Predicate Meets Property

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(i)

When we speak of a predicate's extension, we intend to delineate the class of objects of which it is true. Unfortunately, in some common situations the proper ground for determining whether a predicate is true of a particular individual becomes uncertain or ambiguous. One kind of situation in which this can happen—the kind of situation I will be particularly concerned with in this paper—is one in which the linguistic community is unaware of the existence of kinds of objects to which a predicate might be thought to apply. It is frequently indeterminate whether such unexpected objects should be assigned to the extension or to the counter-extension of the predicate. This common phenomenon suggests deeper issues concerning the rationale for our intuitive extension assignments. I shall discuss some real life examples of this phenomenon, but it will be convenient to begin with a simple fictional case.

I once saw a movie (Island of Lost Women) in which a colony of Druids drifted in ancient times to a South Sea island, where they were subsequently terrorized by cavemen and out-takes from One Million B.C. Their descendants, naturally, were able to speak a variety of English, albeit with miscellaneous archaic features. A B-52 full of regular American types landed on their uncharted island and the Druids exclaimed, “Lo, a great silver bird falleth from the sky.” Aside from the local avian population, this bomber was the first flying device the Druids had ever seen. During the course of the movie at least, the Druids were notably loath to learn new vocabulary like “airplane” and we can imagine that this syntactic conservatism persisted through their eventual integration into the modern world. Airplanes, helicopters and dirigibles are now called “birds” in the Druidic dialect and true aves are specially denoted by compound phrases like “feathered birds.” It is clear that the extension of the predicate “is a bird” for the cosmopolitan Druidese is something like the set of flying devices (including animal varieties).

The crucial question for our purposes is what extension should a covert linguist have assigned to the Druid predicate “is a bird” in the colony’s pre-B-52 days? Should it be \( \{ x \mid x \text{ is a member of aves} \} \) or \( \{ x \mid x \text{ is a flying device} \} \)? A definitive answer will seem quite problematic, given a bit more background on the Druids. Let us assume that our pre-B-52 natives also possessed the following dispositional trait. If the hapless aviators had crashed in the jungle unseen and were discovered by the Druids six months later as they camped discontently
around the bomber’s hulk, their Druid rescuers would have proclaimed, “Lo, a
great silver house lieth in the jungle.” This appellation might stick and the later,
globe-trotting Druids would persist in calling all forms of aviation “flying
houses,” to be distinguished from “stationary houses” and “earthbound but mobile
houses.” Here airplanes are no longer held to be “birds.” If this history had
obtained, the extension in cosmopolitan Druidese for “is a bird” would be \{x \mid x \text{ is a member of } aves\} and for “is a house,” roughly, \{x \mid x \text{ is a man-made enclosure}\}. Which extension should be assigned to “bird” in cosmopolitan Druidese thus
depends upon the history of the introduction of B-52’s to the island (other possible
initiations into the modern world might have induced yet other extensions for
“bird”). In our first scenario, the B-52 clearly belongs to the extension of “bird” in
cosmopolitan Druidese, but our alternative possible development suggests that we
should not uncritically assign this same extension to the word in its earlier
employment. So here we have a predicate (“bird” in parochial Druidese) and a
rather hefty unexpected object (the B-52) which cannot be happily counted within
the extension or without.

The traditional response to our problem is to seek the “concept,” “sense,” or
“universal” the pre-bomber Druids had associated with “bird” and study the
extension determined by this intervening entity. A consequence of this account is
that the Druids in one or both of our alternative histories must have “changed the
meaning” of “bird”—i.e., switched its associated universal. However the Druids
themselves needn’t feel that they have modified or extended the meaning of “bird”
when they apply it to aircraft, for that classification appears spontaneously natural
to them in the circumstances. Upon reflection, post-bomber Druids might admit
that if they had seen the plane first in the jungle, they would have called it a
“house” and not a “bird,” yet cheerfully and consistently avow that they had not
altered “bird”’s meaning when they classified bombers as “birds.” And the
“house”-favoring Druids of our alternate history might make exactly symmetrical
claims. Although such Druid contentions may seem perverse or unpalatable, we
shall find that we make precisely analogous declarations about the developmental
history of our own language all the time!

