustrate, the paradigm of Aristotelian biology provides no concepts for the term ‘virus,’ because it provides no information about the kind virus. On the other hand, the paradigm does provide a concept for ‘whale’: whales are a kind of cetacea in Aristotelian biology. For a paradigm to provide a concept for a kind term, it must provide an account for the kind. Because the
paradigm provides an account for the kind, the kind term expresses the concept about the kind given by the paradigm.

However, every scientific theory has anomalies—the kinds that violate the regulating rules of the paradigm’s taxonomy or its principles. Concerning anomalies and Kuhn’s theory of scientific revolution, philosophers often focus on the possibility that anomalies may lead to the revision of a paradigmatic taxonomy or even paradigm shifts. For example, Parker discusses changes in the concepts of similarity and difference in individual things that result in a revision of the lower branches of a taxonomy’s hierarchy. The revision may be confined to the end of its branch, and thus the taxonomy remains, but is lightly adjusted.

When accommodating an anomaly into the taxonomy causes conceptual changes at a high level, the whole conceptual system may need thorough adjustments and a new taxonomy may emerge in the end.

I hold that anomalies not only serve the discussion of what may lead to the revision of a paradigm’s taxonomy and a paradigm’s change, but also serve as examples of kind terms such that terms can stand for their kinds even though the

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paradigm does not offer accounts for their kinds. A virus is an example of an anomaly in today’s biological paradigm.\textsuperscript{61} ‘Virus’ was meaningfully employed before biologists included it in the biological taxonomy; that is, ‘virus’ was meaningfully employed before science had provided an account for it. Biologists debated whether to regard a virus as a living organism. The taxonomy of today’s biological paradigm classifies things into organisms and non-organisms—or living things and non-living things. However, a virus broke this boundary.

A virus cannot reproduce on its own; however, it reproduces within a host cell. A virus uses the material inside the host cell to replicate. The replicated viruses aggregate inside the host cell and the host cell eventually bursts when it is full. A virus is considered alive only within its host cell; it does not belong to the categories of living or non-living organism. Therefore, biologists created a new category in the biological taxonomy for virus, i.e., non-cellular life.

Biologists knew what ‘virus’ meant even when its mechanism was unknown. Now they are able to identify a virus, and they have a classification for different kinds of viruses called ‘virology.’ Therefore, ‘virus’ was meaningfully employed

both before and after a virus was accounted for by today’s biological paradigm and had a place in the taxonomy of the paradigm. Though biology offered no clear account of a virus—in other words, the biological paradigm did not provide a clear context for ‘virus’— ‘virus’ was still meaningfully employed and stood for a virus.

There are kinds whose locations in their taxonomy are yet to be determined. Their kind terms are thus examples that the concept expressed by them is not entirely dependent on the paradigm. A giant panda, for example, shares similar characteristics with both a bear and a raccoon. Some scientists hold that it belongs to the bear family, while others hold that it belongs to the raccoon family. Because of this controversy, some suggest that a panda belongs to its own panda family. In other words, the kind panda could be assigned to the panda, bear, or raccoon family—or it could be included in none of them. Today’s biology provides ambiguous accounts for the kind panda, and the classification of panda is not yet settled. Since it is difficult to accommodate for the kind within the biological taxonomy, the paradigm of today’s biology does not provide a clear definition for the kind term ‘panda.’ Despite this, ‘panda’ can still stand for and
express concepts about the kind panda.\textsuperscript{62}

Giant panda and virus are kinds about which biologists are trying to generate knowledge while figuring out how to accommodate them within the taxonomy of today's biological paradigm. In such cases, the concepts expressed by the kind terms 'panda' and 'virus' are somewhat independent from the paradigm of modern biology. For the paradigm does not provide clear accounts for the kinds. The terms stand for the kinds despite the fact that the locations of the kinds in the taxonomy of the paradigm are not yet settled. Since the terms are meaningful employed, thus are understood, without clear accounts for the kinds provided by the paradigm, some kind terms can be understood and used independent of their paradigm. The examples of 'virus' and 'panda' indicate that the meanings of the terms do not exclusively rely on the context provided by a paradigm.

The fact that some kind terms precede and are more indispensable than scientific practice in human life proves that some kind terms can be acquired without acquiring their paradigms. I agree that certain kind terms, such as \footnotesize\textsuperscript{62} Pluto can be a similar case in astronomy. It was regarded as the ninth planet ever since it was discovered in 1930. However, Eris, which has more mass than Pluto, was discovered in 2005, and the planethood, which included Pluto but not Eris, was questioned. Now both Eris and Pluto are regarded as dwarf planets.

‘carnivore’ and ‘cetacea,’ need to be understood with respect to their paradigm; they are themselves terms belonging to a particular paradigmatic taxonomy and compose the hierarchy of their taxonomy. But some kind terms, such as ‘water,’ appear in a linguistic community before scientific practice—their appearance in the linguistic community precedes any scientific paradigm. Thus it is not true that kind terms are necessarily acquired together with a scientific paradigm, or that they are meaningfully employed only within the context provided by a scientific paradigm.

3. Conclusion

In this chapter, I discussed Kuhn’s accounts of scientific revolutions and natural kind terms. By introducing the idea that the alterations of the concepts expressed by natural kind terms reveal a paradigm shift, Kuhn’s theory of paradigms and scientific revolutions connects to natural kind terms. He explains that kind terms need to be understood with respect to their paradigms, and that alterations in the concepts expressed by natural kind terms characterize a paradigm shift. However, given that some natural kind terms exist in a linguistic community before scientific practice, the usage of kind terms, and thus the
concepts they express, does not entirely depend on scientific paradigms. Since Kuhn considers natural kind terms only in light of scientific paradigms, his account of natural kind terms does not note that kind terms can stand for their kinds and can be used in the situations and discussions that are irrelevant to their paradigm.
Chapter Three: Hilary Putnam On Natural Kind Terms

This chapter provides a detailed examination of Putnam’s treatment of natural kind terms, in particular his explanation of the reference of a kind term and his Twin Earth argument, which argues against the traditional view of meaning that suggests meanings are in the head. I include a detailed examination of the Twin Earth argument and offer criticisms of his account of reference.

1. The Twin Earth argument and Putnam’s account of reference

For Putnam, how a natural kind term stands for its kind is a question of the relationship between the intension and the extension of the term. To answer the question of how a kind term connects to its kind is to answer the question of how the extension of the kind term is determined. Putnam provides two accounts for this issue. First, he provides the Twin Earth scenario to argue that the intension of a kind term does not determine its extension—in the sense that a person’s mental states and intrinsic properties do not determine the extension of the term.

Second, he holds that the experts of a kind within a linguistic community fix the extension of the kind term—this is an idea of semantic externalism, because the extension, and thus the meaning, of a kind term is determined by the linguistic
labor of the scientific community researching natural individual things. In a word, he holds that the extension of a kind term is determined by scientific stipulation, which is executed by a particular linguistic labor (usually that of the experts of the kind or scientists) in a linguistic community. Putnam’s answer to how a kind term refers to its kind is therefore scientific stipulation.

In “The meaning of meaning,” Putnam designs the Twin Earth argument to defend the claim that intension does not determine extension. I summarize it as a two-step argument. First, suppose that there is a Twin Earth where everything is just like Earth except for water. “One of the peculiarities of Twin Earth is that the liquid called ‘water’ is not H₂O but a different liquid whose chemical formula is very long and complicated. I shall abbreviate this chemical formula simply as XYZ.” In Twin Earth, the thing that is called ‘water’ and plays the chemical and biological roles that H₂O does on Earth has the chemical structure XYZ. This is the only thing on Twin Earth that differs from Earth. When a person on Twin Earth utters ‘water,’ she refers to XYZ; when a person on Earth utters ‘water,’ she refers to H₂O. Thus, this step shows a scenario in which the term ‘water’ has two

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64 Ibid., pp.223.
extensions: one is XYZ and the other is \( \text{H}_2\text{O} \).

Second, further suppose that there were human duplicates on Twin Earth and Earth in 1750 when modern chemistry had not yet developed. The duplicates\(^{65}\) were identical to each other, and they had the same mental history. Since they were exactly the same and their surroundings were exactly the same, when they thought of the term ‘water,’ the intension of ‘water’ was the same. However, the intension of ‘water’ had two extensions, one was XYZ and the other was \( \text{H}_2\text{O} \).

Thus, Putnam concludes that this is a case in which the intension does not determine its extension, for the same intension ‘water’ has two extensions, and one cannot tell to which extension the duplicate refers just by looking at the intension.

After arguing in this way that the intension of a kind term does not determine its extension, Putnam provides his account of reference to argue that the extension of a kind term is determined by the experts of the kind. Putnam’s account of reference comprises two steps. The first step is to connect a kind term and an individual thing. There are two ways to create this connection, i.e., by

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\(^{65}\) One may object that this assumption of duplicates is not appealing, because one of the biological structures of the duplicates is made of \( \text{H}_2\text{O} \), and the other is made of XYZ. Although this objection is appealing, for the sake of the argument, let us ignore it.
ostensive definition or by descriptions. Putnam holds that ostensive definition makes the connection in most cases. For example, in order for ‘water’ to refer to water, one could claim that ‘water’ means the liquid in the cup (pointing to the cup). The other way to create the connection is using descriptions. For example, to connect ‘water’ and water, one could claim that ‘water’ means the liquid in Lake Michigan. Putnam holds that descriptions rarely make the connection. Even in the case that the connection is made by descriptions, the descriptions are just for picking out the referent and they are irrelevant to the meaning of the kind term.⁶⁶

After the connection between a kind term and the individual thing is created, the second step is to build the relationship between the individual thing and other equivalent entities. The relationship is built by the experts of the kind or scientists in the linguistic community. For example, after making the connection between ‘water’ and the liquid in the cup, or ‘water’ and the liquid in Lake Michigan, ‘water’ also refers to the existents that scientists determine to be the same as the liquid in the cup or the liquid in the lake. For scientists determine

the sameness relation among constituents of the kind water. In short, Putnam’s account of reference of a kind term is that a kind term connects to an individual thing, and then the term refers to whatever bears the sameness relation that is determined by the linguistic labor in the linguistic community. Since the experts of the kind determine what bears the sameness relation, they determine the extension of the kind term.

2. My criticisms for the Twin Earth argument

A. The ambiguity of extension determining

Putnam argues that psychological states\(^\text{67}\) in the narrow sense do not determine the extension of a natural kind term. As Abbott puts it in other words nicely, ‘typically unknown internal structure properties are necessary in fixing the reference of natural kind terms—atomic or molecular structure in the case of words for substances, and genetic makeup in the case of plant and animal species names.’\(^\text{68}\) The extension of a kind term, according to Putnam, is determined by the nature of the kind, and not by private mental states. However, there is an

\(^{67}\) A psychological state has two senses, i.e., in the wide sense and in the narrow sense. ‘A psychological state in the wide sense’ is that of a state that presupposes the existence of the subject to which the state ascribes and the existence of the external world. ‘A psychological state in the narrow sense’ is that of a state that presupposes only the existence of the subject, which the state ascribes. ‘A psychological state,’ for which I also use ‘private mental state’ as an equivalent, in Putnam’s account is in the narrow sense.

ambiguity in his expression ‘determine the extension of a kind term.’ It could mean both ‘delineate the contour of a kind term’ and ‘refer to an example of a kind.’ ‘Delineate the contour of a kind term’ is to determine what is included in and what is excluded from the kind—it is to set the boundary of the kind and to differentiate what belongs to the kind. For example, the kind jade includes nephrite and jadeite and excludes other minerals. The kind water includes hard water, soft water, distilled water, heavy water, tritiated water, but excludes acetone and ethanol. To ‘delineate the contour of a kind term’ is to determine the constituents of the kind.

‘Referring to an example of a kind’ is a different sense of ‘determining the extension of a kind term.’ When one utters ‘water,’ she is referring to a certain thing that is an example of water. The phrase does not indicate a determination of whether something belongs to water, e.g., whether ethanol belongs to water. The phrase does indicate a determination of whether a certain thing is an example of water. When someone refers to water, no matter whether the thing referred to is ice, raindrops, distilled water, or the liquid in the river, as long as it is H₂O, she is referring to an example of water.
If ‘determine the extension’ is taken to mean ‘delineate the contour of a kind term,’ then, according to the Twin Earth argument, the same intension of a natural kind term would not determine the contour of the extension. However, this claim can be split into two different claims. First, that the intension alone does not determine the contour of the extension; second, that the intension does not have any effect in determining the contour of the extension. The first claim is trivial. Whether a certain particular belongs to a natural kind is a scientific question. A scientific question requires empirical researches and scientific theories to answer it. It is not something to be settled solely by mental deliberation, mental states, or intensions of some terms alone. For example, it is obvious that when heavy water was discovered, ordinary people’s mental states were irrelevant to determining whether heavy water belonged to the kind water.

The second claim is that intension plays no role in delineating the contour of the extension. That is, in delineating the contour of the extension, the intension of the kind term is irrelevant. I suggest this is what Putman has in mind. He holds that the connections of natural kind terms and natural kinds are rigid. The nature of the kind is the external fact, the fact out there, determining the
connection of the kind and its term. However, it is still up to people to discover the fact of the nature of the kind. It is people who decide what the facts are that have an impact on the connection. In particular, there are many facts about the nature of water: water is H$_2$O, water freezes at zero degrees Celsius, water boils at 100 degrees Celsius, water is a tasteless liquid, etc. Among these features, people choose H$_2$O as what identifies water. This decision is made by people, not by nature itself. Besides, as D.H. Mellor$^{69}$ points out, no matter who determines the extension, it is still intension that determines extension. If ordinary people have the privilege to determine the extension of a natural kind, then it is the intensions of ordinary individuals that do the job; if it is scientists who have the privilege, then it is the intensions of the scientific community that does the job.

The claim that intension is irrelevant with delineating the contour of the extension is therefore not convincing.

If ‘determining the extension’ is taken to mean ‘referring to an example of a kind,’ then, according to the Twin Earth argument, the intension of a natural kind term would not determine the examples of a kind. The duplicate scenario shows

that this is the case. By investigating the intension of ‘water’ for the duplicates, we cannot tell whether the liquid referred to is H₂O or XYZ. So, the intension of ‘water’ does not determine whether it is an example of H₂O or it is an example of XYZ. However, this line of thought is misleading. It is true that the intension of the duplicates determines neither examples of H₂O nor examples of XYZ. Instead the intension determines examples of water. By investigating the intension of ‘water,’ we are sure in both worlds that ‘water’ refers to examples of water.

This scenario does not demonstrate that intension does not determine the examples of a kind. The intension under discussion is water, and what the duplicates intend to refer to is water; therefore, what they refer to are examples of water. If ‘determine the extension’ was taken to mean ‘determine examples of the kind,’ then the scenario would show that the duplicates’ intension of ‘water’ does not determine the examples of water. In other words, in this case, the argument would be convincing. But what the scenario shows is that the intension of water does not determine examples of H₂O or XYZ. This is like when someone says, ‘Would you pass me the salt.’ What he intends to refer to is salt. His intension of salt does not determine examples of apple or anything else. The
intension of salt is only relevant to the examples of salt. It is misleading therefore to argue that the intension of ‘water’ does not determine examples of $\text{H}_2\text{O}$ or XYZ.

I suggest that what the duplicate scenario shows is that one intension has two referents, rather than two examples in two extensions. Whether XYZ belongs to the extension of ‘water’ has not yet been determined. When it is settled that the extension of ‘water’ does not include XYZ, and the term ‘water’ becomes an ambiguous word, then it can be said that the term ‘water’ has two extensions—one is $\text{H}_2\text{O}$ and the other is XYZ. That is, when ‘water’ is used on Earth, its extension is $\text{H}_2\text{O}$; when it is used on Twin Earth, its extension is XYZ.

When this is the case, then it is shown that ‘water’ has two extensions. According to Putnam, however, the duplicates don’t have the knowledge that the molecular structure of the liquid is $\text{H}_2\text{O}$ or XYZ since they live in 1750. What they know is simply the superficial features of the liquid in their environments. Therefore, whether ‘water’ has two extensions is yet to be determined in the scenario of the Twin Earth argument. Thus, the argument does not show that the intension of ‘water’ has two extensions.

One might ask ‘but when the duplicates refer to examples of water, doesn’t
it mean that the examples are already in the kind? How can the duplicates refer
to examples of water when H$_2$O and XYZ are not in the kind water?’ This question
assumes that referring to certain things presupposes that the referents are
already in the extensions of their kinds. However, some cases show that this
assumption is not true. For example, when a piece of stone is discovered and
referred to, the atomic or molecular elements of the stone may not yet be
verified or classified—the stone has yet to belong to any extension of a kind
understood in this sense. But, it can be referred to by the people who discover it.

Objects do not need to be in certain extensions of a kind to be referred to.

Similarly, when the duplicates refer to the liquids in their surroundings, the
liquids are their referents, and whether they (H$_2$O and XYZ) belong to the same
kind, understood scientifically, has not been determined.

**B. What would happen when a spaceship arrives on Twin Earth?**

Putnam asserts that if scientists arrived on Twin Earth and found the stuff
called ‘water’ had the chemical structure XYZ, they would report that “On Twin
Earth the word ‘water’ means XYZ”\(^70\)—which means that the extension of ‘water’

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on Twin Earth would be XYZ. Putnam claims that in such a situation the
scientists would decide to exclude XYZ from the extension of ‘water’ in the
English linguistic community.

However, after Ian Hacking presents various cases of how jade was
baptized—in the US in 1569, jadeite was baptized as ‘jade,’ which implied the
power of the stone; in France in 1863, jadeite was baptized ‘jadeite,’ but white
jade (nephrite) and green jade (jadeite) were seen as kinds of jade; and in China,
the Chinese word for jade, ‘yu,’ applied to nephrite and jadeite, but was
determined by the workability of the substances, their polished appearance, and
a deep cultural tradition—he concludes, ‘If philosophers were to pay a little
more attention to the real-life historical contingencies of language use, they
would be less inclined to construct zealously over-confident arguments about
what we would or should say, if.’

71 Searle also comments on the Twin Earth argument using the example of jade. Searle writes ‘Suppose, for example, there
had been a great deal of going and coming between Earth and Twin Earth so that
the speakers were likely to have encountered both. Then it seems likely that we

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would construe water as now we construe jade.’

Whether or not scientists would include XYZ in the extension of ‘water’ is a question for discussion, but I will examine Putnam’s Twin Earth scenario and consider the case in which a spaceship with a group of scientists visits Twin Earth. I shall show that the claim that an intension does not determine its extension is not compatible with the claim of the rigidity of kind terms, and that including XYZ in the extension of ‘water,’ contrary to Putnam’s claim, leads to the consequence that an intension does not determine its extension.

First of all, let me assume that when the scientists arrive on Twin Earth and encounter water, they say, ‘here is water.’ Suppose that their referring to XYZ is successful—when they talk about water, they do refer to the liquid stuff on Twin Earth. They can refer to the liquid stuff using the term ‘water.’ When they talk to the people who live on Twin Earth about water, they have no problems in communication. When the scientists talk to each other using the term ‘water,’ they all know to what they refer. Therefore, it is appealing to claim that the term ‘water’ refers to XYZ on Twin Earth.

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When this is the case, how the scientists understand ‘water’ does not interfere with the reference of ‘water.’ Though they believe water is H$_2$O, and the intension of ‘water’ is H$_2$O, ‘water’ can refer to XYZ. This, then, is a case where intension does not determine the examples of the extension. For the intension of ‘water’ is H$_2$O, but the extension includes XYZ. XYZ is an example of ‘water,’ so the extension of ‘water’ consists of XYZ. This is a case where ‘water’ is not rigid, for ‘water’ not only stands for H$_2$O, but for XYZ.

On the other hand, when the scientists arrive on Twin Earth and say, “here is water,” let’s suppose that their referring to XYZ is not successful. That is, when they refer to water, they do not refer to the liquid stuff on Twin Earth successfully. The term ‘water’ does not refer to XYZ on Twin Earth. The intension of ‘water’ is H$_2$O. When they talk about water, what they talk about is H$_2$O; they don’t talk about XYZ. When they use the term ‘water,’ what they intend to refer to is H$_2$O. When they discuss anything about ‘water,’ it is irrelevant to XYZ. When the people who live on Twin Earth hear the scientists talk about water, and they think that the scientists talk about XYZ, they misunderstand the scientists. This is a case where the intension of ‘water’ determines the examples of the extension.
The intension of ‘water’ confines the reference of ‘water’ to H\textsubscript{2}O exclusively. The extension of ‘water’ is only H\textsubscript{2}O. When ‘water’ is used to refer to XYZ, it fails.