An alternative response to our dilemma is to modify our notion of
“extension.” The classical treatment demands a choice between \{x \mid x \text{ is a member
of aves}\} and \{x \mid x \text{ is a flying device}\}, but such a selection seems tantamount to a
prediction about how the Druids will come to classify aircraft. The “semantical
facts” about prebomber Druids do not seem to warrant such extrapolation. If we
complicate our “extensions” somewhat, we can hedge against these forecasts.
Accordingly Hartry Field⁴ and others have suggested an assignment of a set of
“partial denotations” to predicates—i.e., a class of classical extension sets for each
predicate. Thus both of our candidate extensions will be “partial denotations” for
"bird." My own proposal in this paper represents a variation on this strategy, employing "implicit parameters" to tie the various "partial denotations" together.\(^5\)

Articulation of a precise formal device, however, is not the primary interest of this essay, which is instead to probe the grounds for its employment. The Druids may have been likewise unacquainted with kiwis, ostriches and other nonstandard specimens of *aves* and will not be inclined to call them "birds" upon first acquaintance. It is an anthropological fact\(^6\) that labeling an ostrich a "bird" will strike the natives as more of a distortion of meaning than any bomber dubbing. Nonetheless, our inclination is to assign the various avian oddities to parochial "bird," despite native truculence. Do we possess systematic standards for deciding whether an unexpected object can be fitted into a simple extension (as the kiwi) or instead mandate assignment of more complicated "partial denotations" (as the bomber)?

Although an acceptable criterion can be adduced for the present case, I do not believe that all of our intuitive hunches about the "proper extensions" of various predicates ultimately follow any simple pattern. Instead they seem to be the product of a tangled web of incompatible descriptive aims. Unfortunately acceptance of a traditional theory of meaning (as outlined in Section ii) has blinded us to these disparate purposes. My method for dealing with this situation will be as follows: after study of the related but simpler locution "device m can detect the property P," I shall extract a core notion of "extension" that captures in a crisp and systematic manner a portion of the empirical utility of the preanalytic notion. In particular, I shall insure that my reconstruction meets the following rough adequacy condition:

The evidence for assignment of an extension to a predicate should be limited to such linguistic behavior as can be reasonably extrapolated from the community's contemporaneous practice and should not reflect accidental features of the society's later history.

For example, the fortuitous mode of bomber arrival was responsible for the later Druid classificatory behavior, which should not be adduced as evidence about the proper extension of parochial "bird." On the other hand, study of pristine Druids may allow us to predict that they will eventually come round on the kiwi question and thus legitimate their assignment to the extension. Finally, in Section x, we shall study the prospects for extending my core treatment of "extension" consistent with this adequacy condition.

This program for building up, by degrees, an empirically sound notion of "extension" will be disdained as "operationalist" by many, especially those who view extension assignments as "theoretically determined" relationships. However,
the history of science has seen many instances when a notion has improved in scientific utility through a bit of "theoretical" disfranchisement. For example, consider the term "species" in zoology. Naturalists from Aristotle to Linnaeus regarded specieshood as a primitive theoretical property, assuming that it is manifest in nature when two animals belong to the same "natural kind" (although it may require diligent dissection to discover the hidden essential characteristics). However, actual difficulties in classification forced elucidation of a complicated and detailed set of criteria for specieshood, a list which is under continual revision. Although these standards are intended to reflect facts about the genetic nature and phylogenetic development of the animals classified, it nonetheless remains a strictly taxonomic notion and no biologist believes that specieshood means that much on a genetic level (i.e., dogs don't carry little messages "I am a Canis Familiaris" in their DNA). "Species" remains a central and indispensible concept in modern biology, but this theory does not free it from the need for criterial explication. The cry "don't be operationalist about 'species'" would have led to stagnation in biology, for it would have protected the "natural kinds" picture of animal life and obscured the variety of quite different mechanisms which produce genetic isolation in nature. The traditional theory of "extension" accords the term a relatively lofty status, free from much need for critical examination. However, I believe that this theory is mistaken and leads us to overlook many fundamental aspects of linguistic evolution. If "extension" is to survive as a useful taxonomic tool in linguistics, it will greatly benefit from some further explication and correction. I hope this essay will prove a useful start in that direction.

On the other hand, if the reader is currently inclined to accept the traditional view (or some appropriate modification thereof), my reconstruction may nonetheless have value as a vehicle for uncovering unnoticed facts about language. Einstein's methodology in "The Electrodynamics of Moving Bodies" may be profitably viewed from this vantage. His alleged "definition" of "simultaneity" actually consisted in the introduction of a new notion, simultaneity with respect to an inertial frame, whose classificatory utility in low velocity situations closely resembles that of the Newtonian absolute simultaneity. Since his new notion was explained by appeal to the behavior of light signals and since he misleadingly wrote of defining "simultaneity," he has frequently been read as an operationalist a la Percy Bridgman. The true motivation for his apparent "operationalism" was instead to delineate an empirical arena where classical theory was untested by experiment and to indicate the minimal conception of time order a rival theory requires to save the familiar facts about apparent simultaneity. Einstein would have readily admitted that such "analysis" would have proved completely sterile if his hunch about the infirmities of classical theory had not been empirical fruit. My reconstructed "extension" is likewise designed to mark
both the strengths and weaknesses of its classical original. In Section xi, we shall
examine certain uncomfortable aspects of the traditional account in light of the
data encountered en route.

My central idea is to tie sets to predicates by treating the term’s employers
as imperfect measuring instruments for a property with that extension. Motivation
for this approach will occupy us until Section v, whereupon my actual proposal
and its attendant case studies will follow.

(ii)

In this section, I shall briefly sketch the classical account of extension,
drawn from the works of Frege and Russell (their many differences in detail do not
affect our present concerns). They held that an intermediate entity exists which
forges a bond between predicate and set. These Platonic go-betweens were called
“senses” by Frege and “universals” by Russell. A predicate “P” will allegedly
denote a universal A, which in turn fixes the set \{x| x falls under A\}. The

correlation of attribute and language performs two functions:

1) The speaker’s “grasp” of the universal provides a necessary condition for
his understanding of the predicate. The attribute represents what he shares
in common with other speakers of the language with respect to the particular
bit of syntax.

2) On its own, the attribute determines a set of objects in the world as
extension.

This account intends to encompass a rich variety of linguistic data, such as a
speaker’s alleged “intuitions” of synonymy, ambiguity and informativeness.
However, insofar as I can determine, the classical explanations of these
phenomena do not require attributes to determine extensions at all.\textsuperscript{9} Rather, the
sets are grafted onto language largely as a measure of the speaker’s ability to apply
the predicate to the world, as witnessed by an ability to classify objects under the
predicate. The extension of a predicate consists of the objects that the intervening
universal should lead one to positively classify.\textsuperscript{10} Unfortunately, classical theorists
are rather unforthcoming about the process that ultimately connects the attribute
with the resulting activity. In fact, the invocation of attributes can be viewed in
two ways:

I.) The attribute plays a causal role in guiding human classification, rather as
a template steers the activity of a machine. The attribute thus constitutes
part of the explanation of human classificatory skills.\textsuperscript{11}

II.) The association of attribute with predicate is not intended to explain the speaker's ability to use the word (which must await better understanding of brain mechanics) but simply as a salient means for cataloging the ability. This I call the taxonomic view of the attribute-predicate linkage.\textsuperscript{12}

The tension between these two readings can be seen if we examine a recent critique of the classical view, Hilary Putnam's.\textsuperscript{13} He doubts whether any entity can perform the dual tasks [(1) and (2)] the classical theory requires. In particular, concepts regarded as "ideas in the head," cannot completely determine extensions, because two speakers could conceivably share the same "ideas" with respect to a pair of predicates that intuitively possess quite different extensions. However, a true-born Fregean might remain unimpressed since universals were never supposed to dwell "in the head," but rather in an extraterrestrial "third realm." An allowable "indexicality" in the speaker's mental state might produce a link to distinct concepts in the Platonic stratosphere.

Putnam is obviously insisting on something like I) in his interpretation of classical theory, whereas his opponent has retreated to II). But as long as the explanatory function of the universals is minimized and their value as ideal standards for cataloging behavior is emphasized, then the suggested response seems cogent. As an analogy, consider the relationship between human manipulation with numerals and the addition function of mathematics. That various of our calculations with small numerals approximately correspond to values of the addition function in itself justifies association of the human activity to the divine rule. Putnam's objections are in order only if we require the function to be "in our head" or suggest that some quasi-mechanical, although supersensible, interaction with the function guides our calculation. Treating the attribute-predicate link as merely an external, "black box" measure of a speaker's ability to employ the predicate may be an exceedingly minimal construal of classical theory, but it indicates the direction I wish to follow.

But given that subjects often make mistakes in the employment of a predicate, how should we correlate "grasp" of an attribute with linguistic behavior? Paraphrasing a remark of Michael Dummett's, the tightest link we might expect is that "the correct application of a predicate to an object x involves the possibility in principle that this classification should be or should have been recognized as correct by a being—not necessarily a human being—who grasps the universal associated with the predicate and is appropriately situated and with sufficient perceptual and intellectual powers."\textsuperscript{14} This treats the "ideal observer" as a sort of \textit{perfect detection device} for the "universal" in question. Dummett
correctly stresses that a Fregean is reluctant to improve upon this rather vague counterfactual, perhaps excusing his taciturnity by appeal to the specially postulated nature of universals. However, in the philosophy of science, we know ways to convert loose attributions of “ideal” measurement capacities into statements of greater precision. I believe this analogy provides a valuable clue for the empirical reexamination of “extension.” By following its lead, I shall develop a concrete bond between usage and “attribute” (and, derivatively, sets) that achieves some of the goals of traditional theory, yet at the same time delineates its limitations. Perhaps this one-strand analysis of “extension” will prove too limited to serve as a fully satisfactory surrogate for the traditional notion, but the facts we note in working it out should persuade the Fregean to amplify his account. A first step towards progress is to scrutinize the notion of “attribute” more carefully.