This is a case where the intension of ‘water’ prevents its referring to XYZ on Twin Earth. This is also a case where the term ‘water’ rigidly connects to H\textsubscript{2}O and nothing else. That is, the extension of ‘water’ is always H\textsubscript{2}O, and ‘water’ always refers to H\textsubscript{2}O. Whenever ‘water’ is used to refer to things other than H\textsubscript{2}O, it is an incorrect usage. Whenever and wherever the term ‘water’ is used, it refers to H\textsubscript{2}O and nothing else. This is a case where ‘water’ rigidly stands for H\textsubscript{2}O.

In this case, is it a coincidence that the intension of ‘water’ is H\textsubscript{2}O, and ‘water’ also rigidly stands for H\textsubscript{2}O? I don’t think so. One way to tell water from other liquids is to see whether its molecular structure is H\textsubscript{2}O. Something having the molecular structure H\textsubscript{2}O is water—the molecular structure H\textsubscript{2}O is regarded as the identity of water. It is what makes water water. This is why ‘water’ rigidly connects to H\textsubscript{2}O, and not other features of water. When ‘water’ rigidly stands for H\textsubscript{2}O, we are sure that ‘water’ refers to water and not something else. However, what determines the identity of water? What determines core feature that differentiates water from something else? It is scientists and scientific theory.
Scientists define one of the features of water as a core feature, and what ‘water’ rigidly connects to is based on this core feature. Now people agree that the intension of ‘water’ is H₂O. It is not convincing to claim that scientists and scientific theory are irrelevant to the intension of ‘water.’ After all, following this line of thought, it is scientists who discover the molecular structure H₂O, and they define H₂O as the identity of water, which determine the extension of ‘water.’ Since ‘water’ should mean its extension, the meaning of ‘water’ is relevant to its extension. Suppose that the intension of ‘water’ is relevant to scientific results. And say that scientific results are relevant to what ‘water’ rigidly stands for. Then it is convincing to claim that the intension of ‘water’ is relevant to what ‘water’ rigidly stands for. If so, then this is a case where ‘water’ rigidly stands for H₂O, while the intension of ‘water’ is relevant to this determination. That is, this is a case where ‘water’ is rigid, but the intension of ‘water’ plays a role in the rigidity.

The above discussion shows that when ‘water’ is not taken to be a rigid designator⁷³, the intension of ‘water’ does not determine the examples of the

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⁷³ By a rigid designator, I mean that the word ‘water’ stands for anything with the essence of water, and anything with the essence of water must have the molecular structure H₂O. The word ‘water’ only refers to things with the molecular structure H₂O and nothing else.
extension. On the other hand, when ‘water’ is taken to be a rigid designator, the
intension of ‘water’ plays a role in determining the example of the extension. The
discussion shows that it is not consistent to assert that ‘water’ is a rigid
designator and that the intension of ‘water’ does not determine the examples of
the extension of water.

Secondly, whether or not the scientists referring to XYZ using ‘water’ fail,
they will do scientific research on Twin Earth, and they may discover that the
moisture liquid is XYZ. Though this is not guaranteed, let’s suppose that they find
out that the liquid is XYZ. Putnam’s line of thinking may go like this: First of all,
water is H₂O. XYZ is not H₂O. So water is not XYZ. If water is not XYZ, then XYZ is
not in the extension of ‘water.’ Secondly, I further assume that the intension of
‘water’ determines the extension of ‘water’, and since one of the intensions of
‘water’ is that water is H₂O, then the extension of ‘water’ is H₂O. XYZ is not in the
extension of ‘water’.

It turns out that if Putnam wants to hold that the intension of ‘water’ does
not determine its extension, he should deny that the extension of ‘water’ is H₂O.
That is, if he allows XYZ to be in the extension of ‘water’, he can easily deny the
claim that the intension of ‘water’ determines its extension. Putnam intends to exclude XYZ from the extension of ‘water’ and asserts that intension does not determine extension. However, in order to argue that the intension of ‘water’ does not determine its extension, XYZ should be in the extension of ‘water’.

Thirdly, the scientists can determine if the statement ‘water is XYZ’ is true or false. When they include XYZ in the extension of ‘water,’ the statement is true; when they exclude XYZ from the extension of ‘water,’ the statement is false. They make the statement true or false on the basis of certain facts. The facts that make the statement false may be that water is H\(_2\)O, and that XYZ is not H\(_2\)O. So, ‘water is XYZ’ is false. On the other hand, there are also facts that may make the statement true. For example, water is the liquid that is found in the river, water is what rain drops are made of, water is the tasteless and odorless liquid that is essential for life. These are facts of H\(_2\)O on Earth, and these are also facts of XYZ on Twin Earth. Thus, water is H\(_2\)O and also XYZ, and ‘water is XYZ’ is true.

Though the statement’s truthfulness is based on facts, the facts selected to determine the truthfulness are not predetermined. Facts are neutral in themselves and are always interpreted in the light of a certain intension.
I do not think the scientists would decide that XYZ and H\textsubscript{2}O should be the same kind immediately after discovering the chemical structure of XYZ. They would first discuss and deliberate to reach a final agreement. My questions are as follows: Is it appealing to claim that in the period of time when they discuss and deliberate the issue of whether XYZ and H\textsubscript{2}O belong to the same kind, the intension of ‘water’ would play no role? Is it appealing to claim that when they discuss whether to include XYZ in the extension of water, the intension of ‘water’ has nothing to do with the discussion? Is it appealing to claim that when they deliberate what facts about water should be considered, the intension of ‘water’ has no effect on their deliberations? If the answer to any of the above questions is yes, then it is not appropriate to claim that the intension of ‘water’ does not determine its extension.

C. The possibility of two extensions of a natural kind term

I wonder whether is it possible that a natural kind term has two extensions. Suppose that the scientists include XYZ in the extension of ‘water.’ Now this would mean that the extension of ‘water’ has two constituents, i.e., H\textsubscript{2}O and XYZ. But ‘water’ would still have only one extension. In fact, the kind water has many
constituents, for example, D$_2$O and T$_2$O. In this scenario, the kind water would just have one more constituent, i.e., XYZ. When this is the case, it is not true that ‘water’ has many extensions; it is just that the extension of ‘water’ has many different constituents. In reality or in this scenario, no matter whether the extension of ‘water’ is constituted by D$_2$O, T$_2$O, and H$_2$O, or by H$_2$O and XYZ, ‘water’ has only one extension. On the other hand, suppose that the scientists excluded XYZ from the extension of ‘water’. That is, XYZ and H$_2$O were not regarded as the same kind. Then the extension of ‘XYZ’ is XYZ, and the extension of ‘water’ would be H$_2$O, D$_2$O, and T2O. ‘XYZ’ and ‘water’ would both have one extension. To sum up, no matter whether XYZ is included in or excluded from the extension of ‘water,’ no matter how many constituents are in the extension of ‘water,’ ‘water’ has only one extension. That is, in reality or in the scenario of the Twin Earth argument, there is no case where ‘water’ has two different extensions. In other words, there is no case where a natural kind term has two extensions.

One might ask, “How about the duplicate scenario? Isn’t that a case where ‘water’ has two extensions?” I think it is not a case where ‘water’ has two
extensions. Instead, it is a case where ‘water’ has countless extensions. When ‘water’ has countless extensions, the kind water dissolves into particulars; the kind water is no longer available.

The scenario of the duplicates is set in 1750 where scientists had no idea about the molecular structure of water. Since Putnam claims that the molecular structures of H$_2$O and XYZ make ‘water’ into two extensions, we may suppose that there are other important features of water that we don’t yet know, that these features make water into more kinds, and that ‘water’ has more extensions. The supposition may go on and on. Then we arrive at a case where ‘water’ has indefinite extensions.

There may be many important features of water that we don’t know. I don’t think the scientists would claim that H$_2$O is the ultimate essence of water and that they will never discover any new features about water. Since we don’t know how many features of water we have not discovered, and assuming that all unknown features of ‘water’ make it into more extensions, we do not know how many extensions of ‘water’ there actually are.

When we are unsure how many extensions of ‘water’ there are, it could be
that many different liquids belong to the extension of ‘water,’ or that very few belong to the extension. When this is the case, water can no longer be a kind, because it is not clear what kind of liquids belong to it. When water cannot be a kind, it is senseless to talk about the extensions of ‘water,’ and the term ‘water’ becomes an empty word. The duplicate scenario is not a case where ‘water’ has two extensions; it is a case where ‘water’ has indefinite extensions. This makes water lose its status as a kind, and makes the term ‘water’ senseless.

So far scientists have found D$_2$O and T$_2$O within water. Since their molecular structures differ from H$_2$O, Putnam would claim that D$_2$O, T$_2$O, and H$_2$O should not be the same kind$^{74}$—or at least he would say it is unclear whether they belong to the same kind. However, since we are not sure how many substances we might find within water, we cannot be sure how many new kinds would be discovered within water, consequently we cannot be sure how many extensions the term ‘water’ has. Of course, unlike what Putnam would claim, D$_2$O, T$_2$O, and H$_2$O are all regarded as water. We should therefore say that they are different

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$^{74}$ One might argue that H$_2$O, D$_2$O, and T$_2$O have the same chemical structure, for they are all consisted of two hydrogen atoms and an oxygen atom. However, D$_2$O and T$_2$O contain different isotopes of the hydrogen atom. D$_2$O consists of deuterium, and T$_2$O consists of tritium. Deuterium contains one neutron, tritium contains two neutrons, and a hydrogen atom contains no neutrons. Even if they are regarded as having the same chemical structure, their physical properties differ. In particular, their boiling points, melting points, and chemical reaction times differ. Given these considerations, it is not unreasonable for one to hold that D$_2$O and T$_2$O are different kinds from H$_2$O.
constituents of the extension of water.

3. My criticisms of Putnam’s account of reference

Putnam considers the question of the connection between a kind term and its kind to be a question of the relationship between the intension of the term and its extension. The account of reference, he suggests, is that the intension of a kind term connects to a particular indexical and the indexical connects to other equivalent existents in the kind. Scientists determine equivalent existents as a kind and the particular is one of the existents. The existents thus connect to the particular indexical and to the kind term. The indexical and the existents are therefore taken into the extension of the term. The intension of a kind term does not relate to the extension of the term. It is scientific stipulation that determines the extension of the kind term.

There are some problems with Putnam’s account of reference. First, the reason that scientists gather individual things into a kind is not always because they bear the sameness relation. The account applies to natural kinds like gold and water well, because there is little variety in the constituents of the kinds—‘Gold’ refers to Au-79 and its isotopes; ‘water’ refers to H2O and its
isotopes. But it is difficult to apply the account to kinds such as dog and human being. There is a great deal of variety in the constituents of the kind dog. It is difficult to figure out the sameness relation among, say, a bulldog, a Chihuahua, and a Chow Chow. It is difficult to assert that 'dog' refers to that (pointing to a dog) and whatever bears the sameness relation to it. Scientists would not claim that dogs are grouped into a kind because they bear the sameness relation and it is not clear what particular feature shared by members of the kind dog is defined as the same feature. Human being is an interesting case among kinds. What feature is common to all human beings and thus differentiates humans from other creatures is philosophical. There is no consensus of opinion; biologists, ethicists, Christians, and Buddhists would suggest different answers.

Putnam might instead assert that individual things are grouped into kinds by shared essences. For example, the essences of water and gold are their chemical structures, and the essences of human being and dog are their genetic sequences. However, on the other hand, it is difficult to explain why chemical structure and genetic sequence are selected to be the essences of the kinds. The melting and boiling points of water and gold could be the selected essences, too.
On the other hand, I don’t see why it is not appropriate to gather dogs of the same region into a kind—the place of birth is the feature common to them, and thus could be selected as the essence of them. In comparison, planets are gathered into different kinds according to their mass regimes, orbital regimes, or compositions. There is more than one way to group planets into a kind. As Slater puts it, ‘biological species, for example, appear not to have any intrinsic properties that are fit candidates for being essences… even if there were properties that all and only members of a particular taxon possessed, it’s unclear that we should rightly count them as that taxon’s essence.’

Whether a biological species has essences is a question and how to determine the essences among the various features of the species is another, but neither of them has an affirmative answer.

Second, Putnam claims that a natural kind term is a rigid designator, but this claim is based on an inappropriate assumption. Putnam’s account of reference is based on the connection between a kind term and an individual indexical, and the connection between the indexical and other existents that are the same with

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it. The sameness relation is authorized by science, which is part of the linguistic labor of the linguistic community. In order for the kind term to be rigid, the reference of the term cannot be changed. However, the reference of kind terms do change. For example, ‘water’ means liquid water, three states of water, and H₂O and its isotopes in different historical periods. The extension of ‘water’ expands with the progress of science. Putnam holds that science determines identities of kinds, but he ignores the fact that science updates theories of kinds. When science generates a new theory or updates accounts about a kind, the extension of the kind term is very likely changed.

Third, Putnam makes the contribution of inviting social interactions to his theory of meaning, as Burge puts it: ‘Because distinguishing and informatively specifying the natures of the referents of natural kind terms require empirical investigation, there is natural scope for relying on others... they may know more, even about basic identifying characteristics, of those referents. Putnam described this phenomenon as a division of linguistic labour.’ But I wonder how this

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76 Two other examples are ‘planet’ and ‘element.’ The referents of ‘planet’ and ‘element’ change. Pluto was excluded from the extension of ‘planet’ in 2006, after Eris, which is larger than Pluto, was discovered in 2005. This made the planethood of Pluto inappropriate. Nihonium is a newly discovered element and was added to the extension of ‘element’ in 2016.

notion of linguistic labor is compatible with this assertion of the rigidity of kind terms. Different linguistic labors have different responsibilities: journalists popularize a kind term, teachers teach a kind term, and scientists determine the sameness relation among the members of a kind. Since scientists determine the sameness relation which determines the extension of a kind term, the extension of the term is determined by the linguistic labor. However, it is always possible for the linguistic labor to determine the extension of a term in another way. When all other possibilities of determining the extension are ruled out, then the kind term can be rigid. But I don’t see how the possibility can be excluded.

Finally, how ostensive definition applies to an individual thing can be puzzling. For example, when a person utters, ‘dog means that’ (pointing to a dog), how do people know what the ostensive definition applies to. It could apply to, say, the shape, the color, the tale, the nose, or the eyes of the dog. It could also apply to the location of the dog, the position of the dog, or the health status of the dog. Ostensive definition is not as simple as Putnam suggests. How ‘dog’ refers to a particular dog is questionable. Moreover, there are cases where referents cannot be picked out by ostensive definition. Kuhn points out that a single act of
ostensive definition is not enough to fix the reference of some kind terms—in cases such as electric charge and neutron. It is also not possible to apply an ostensive definition, and to fix the references of ‘swan’ and ‘goose,’ either. Because fixing the reference of ‘swan’ and ‘goose’ requires not only the kind in question but also other similar kinds that might be mistaken for swans and geese. Putnam’s account of the ways of fixing the reference is not satisfying. Putnam believes that once the extension of a term is determined, the reference of the term is determined. However, I propose that the reference of a kind term is generated by knowledge of the kind. In determining the reference of a kind term, knowledge of the kind is more salient than the extension of the term.

A reference is empty when its extension is not cognitively shared. Consider a scenario where a professor says, ‘give me the water’ in a laboratory. Suppose that there is a bottle of heavy water and a bottle of drinking water. Also suppose that the students do not know that the extension of ‘water’ includes heavy water. No student would give the professor the bottle of heavy water. If, by ‘water’, the professor means the bottle of heavy water, he would not get it. The reference of

'water' to heavy water is empty because the students and the professor do not share the knowledge of the extension of 'water.' A reference in which 'water' means heavy water does not function in this scenario. On the other hand, when the students have the knowledge that heavy water is in the extension of 'water,' what the professor means by 'water' is communicated, and the professor might receive the bottle of heavy water. The reference of 'water' to heavy water applies in this scenario when at least some of the people involved in this conversation share the knowledge of the extension of 'water.'

The meaning of a kind term is not just its extension. For example, the term 'element' now refers to the chemical elements in the periodic table determined by modern chemistry. But in everyday life people could use 'element' to mean a basic unit of something or the constituents of something. The meaning of 'element' is more than the extension of 'element.' Laport gives an example to illustrate this idea, "'The honeybee' may be used to designate the honeybee kind, as in 'The honeybee is a kind essentially marked by its ...', but it can also be used to refer to a particular insect, as when a speaker relates an encounter with one:
"The honeybee stung Martha when she swatted it."79

Shared knowledge of elements allows people to know the reference of ‘element.’ When few people in a linguistic community have knowledge about elements, that ‘element’ stands for elements could not apply generally. To illustrate, suppose a linguistic community where few people recognize that ‘element’ means the elements of the periodic table, while most recognize that ‘element’ means a basic unit of something. In such a community, when one utters ‘element,’ people would likely think it refers to a basic units of the thing, and would not think it refers to the elements in the periodic table.

The reference of a kind term is based on shared knowledge of the kind and common usages of the term, not the extension of the term given by scientists. The meaning of a kind term can be irrelevant to its extension, for example, ‘element.’ When people have no shared knowledge of the extension of a term, the reference of the term has no application, as, for example, in the case of ‘water.’

Putnam claims that ‘meanings just ain’t in the head.’80 By ‘the head,’ he

means ‘methodological solipsism.’\textsuperscript{81} Putnam presents two assumptions. First, that knowing the meaning of a term is a matter of being in certain private mental states.\textsuperscript{82} The psychological state only presupposes the existence of the subject to which it ascribes and nothing else. Second, the meaning (or intension) decides the extension of the term.\textsuperscript{83} He holds that the two assumptions cannot be jointly true, and he provides the Twin Earth argument to show that the second assumption is false. In short, the quote “meanings just ain’t in the head” means that the extension of a kind term is not determined by a psychological state in the narrow sense. Though the Twin Earth argument is problematic, I agree with Putnam that the extension of a kind term is not determined by a psychological state in the narrow sense.

Putnam has an insight that meanings are not private mental entities but social linguistic products existing in every human community. He tries to show that natural kind terms’ referring their kinds is a result of linguistic labor interacting with natural existents. However, first of all, after investigating his

\textsuperscript{81} Ibid. pp. 136.


Twin Earth argument, I show that the argument does not defend the claim that intension does not determine extension successfully. For his phrase ‘determining extension’ is ambiguous; moreover, he could reach the intended claim in an opposite scenario—if he allows XYZ to be included in the extension of ‘water’ he could get the result that intension does not determine extension. Furthermore, a kind term can have two or more constituents in its extension, but it cannot have two or more extensions. Finally, his account of reference of natural kind terms is not compatible with the fact that reference of a kind term can and does change.

4. Conclusion

This chapter presents Putnam’s accounts of natural kind terms, in particular the Twin Earth argument and his account of reference. My criticisms show that his accounts are problematic and that his claims are inconsistent with each other. This chapter ends with an elaboration of my theory of reference and a summary of my criticisms of Putnam’s theory.
Chapter Four: Saul Kripke on Natural Kind Terms

Kripke develops his account of the rigidity of proper names by arguing against descriptivism, the view that proper names are abbreviated definite descriptions. He then develops a theory of natural kind terms by extending the notion of rigidity from proper names to nature kind terms. This chapter presents the background of Kripke’s theory of natural kind terms, and my discussion of the theory.

I shall divide Kripke’s account into three parts: first, his presentation of descriptivism; second, three arguments that he suggests against descriptivism; and finally, his arguments for the rigidity of proper names and kind terms. The fourth part of this chapter presents my criticisms of Kripke’s theory of kind terms. At the end of this chapter, I modify the three arguments against descriptivism into arguments against my account of kind terms and I reply to them.

1. Descriptivism

Descriptivism concerns two questions; first, whether proper names have
meanings and, second, how proper names determine their references. According to Kripke, Bertrand Russell, a main supporter of descriptivism, claims that names are abbreviated definite descriptions. For example, the definite description ‘the president of the United States in 2016’ uniquely picks out a particular individual; the name ‘Barack Obama’ also picks out the same individual. Since the name ‘Barack Obama’ and the definite description ‘the president of the United States in 2016’ both pick out the same individual, they mean the same thing, for example, that particular individual. Thus, Russell claims that ordinary proper names are abbreviated definite descriptions.

Descriptivism is a view against the claim that a proper name merely means its referent. Intuitively, what else does a proper name mean other than the particular individual that receives the name? John Stuart Mill, for example, holds this view—‘Hesperus’ means the planet Venus, period. However, Gottlob Frege suggests a puzzle to show that names may not merely mean their referents. For example, ‘Hesperus’ and ‘Phosphorus’ both mean the planet Venus. The

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statement ‘Hesperus is Hesperus’ is intuitively true; one does not need to know

that Hesperus is Venus to tell that the statement is true. But one requires a
certain knowledge to tell whether ‘Hesperus is Phosphorus’ is true. If a name
only means its referent, then one should be able to know the truth-value of the
statement ‘Hesperus is Phosphorus’, just as one knows the truth-value of the
statement ‘Hesperus is Hesperus’. Thus, Frege claims that there are different
cognitive values between the two statements. And this shows that proper names,
such as ‘Hesperus’ and ‘Phosphorus’, do not merely mean their referents.

To solve this puzzle that two statements of identity with the same
truth-value have different cognitive values, Frege suggests that names have
senses, and senses are modes of presentation. In the case of Venus, for example,
the senses of ‘Phosphorus’ and ‘Hesperus’ are different ways of representing
Venus and thus the two senses determine the referent in different ways.

Phosphorus is sometimes called the ‘morning star,’ and Hesperus is called the
‘evening star.’ The morning star and the evening star are modes of
representation of the planet Venus. People see Venus in the morning and call it
‘Phosphorus’; people see it in the evening and call it ‘Hesperus’. The sense of Phosphorus represents Venus as a star that appears at a certain angle in the morning. It also indicates how to determine the referent of ‘Phosphorus’. It is the star that appears at a certain angle in the morning. The sense of ‘Hesperus’ is another mode of presentation of Venus; it shows another way of determining the referent.

A descriptivist would hold that proper names have meanings that are their definite descriptions and that the definite descriptions pick out the referents and thus decide the references of the names. How do names refer to their referents? A descriptivist would answer that the particulars that satisfy the definite descriptions are the named particulars. In short, names have meanings, and the meanings are the definite descriptions. The references of the names result from the definite descriptions picking out the named particulars. The definite descriptions make the references of proper names possible, and they are also the meanings of the names.

2. Three types of arguments against descriptivism
Kripke arms himself with three types of arguments to refute descriptivism:

the semantic argument, the modal argument, and the epistemic argument. The

semantic argument argues that a name refers to its referent even when most

people only have vague and unclear descriptions about the referent. The modal

argument argues that descriptivism does not apply to the situations in which the

referent of a proper name could have been otherwise. The epistemic argument

argues that a name refers to its referent even when people use false definite

descriptions.

According to the semantic argument, it is not true that people have specific
definite descriptions in mind when they use names. Rather, they may have

unclear, vague, or unspecific descriptions about the referents of the names.

Kripke takes Cicero as an example. He explains that people may only know

that Cicero is a Roman orator, or people may have no idea who Cicero is.

However, regardless of people’s knowledge about Cicero, the name ‘Cicero’

refers to Cicero.

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85 Ibid., pp. 79-81.
The descriptivist holds that names are abbreviated definite descriptions. But the semantic argument shows that when people use names with vague and unclear descriptions, the names still refer to their referents and thus mean their referents. There may be many Roman orators and many people named ‘Cicero’. But when people use ‘Cicero’ with vague and unclear descriptions of the Roman orator, ‘Cicero’ refers to the particular person Cicero. Therefore, the descriptivist’s claim is not true. Names refer to their referents when they are not their abbreviated definite descriptions. Proper names don’t pick out their referents by the definite descriptions.

The modal argument shows that descriptivism does not account for the situations in which referents of proper names could have been or done otherwise. For example, Barack Obama was the President of the United States in 2016. The definite description ‘the President of the United States in 2016’ picks out the person Barack Obama. However, is it a necessary truth that Obama was the President in 2016? It is not. Obama could have lost the election and not been the President. Suppose Obama was not the President of the United States in 2016.
In this situation, what is the referent of the name ‘Barack Obama’? It is obvious that whether Obama was the President in 2016 or not, the name ‘Barack Obama’ refers to the same person.

Definite descriptions do not necessarily pick out the same referents of proper names in different possible situations. The named particulars could always have been otherwise. So-called definite descriptions are therefore not definite at all. They apply only to the actual world and not all possible situations.

To illustrate, the definite description ‘the President of the United States in 2016’ would have picked out Mitt Romney had Obama lost the election. It shows that the definite description picks out different referents in different possible situations. However, the names ‘Barack Obama’ and ‘Mitt Romney’ pick out Obama and Romney regardless of all the possibilities. Therefore, a name is not the same as its definite description. The claim that a proper name is its abbreviated definite descriptions is false.

The epistemic argument shows that people may have false beliefs and use false descriptions of some names, but those names still refer to their referents.
Kripke gives an example. Nowadays many people know that Dedekind, not Peano, discovered number-theoretic axioms. However, suppose someone mentions ‘Peano’ and is asked whom he means by ‘Peano’. He may answer, “By ‘Peano’ I mean the person who discovered number-theoretic axioms.” He may have a false belief about the person Peano and thus use a false description of the name ‘Peano’. However, in this situation, to whom does the name ‘Peano’ refer?

Obviously, regardless of the truthfulness of the beliefs about Peano or the description of the name ‘Peano,’ ‘Peano’ refers to the person Peano. The truthfulness of the descriptions has no influence on the reference of the names.

According to descriptivism, the notion of definite descriptions is supposed to explain the references of proper names. However, Kripke’s three arguments show that the references of the names are irrelevant to definite descriptions—the references of names do not depend on definite descriptions. Therefore, descriptivism does not hold.

3. Necessary properties of natural kinds and the rigidity of kind

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86 Ibid., pp. 84-85.
terms

Since descriptivism is denied by his three arguments, i.e. the semantic, the modal, and the epistemic arguments, Kripke suggests rigidity of proper names.

Subsequently, he believes that rigidity applies to natural kind terms, as well.

Kripke appeals to possible scenarios to argue that proper names are rigid designators. Consider the two statements ‘9 is greater than 7’ and ‘the number of planets is greater than 7.’ It is difficult to imagine any possible situation where the statement ‘9 is greater than 7’ would be wrong. Even in an ancient society or a tribe in a remote jungle, the truthfulness of ‘9 is greater than 7’ would apply in both scenarios. Kripke claims that ‘9’ is therefore a rigid designator, because ‘9’ refers to 9 in all possible scenarios. On the other hand, ‘the number of planets’ is a different case. We could imagine that the number of planets might be otherwise.

In fact, it was not until 1781 that the seventh planet, Uranus, was discovered.

Therefore, the number of planets was six before 1781. We may discover more planets in the future. Therefore, ‘the number of planets’ is not rigid.87

87 Ibid., pp. 48.
I provide another example to illustrate the rigidity of proper names.

Consider the statements ‘Barack Obama is the President of the United States in 2016’ and ‘Barack Obama is the first African-American President’. The US President in 2016 could have been someone else, and Obama could have done something other than be the first African-American President. Obama could have chosen another career, married another woman, and taken another life journey.

In that case, virtually all the descriptions about Obama nowadays would be wrong. However, it is hard to imagine a scenario where Obama is not Obama. The name ‘Barack Obama’ refers to the person Barack Obama regardless of his life journey. That is, the name ‘Barack Obama’ is rigid, for there are no possible scenarios where Obama is not Obama. Indeed, Obama might have been named differently at birth. But this is not the point of the argument. The point is that a name refers to a person, and this reference remains in all possible worlds. There are no situations where this reference changes, and the name suddenly refers to another person. Since proper names refer to their referents in all possible scenarios, their rigidity is proved.
I divide Kripke’s account of rigidity of natural kind terms into two parts. The first part is his claim that natural kinds remain unchanged if their contingent properties turn out to be otherwise, because contingent properties have no influence on the identities of natural kinds. The second part is his claim that there are essential properties of natural kinds, and they make natural kind terms rigid. The individual things with the essential properties are the kinds in all possible worlds. The kind terms thus refer to those individual things with the essential properties rigidly; the kind terms are thus rigid designators.

The first part of the account begins with an example: suppose that gold is, in fact, blue; however, due to some optical illusion, gold appears yellow. Further, suppose that scientists someday discover that gold is actually blue. Would, Kripke asks, there be an announcement in the newspaper that gold does not exist? No, instead there would be an announcement that although gold was previously thought to be yellow, gold has, in fact, turned out to be blue.88

Kripke holds that the contingent properties of gold have nothing to do with

88 Ibid., pp. 128.
the identity of gold. This example shows that when we find that one of the properties of gold turns out to be otherwise, the consequence is that some knowledge of gold is updated, and the identity of gold remains. However, when some knowledge of gold is updated, what remains unchanged? If gold turns out to be blue, and our knowledge of gold is updated, what constitutes the knowledge of the identity of gold? Kripke holds that what remains unchanged is the spreading connection between gold and ‘gold’ in the linguistic community.

When people originally discovered gold, recognized gold as a natural kind, and labeled it ‘gold,’ the connection between the object gold and the label ‘gold’ was built, and the connection spread throughout the linguistic community. That connection remains unchanged even when new properties of gold are discovered. That is, the connection between gold and ‘gold’ remains, even though an identifying mark of gold is updated. Kripke suggests that being yellow is an identifying mark of gold. We have many identifying marks of gold, such as the color or the hardness. However, these identifying marks have no influence on the identity of gold. In comparison, iron pyrites are very similar to gold in
appearance, but they are not gold.

The second part of Kripke's account is to show that natural kinds have essential properties. Kripke does not regard properties of appearances of natural kinds as necessary; rather, he holds that they are all contingent. On the other hand, he believes that a natural kind has essential properties—which are the necessary properties of the kind and make a group of things into the kind necessarily. Regarding the example of gold, he writes:

Gold apparently has the atomic number 79... Is it a necessary or a contingent property of gold that it has the atomic number 79? Certainly we could find out that we were mistaken. The whole theory of protons, of atomic numbers, the whole theory of molecular structure and of atomic structure, on which such view are based, could all turn out to be false... gold could turn out not to have atomic number 79. Given that gold does have the atomic number 79, could something be gold without having the atomic number 79? Let us suppose the scientists have investigated the nature of gold and have found that it is part of the very nature of this substance, so to speak, that it has the
atomic number 79.\textsuperscript{89}

Kripke's argument for the rigidity of natural kind terms is based on the assumption that natural kinds have necessary properties that are the essence of the kinds. These necessary properties are discovered by science, and we suppose that science tells us true necessary properties of kinds. Necessary properties or essences of natural kinds make it possible to hold that kind terms are rigid. In the case of gold, its necessary property is its atomic structure with 79 protons.

Kripke claims that we cannot imagine gold without attributing the atomic number 79 to it; we cannot imagine something with the atomic number 79 without its being gold. With this consideration, he holds that 'gold' refers to whatever has the atomic structure with 79 protons in every possible world. Thus, 'gold' is rigid. The reference between 'gold' and anything with the atomic structure with 79 protons is rigid. In short, Kripke holds that the reference of a kind term is between the term and the things that have the essences of the kind.

To illustrate, since gold has the atomic number 79 in every possible world, 'gold'

\textsuperscript{89} Ibid., pp. 123-124.
refers to au-79 rigidly. Similarly, since water is $\text{H}_2\text{O}$ in every possible world, ‘water’ refers to $\text{H}_2\text{O}$ rigidly.

4. Criticisms on the rigidity of kind terms

I agree with Kripke that proper names are rigid,\textsuperscript{90} because proper names are for individual things that can be directly baptized—names directly label the individual things. However, natural kinds are not individual particulars that can be directly baptized. It is problematic to apply rigidity to natural kind terms. Even though Kripke asserts that the rigidity of a kind term holds between the term and things with the same essence, he does not provide arguments for the claim of essence nor does he defines the term ‘essence.’

Moreover, Kripke’s account ignores the fact that some kind terms mean more than their kinds. For example, ‘element’ means an element in the periodic table and also means a basic unit of something. ‘Diamond’ means a kind of jewelry and also means “60 years” in the context of a wedding anniversary, i.e., diamond anniversary. ‘Apple’ means a kind of fruit and a brand of computer.

\textsuperscript{90} Kuhn also endorses the claim that proper names are rigid. See Thomas Kuhn, “The road since structure,” \textit{Proceedings of the Biennial Meeting of the Philosophy of Science Association}, Vol., 1990, Volume two, Symposia invited paper, pp. 3-13.
These cases show that kind terms are not just rigid designators; there are examples where they mean something other than their referents.

Kripke may respond that the topic in question is natural kind terms; it is irrelevant when kind terms mean something other than their kinds. But even when kind terms mean their kinds, Kripke’s account does not account for cases where the meanings of kind terms are more fine-grained than their referents. The account is unable to explain the case that, say, ‘hearted thing’ and ‘livered thing’ mean differently, though they might have the same referents. Animals that have a heart may also have a liver. Thus ‘hearted thing’ and ‘livered thing’ may share the same extension, and ‘hearted thing’ and ‘livered thing’ may refer to the same referents. If the meaning of a kind term is decided by its referents, then ‘hearted thing’ and ‘livered thing’ should have the same meaning. However, it is obvious that ‘hearted thing’ has a different meaning than ‘livered thing.’

What follows are my detailed criticisms of Kripke’s theory of kind terms. They concern two main topics: first, the argument for the rigidity of kind terms and, second, the relationship between the rigidity of kind terms and science.
A. The argument for the rigidity of natural kind terms

Kripke's argument for the rigidity of natural kind terms is based on the claim that natural kinds have essences that maintain their identities in different possible worlds. However, the claim of the essences of natural kinds has been disputed. For example, Brakel notes that it is not always clear to what 'H₂O' refers. It could refer to one molecule, to a set of similar molecules, to the molecular structure, or to the chemical composition. Even if granted that the essence of water is the property of being H₂O, it is not clear to what 'water' refers, since it is not clear to what 'H₂O' refers.

The claim of the essences of natural kinds is easy to attack, which I have discussed in chapter one, but I shall also point out that Kripke's argument for the rigidity of kind terms is circular. Kripke supposes, in particular, that the essence of gold is the property of having the atomic structure with 79 protons and

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whatever has this atomic structure is gold. Thus gold as a kind remains the same in different possible worlds, and 'gold' refers to gold rigidly. For 'gold' refers to whatever has the atomic structure with 79 protons in all possible worlds.

According to Kripke, 'gold' is supposed to refer to a certain kind of existents in all possible worlds. But what is this kind of existents? Kripke supposes that this kind of existents is whatever has the atomic structure with 79 protons. Since the term 'gold' should refer to this kind of existents, 'gold' refers to whatever has this property. Kripke claims that there is no possible scenario in which gold is something without this property, or in which something with this property is not gold.

But why it is not imaginable that gold does not have this property? It is because Kripke claims in the first place that gold is something with this property. Therefore, to imagine something without this property is to imagine something else. According to Kripke's definition of gold, to imagine something that does not have the atomic structure with 79 protons is to imagine something that is not gold. Since Kripke asserts the premise that gold has this certain essence, he
constructs the rigidity of ‘gold’—‘gold,’ following from his premise, necessarily
refers to whatever has this essence. The argument is laid out as follows:

Premise: gold has the essence of having the atomic structure with 79
protons.

1. In all possible worlds, whatever has the essence of having this atomic
   structure is gold.

2. ‘Gold’ refers to gold in all possible worlds.

3. ‘Gold’ refers to whatever has the essence of having this atomic structure
   in all possible worlds.

4. Since ‘gold’ refers to whatever has the essence of having this atomic
   structure in all possible worlds, ‘gold’ is rigid.

To sum up, Kripke first supposes that gold is something that has the atomic
structure with 79 protons. Then he claims that ‘gold’ refers to gold. Finally, he
concludes that ‘gold’ refers to whatever has this atomic structure. However, since
he supposes that gold is something that has this atomic structure in the first
place, how could ‘gold’ refer to something without this property? If he did not
define what gold is in the first place, ‘gold’ might very likely refer to something not having this atomic structure. In such a case, his claim that ‘gold’ refers to whatever has the atomic number 79 in every possible world would turn out to be false.

Furthermore, the argument for the rigidity of natural kind terms is based on an assumption that the scientific theory we have now is and will always be true, which Kripke offers no arguments to support. The consequence of this assumption is his belief that science reveals the essence of gold, and the essence holds in all possible worlds. However, is it true that science reveals the ultimate essence of a kind? Obviously, it is not. Throughout the history of science, there have been a lot of modifications in theories of kinds. What we regard as true of gold today may be false tomorrow. Therefore, Kripke’s argument is based on an questionable assumption. If we cannot be sure that science reveals the essence of gold, we cannot be sure of the essence of gold. When we cannot be sure of the essence of gold, the claim of the rigidity of ‘gold’ does not hold, because ‘gold’ refers to whatever has the essence of gold, according to the argument.
Moreover, there can be cases where existents share the same fundamental feature but they are not grouped as one kind and where existents grouped as one kind not by their fundamental features. In such cases, it would be difficult for Kripke to make a claim about the essence of those existents and hold that their essences allow them to be kinds. In particular, the molecular structures of sand, quartz, obsidian, and glass are all SiO₂. However, the fact that they share the same molecular structure does not make them the same kind of thing. As Barnett remarks, ‘these are three different forms, or allotropes, of solid SiO₂...While it may be true that quartz is necessarily composed of SiO₂, it is not the case that SiO₂ necessarily forms quartz. If both ‘Quartz’ and ‘SiO₂’ are rigid designators, then they do not rigidly designate the same thing.’⁹³ Scientists may discover more facts about gold and other natural kinds. Which facts are qualified as the essences of them? Kripke provides no answer to the question as to which of these facts would qualify as essences. Meanwhile, Kripke’s claim of the rigidity of kind terms is refuted by the case of ‘quartz,’ and ‘SiO₂,’ for quartz is SiO₂ in all

possible worlds, while SiO$_2$ is not necessarily quartz. Also, creatures in the kind mammal, carnivore, homeotherm, and poikilotherm are not defined as kinds by their fundamental features. Rather it is their particular way of reproduction, habitus, or body temperature makes them one kind. A tiger is a mammal, a carnivore and a homeotherm at the same time; according to Kripke, however, what is the essence of a tiger? In short, the claim that existents are defined as kinds by their essences does not apply in these kinds.

Kripke either admits that there are many modifications in the history of science and abandons the claim of the rigidity of natural kind terms, or he maintains his claim but ignores the modifications in the history of science. If Kripke admitted that modifications in theories of kinds lead to modifications in taxonomies or reclassification of kinds, and that modifications happen often in the history of science, his account would be that the reference of a kind term holds only within a particular scientific theory. He would hold, for example, that ‘aether’ refers to the fifth element that makes up the star in a certain theory, and ‘aether’ refers to a mass-free medium that fills up the universe in another theory.
However, this would force him to abandon his claim of the rigidity of kind terms. In short, the claim of the rigidity of kind terms is not compatible with the fact of science's progression and has many inapplicable cases.

Philosophers who sympathize with Kripke may respond that modifications in theories of kinds do not lead to reference changes. Donnellan, for example, writes that "people in Locke's day might have called some stuff 'salt' that we would not but that does not show that the extension is different, only that people in Locke's day made mistakes which they had no means to correct." Kripke may agree with Donnellan and hold that there are no extension changes of a kind term, only corrections of mistakes that people made in the extension of the kind term.

However, this claim begs the question. First of all, it denies the possibility of extension changes, for any change in the extension would be counted as correcting a mistake. An extension change would never happen, even though the theory of the kind is corrected and this changes the referents of the kind term.

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Secondly, since there is no possibility of extension changes, there is no possibility of kind terms that are not rigid. However, how can a kind term possibly be rigid when the possibility of not being rigid is canceled? Since the possibility of a kind term being not rigid is canceled in the first place, the kind term is constructed to be rigid necessarily. Thus, Kripke does not prove that a kind term is rigid. Instead, he constructs the rigidity of the kind term.

Moreover, since there is always a possibility of correcting the extension of a kind term, we cannot be sure that the current extension of a kind term is appropriate and correct. That is, we cannot be sure of the true extension of a kind term. Consequently, since the extension of a kind term comprises referents of the term and we cannot be sure of the true extension of the kind term, we cannot be sure the referents of the term. I believe Kripke would want to avoid this consequence.

**B. The rigidity of kind terms and science**

1.

Jussi Haukioja discusses the notion of ‘actuality-dependent.’ She explains
that natural kind terms are actuality-dependent because the extensions of kind
terms are determined by the features of the kinds in the actual world, while the
extension of some other kind terms are determined solely by their definitions.

For example, Haukioja writes “‘water’ is actuality-dependent, since its extension
in non-actual worlds is partly determined by the structure of the stuff we
actually refer to, with our tokens of ‘water.’ ‘Bachelor,’ by contrast, is not
actuality-dependent, since its extension in non-actual worlds is not determined
on any features of the actual bachelors, but is rather determined by the very
same criteria as its actual extension.”

Haukioja may imply that all natural kind terms are actuality-dependent;
however, I hold that kind terms such as ‘electron’, ‘heat’, and ‘neutron’ are
counterexamples to this claim. Take the case of neutrons. All people, including
scientists, have indirect and remote contact with neutrons. The contact happens
mostly in a laboratory or a nuclear power plant, through machines, monitors,
and theoretical models. No one really sees or touches a neutron. The natural kind

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neutron is, in fact, an outcome of a series of physical events that a certain theory predicts successfully. Regarding the case of neutrons, what exactly is the acquaintance that people have with neutrons? Is a neutron something that in the nuclear model appears in a physics textbook? Is a neutron something that we infer by certain data when we observe the outer layer of the atmosphere? Or is a neutron the source that makes certain effects happen in a nuclear power plant? What are the features of a neutron that determine the extension of 'neutron' and make 'neutron' actuality-dependent? We have no acquaintances with any tokens of neutron. In such a case, the features of the kind neutron do not determine the extension of 'neutron.' For the kind neutron is, in fact, a scientific model describing a series of physical events. The extension of 'neutron' in a non-actual world is not determined by the stuff we actually refer to; the stuff that we actual refer to is actually a scientific model.

Furthermore, it is problematic if we apply Kripke's account of reference to the case of neutron. Kripke holds that the reference between a kind term and its kind is between the term and the things that have the essences of the kind.
However, there are kinds that people have no contact with until experiments later prove their existence. For example, scientists proposed the neutron’s existence in the 1920s, but its existence was not proven until 1932. Between 1920 and 1932, the existence of the neutron was an hypothesis. In this situation, one could not claim that ‘neutron’ referred to the particles that have the essences of neutron, for the very existence of neutrons was not yet proven and people had no acquaintance with it.

According to Robert Nola, Kripke might respond that “we can fix the reference (but not thereby give the intension) of the term ‘light’ by causal descriptions such as ‘whatever, out in the world, affects our eyes in a certain way’, and fix the reference (but not thereby give the intension) of the term ‘heat’ by ‘whatever gives us a certain sensation which we call the sensation of heat’.”

However, even if one is satisfied with this response, it does not explain the case of a kind that is an hypothesis. How can people claim essences of something when they don’t know of its existence and have no acquaintance with it?

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The connection between neutron and ‘neutron’ cannot be simplified into baptizing or any naming ceremony because there are no samples of neutron to be directly baptized. The connection cannot be simplified into ‘neutron’ and the particles that have the essences of neutron, because neutron is itself a scientific model and it is not appropriate to claim essences of a scientific model. Kripke’s claim that the reference of a kind term is between the term and the things that have the essences of the kind does not apply to kinds such as neutron, proton, and electron. Kripke’s claim about the reference of kind terms owes us explanations when it comes to theoretical kinds.

2.

Kripke’s claim about the rigidity of kind terms has many counter examples. Take Kripke’s own example, gold, to illustrate. According to Kripke, ‘gold’ is rigid, ‘gold’ refers to gold in every possible world, and gold is the metal with the atomic number 79. However, there are five isotopes of gold; ‘gold’ refers to each of them, and their atomic numbers are not 79. The isotopes are Au-195, Au-196, Au-198, Au-199, and Au-197. Among them, Au-197 can be found in natural environments;
the rest are artificial. Contrary to Kripke’s claim, the kind term ‘gold’ refers to
something other than Au-79, and there are things other than Au-79 that are in
the extension of ‘gold’. Therefore, it is false to claim that ‘gold’ refers to whatever
has the atomic structure with 79 protons. The reference between ‘gold’ and
whatever has this atomic structure is not rigid, because scientists may add or
delete items under the category gold, which would add or delete referents of
‘gold’. The same argument applies to all other elements and compounds. For
example, ‘water’ refers not only to H₂O but also its isotopes, in particular, D₂O,
DHO, and H₂¹⁷O. ‘Water’ may also refer to the isotopes discovered in the future.

Furthermore, references of kind terms do change. Some kind terms refer to
things with different features in different historical periods. The term ‘aether,’
for example, has a long history. In Greek times, Aristotle held that ‘aether’
referred to the fifth element, the finest element that made up the sun, the planets,
and the stars. In the 19th century, ‘aether’ referred to the mass-free medium that
filled up the universe. Scientists at that time believed that light needed a medium
to transfer, just as sound transfers through air. They believed that light was a
wave, and aether was the medium to transfer it. Therefore, they held that the
universe was filled with aether, and light transferred from the sun to the earth
through aether. Nowadays we don’t believe that aether exists at all. We know
that particles, cosmic rays, void, and many other unknown things fill the universe,
and light does not need a medium to transfer. The term ‘aether’ now refers to
nothing. This is a clear example that a kind term changes its referent from time
to time.

Similar cases include ‘element’ and ‘phlogiston.’ Scientists continue to add
referents to ‘element’ in the periodic table, as they discover additional elements
with the developments of science. In particular, the newly found element
nihonium was officially recognized in 2015 and named in 2016. The reference of
‘element’ was expanded with a new referent, i.e., nihonium. On the other hand,
scientists used to believe that things required phlogiston to burn, but they later
found out that burning is for a thing to be oxygenized. Thus, there exists no such
thing as phlogiston; ‘phlogiston’ changes its reference from a hypothetical thing
to nothing.
3.

Kripke writes “scientific discoveries of species essence do not constitute a change of meaning.”\textsuperscript{97} For Kripke, a natural kind term is as a proper name: the information of the kind, as the information of the referent of a proper name, does not constitute the meaning of the kind term. A kind term and a proper name mean their referents, period. However, the claim that scientific discoveries don’t change the meaning of kind terms does not apply to terms such as ‘mammal,’ ‘fish,’ and ‘bird,’ which are themselves categorical terms for the biological taxonomy and include many different subclasses. To illustrate, when biologists transfer whale from a subclass of fish to a subclass of mammal, whale is deleted from the referents of ‘fish’ and is added to the referents of ‘mammal.’ Since whale was deleted from the referents of ‘fish’ and ‘fish’ does not mean whales anymore, ‘fish’ changed its meaning. ‘Mammal’ also changed its meaning because it now stands for more things, namely whales.

Mellor gives an explanation of Kripke’s claim of essential properties of

natural kinds. He says that 'the necessity of essential properties is metaphysical, not epistemic. The claim is that things of a kind have its essential properties in all possible worlds, not that its essential properties are knowable a priori.'

However, given the necessity of the essences of each thing, the rigidity of kind terms still cannot be secured. The necessary properties of kinds do not follow from the necessary properties of individual things. Different individual things could share different sets of essences; the determination of kinds is thus not necessary. Say there are three individual things, a, b, and c, with the essences A and B, B and C, and C and A, respectively. When the essence of B is considered, a and b are a kind; when the essence of C is considered, b and c are a kind. Thus, given the necessary properties of each particular, there are still no necessary essential properties of kinds because individual things could be grouped into kinds in different ways.

Furthermore, the extension of a kind term is supposed to be relevant to the discoveries of the information of the kind. To illustrate, the extension of ‘gold’,

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according to the scientific theory of gold we have today, is the elements with the atomic number 79 and its isotopes. Scientific theory of a kind tailors the extension of the kind term. The referents of ‘gold’ are defined by the theory of gold. If the scientific discoveries of gold have nothing to do with the meaning of ‘gold,’ according to Kripke’s theory, they should have nothing to do with the extension and the referents of ‘gold.’ If this is the case, what should be responsible for deciding the extension and referents of a kind term? Kripke suggests no alternatives in response to this question other than science. Thus, the claim that scientific discoveries are irrelevant to the meaning of a kind term is not compatible with the claim that extension and referents of a kind term are determined by science.

To sum up, Kripke holds that natural kind terms are rigid designators. ‘Gold’ refers to gold in every possible situation. One would have difficulty thinking of a scenario where ‘gold’ does not refer to gold. However, what is gold? Different individual existents can all be entitled ‘gold.’ What is the rule that decides which existents should be entitled ‘gold’? Kripke’s answer is that since science reveals
the essence of gold as anything with the atomic structure with 79 protons, gold is
whatever has it. Having this atomic structure is the rule for what should be
entitled ‘gold.’ Since it is not possible to think of a scenario where ‘gold’ does not
refer to gold, ‘gold’ refers to gold in every possible situation and thus ‘gold’ is
rigid. In other words, ‘gold’ refers to whatever has the atomic number 79 in
every possible situation.

This argument has two major problems: it begs the question and it is based
on an inappropriate assumption. Kripke supposes that a kind has essences, and
the essences make the identity of the kind. For example, having the atomic
number 79 is the identity of gold. However, Kripke sets the rule in the first place
that gold is something with this property; the consequence is that ‘gold’ refers to
whatever has this property. Otherwise, ‘gold’ does not refer to gold. That is, the
conclusion that ‘gold’ rigidly refers to whatever has a certain property is deduced
from the premise given in the first place that the kind gold has a certain property.

Thus, the argument begs the question.

The second major problem is that kind terms change their references with
the developments of science. Kripke’s argument is based on the assumption that science reveals the essences of kinds. Therefore, he thinks that it is appropriate to suppose that gold is and always will be the metal with the atomic number 79. However, it is shown from the history of science that science is progressive. Unless science no longer makes modifications or corrections, I don’t think it is appropriate to suppose science will never revise the essences that it asserts about a kind. Additionally, there are kinds that don’t seem to have distinctive essences, for example, river, stream, creek and brook.

Even granting that science reveals the essences of kinds, scientists keep updating and refining theories of kinds. Thus, I believe that no scientist would claim that the essences he attributes to a kind are ultimate and will never need updating or revision. The claim that science uncovers the essences of a kind—and the argument of the rigidity of natural kind terms based on this claim—is not realistic.

5. **Replies to the modified arguments**

I modify Kripke’s three arguments against descriptivism into arguments
against my account of natural kind terms, and I respond to them in this section.

The original epistemic argument is that even when someone has false
descriptions about a name, the name still refers to its referent. I modify this
argument into one in which someone has false information about a kind, but his
utterance of the kind term still refers to the kind. In this situation, I hold that the
speaker would have difficulty communicating with other people. For example,
someone who thinks that ‘elm tree’ refers to a kind of computer would have
difficulty talking about the topic of elm trees. His knowledge of elm tree and his
usage of ‘elm tree’ are too different from other people’s commonsense
knowledge and usages. What he means by ‘elm tree’ would not be understood by
other people in the linguistic community.

The original semantic argument is that when someone has vague and
unclear descriptions about a name, the name still refers to its referent. This
argument is modified as follows: someone has vague and unclear knowledge
about a kind, but his utterance of the kind term still refers to the kind. In this
situation, I hold that the speaker could address the topic of the kind, but he may
eventually modify his knowledge of and learn more about the kind, so that what
he knows about the kind becomes more consistent with other people's
commonsense knowledge in the community. For example, someone who thinks
that ‘Chow Chow’ refers to a police dog could communicate with other people
about Chow Chows and police dogs. But the more he discusses the topic, the
greater the chance that he and the other people in conversation with him will
realize that his knowledge of Chow Chow and his usage of ‘Chow Chow’ need
correction. His knowledge of Chow Chow and his usage of ‘Chow Chow’ may
eventually be consistent with other people's knowledge and usages in the
linguistic community.

The reference of a kind term does not depend on private mental statements.
A speaker's vague or false information of a kind do not determine the reference
of the kind term. The reference of a kind term depends on the mutual
understandings of the kind in the dialogue—in which the understandings are
shared by the persons in the dialogue—or the reference depends on the
collective knowledge of the kind within the linguistic community—in which the
knowledge is shared by typical speakers in the linguistic community. In the case where the speaker has vague information of a kind—for example, he believes that ‘Chow Chow’ refers to a police dog—as long as other speakers in the dialogue have the knowledge that ‘Chow Chow’ refers to Chow Chow, ‘Chow Chow’ refers to Chow Chow. Collective speakers’ knowledge of Chow Chow determines the reference of ‘Chow Chow.’ The reference of ‘Chow Chow’ does not depend on the speaker’s private vague understanding of Chow Chow. The collective knowledge of Chow Chow is more salient than the speaker’s own information when determining the reference of ‘Chow Chow.’ On the other hand, when all the speakers in a dialogue have false information about a kind, the kind term would not refer to its correct referents. For example, in a dialogue where all the people involved believe that ‘elm tree’ refers to a kind of computer (they may believe that a new kind of computer is named ‘elm tree’), ‘elm tree’ then stands for a kind of computer within this dialogue. These two examples show that the mutual or the collective knowledge of a kind determine the reference of the kind term. What matters for determining the reference of a kind term is not the
individual speaker’s understandings of the kind.

The original modal argument is that the referent of a name could have been otherwise, but the name still refers to its referent. I modify this argument into a question: if the story of a kind had been otherwise what would the reference of this kind term have been? For example, if the isotopes of gold had not been discovered, what would the reference of ‘gold’ have been? Obviously, ‘gold’ would not refer to isotopes of gold if the isotopes were not discovered, for there would be no information about them, and thus no terms for the isotopes. Take water as another example. If water had not been discovered existing in three states, what would the reference of ‘water’ be? In this situation, ‘water’ would not refer to ice and steam, as there would be no knowledge that ice and steam are the other states of liquid water unless we discovered or noticed other resemblance between ice, steam, and liquid water and made them into a kind based this resemblance.

The knowledge about a kind determines the reference of the kind term. The discovery of the isotopes of gold makes ‘gold’ refers to gold and isotopes of gold.
The reference of ‘gold’ is changed as more information is discovered about gold.

Similarly, as more information about water is discovered, more knowledge about water are generated, the knowledge may change the reference of ‘water.’

6. Conclusion

This chapter begins with a brief introduction of descriptivism, which Kripke attacks and by which he develops his theory of rigidity. The rigidity of a proper name is proved by the necessary truth that the reference of the name cannot be otherwise. The essence of a kind is the reason Kripke asserts the rigidity of a natural kind term. The problem is that the theory of the rigidity of natural kind terms presupposes essentialism, which is controversial because of facts in the history of science. Some kinds do not have distinctive essences, such as river, stream, creek, and brook; other kinds are given different essences in different historical periods, such as water; some kinds are defined by habitus, modes of reproduction, anatomical features or temperature, such as carnivore, mammal, marsupial, and homeotherm; and yet other kinds are given essences that cause philosophical debates that last hundreds of years and have not yet reached
consent, such as human being. Furthermore after addressing Kripke’s theory of rigidity and presenting my criticisms to it, I end this chapter with responses to the modified epistemic, semantic, and modal arguments.
Chapter Five: Conclusion

How are referents of a kind term decided? Scientific stipulation is a straightforward answer to this question. But, how does the stipulation happen? Putnam argues that the collective body of the scientific community possesses ways to identify a kind. The kind term refers to whatever is identified as the kind.

Kripke tells a similar story. He claims that science dictates the essence of a kind and that a kind term refers to whatever has that essence. Roughly speaking, Putnam and Kripke hold that scientists stipulate the connection of a natural kind term and its kind. However, Putnam does not specify how scientists identify kinds, and Kripke does not specify how essences of kinds are determined. Kuhn provides a more specific account of how kind terms connect to their kind. He holds that a particular scientific paradigm address their kinds in a certain way, so natural kind terms need to be understood with respect to a paradigm.

However, I propose that knowledge of a kind, whether scientific or not, can also enable people to know its term and to use the term to refer to the kind. When individual things are recognized as a kind, it means that some knowledge can be ascribed to them. People have the knowledge that they resemble one another in
certain ways and they know that what is true for one example can be true to all
the members of the kind.

This dissertation presents Kuhn's, Putnam's, and Kripke's theories of natural
kind terms. I suggest criticisms to these theories and propose the claim that
knowledge about a kind, scientific or not, allows people to know its term and to
use the term to refer to the kind. Possible candidates to account for connections
between natural kind terms and their kinds are not just scientific stipulations or
paradigms but also knowledge.

Chapter one gives my account of natural kind terms, which is based on a
discussion of definitions of 'natural kind.' A natural kind includes existents that
resemble one another in certain respect or respects, and these resemblances can
generate knowledge about the existents as a kind. I present three cases of
natural kinds and discuss their terms. The case of neutrons shows that a
particular scientific account about a kind enables people to know what its term
stands for. The case of whales shows that a kind term can be made meaningfully
employed in different scientific accounts. The case of water shows that a kind
term can be used in scientific and non-scientific discussions. I remark on Kripke's
account of the reference of natural kind terms and suggest that the reference is based on the linguistic community’s recognition of the kinds. Because most people in a linguistic community know for what a natural kind stands, there can be reference of the term.

In chapter two, I present Kuhn’s theory of natural kind terms—different paradigms can provide different concepts for a kind term because paradigms may address the kind differently. Thus, a kind term needs to be understood with respect to a particular paradigm. However, Kuhn’s account does not note that some kinds and their terms are precedent to scientific theories and paradigms. Languages used by isolated tribes where there are no scientific practices contain kind terms such as ‘water.’ A five-year-old without any scientific education acquires kind terms such as ‘dog’ and ‘banana.’ Natural kind terms are used in scientific and non-scientific discussions.

In chapter three, I discuss Putnam’s Twin Earth argument and his account of reference. I agree with the idea defended by the Twin Earth argument that psychological states in the narrow sense do not determine the extension of a kind term. However, the argument itself is problematic. First of all, ‘determining
the extension of a kind term’ is ambiguous. When it means ‘delineating the
contour of a kind term,’ the defended claim is either not interesting (intension
alone does not delineate the contour of a kind term) or not true (intension does
not play any role in delineating the contour of a kind term). When it means
‘referring an example of a kind,’ the argument is irrelevant. (The duplicates do
refer to examples of water. It is irrelevant whether they refer to the examples of
H\textsubscript{2}O or XYZ.) Second, the story of scientists’ arriving the Twin Earth indicates
that the assertion of the rigidity of ‘water’ and the claim that intension does not
determine its extension are not compatible. Third, by modus tollens, the
situation that the extension of ‘water’ includes XZY—a negation of the situation
that the extension of ‘water’ is H\textsubscript{2}O—results from the claim that the intension of
‘water’ does not determine its extension. That is, Putnam’s intended
claim—intension of a kind term does not determine its extension—could be
inferred by denying his own assertion from the Twin Earth scenario. Finally,
there are no cases of two extensions of a kind term—there are only cases of
multiple constituents in the extension.

Putnam holds that a kind term refers to whatever bears the sameness
relation to an example of a kind and is rigid. However, scientists do change the referents of kind terms. For example, the isotopes of gold have been added to the referent of ‘gold.’ Therefore, a natural kind term is not a rigid designator.

Chapter four begins with Kripke’s discussion of descriptivism. The descriptivist claims that names are abbreviated definite descriptions. Kripke suggests three arguments against descriptivism, and he suggests that names and kind terms are instead rigid designators. He argues that contingent properties have no influence on the identities of natural kinds. There are essential properties of natural kinds, and they make natural kind terms rigid. Things with the essential properties belong to the kinds in all possible worlds. The kind terms are thus rigid because they refer to whatever have the essential properties in all possible worlds.

However, the claim that kind terms are rigid is based on the inappropriate assumption that science determines the ultimate essences of kinds. There have been many modifications throughout the history of science, and science has assigned different essences to the same kind in different historical periods. For example, in Greek times, ‘aether’ referred to the fifth element. In the 19th
century, ‘aether’ referred to a mass-free medium that fills up the universe.

Nowadays we don’t believe that aether exists. Moreover, Kripke’s argument for the rigidity of kind terms is circular. In particular, Kripke supposes that gold is something that has the atomic number 79; then, he claims that ‘gold’ refers to gold; finally, he claims that ‘gold’ refers to whatever has the atomic number 79.

But, given his premise that gold has the essence of having the atomic number 79, ‘gold’ is constructed to refer to things with that essence rigidly. Finally, some kinds are themselves scientific models; it is not appropriate to claim essences of them.

This dissertation proposes a new approach to the issue of natural kind terms. It offers a semantic externalist view without asserting the rigidity of kind terms. The reference of a kind term and the connection between a kind term and its kind can be based on knowledge about the kind. By understanding natural kind terms in terms of knowledge, which can be generated by everyday life activities and be irrelevant to scientific accounts of the kinds, the meanings of natural kind terms can be viewed within and outside the context of science.

Knowledge of kinds offers a more inclusive context for kind terms.
Bibliography