(iii)

Recently some philosophers have recognized that two quite distinct motivations for positing attributes have historically been confused.\textsuperscript{15}

A) As in the Frege-Russell theory, concepts are hypothesized to explain common linguistic understanding so that if Gary and Danny understand the same thing by “P,” they must have each grasped the same attribute $\varphi$ and assigned it to “P.” Such attributes will be identical only if they represent the same idea or concept. I shall reserve the term concept for these linguistically motivated entities.

B) “Attributes” constitute the range of physical traits which objects might be discovered to possess. A scientific theory will articulate this realm of potential traits through its specification of which systems are physically permissible. The nature of this collection and its associated identity conditions are to be discovered empirically through the development of physics and is completely independent of the linguistic motivations of the “concept” view. Employment of this use of “property” is clearly displayed, for example, in the general contentions about “physical quantities” revealed in the Poisson bracket or commutation relations of classical and quantum physics. These relationships would make no sense if the range of the quantifications includes concepts derived from alien physical theories--e.g. it is nonsense to seek the Poisson bracket of classical energy with Aristotelian impetus. Attributes so construed I shall call physical properties (or simply properties when no confusion would accrue).
The predicates (= open sentences) of a physical theory T denote typical specimens of the physical properties postulated by T. Thus the predicates of current scientific theory represent our "best guesses" so far as to the realm of physical traits in the universe. From this point of view, there is absolutely no reason to hold that the predicates of a discarded scientific theory, such as "contains caloric," correspond to properties at all. Only confusion with the linguistic motivations of the concept view could make us think otherwise; as we have just seen, such assimilation would make hash of the typical property quantifications of science. For clarity, I shall adopt the following notation: *P* shall name the physical property (if any) corresponding to a given predicate "P." !P! will represent its correlated concept (if it exists), and "P" indicates the linguistic expression itself.

In this essay, I shall comprehend the attribute-predicate link in a purely taxonomic (i.e., non-explanatory) way, but claim that we should employ physical properties rather than concepts as the appropriate middle terms. If members of a linguistic community can independently agree in most of their attempts to classify objects under a predicate, this unanimity of results is to be partially explained by objective features of the objects catalogued. In parallel fashion, the fact that a variety of instrumentation (mercury, gas and resistance thermometers) supply approximately equal numerical values over the same range of objects partially rests upon objective thermal traits of the objects tested. Roughly speaking, my purpose is to codify such objective features into a so-called property index for the predicate and then relate our intuitive assignments of extensions to these indices. This procedure, I believe, represents a tolerably accurate first approximation to our preanalytic method of assigning extensions to predicates. Part of my motivation in following this nonstandard course is that I believe the "concept" notion to be a child of confusion, whose unhappy parentage cannot be redeemed through postulation.

In this regard, it is worth pointing out that Hilary Putnam and Saul Kripke have already proposed a physical property linkage for a limited class of "natural kind predicates." On their account, an unspecified causal relationship is established between a "natural kind" attribute in the physical world and a predicate via an initial baptism ceremony and this tie is inherited by the descendental linguistic community. The extension of the predicate becomes simply the set of objects possessing the natural kind in question. The salient aspect of this account, from the present viewpoint, is that natural kinds must constitute a genus of physical property, rather than concept, for the attached "natural kinds" are not intended to represent the speakers' conception of the predicate in question. Thus *contains largely H2O* will be the natural kind index of "is water," even for speakers who have no conception of molecular chemistry.

I find the assumption of a subcategory of "natural kinds" and unique causal
chains physically unpersuasive (cf. section ix). Nor do I understand the limitation to “natural kind predicates.” It may be suggested that competent English speakers intend “is gold” to correlate with a “natural kind,” whereas they lack similar designs upon “is a chair,” but I find such a thesis incoherent or empirically false. As long as no pretence is made, however, that the intervening properties represent the speaker’s conception of his predicate or its meaning, there is no reason to limit this account to “natural kind” predicates. “Is a chair” can be indexed by the complex physical properties which lead us to classify chairs as such (insofar as our classifications depend upon such traits, rather than the nomenclatural whim of the manufacturer) and the aboriginal gavagai can be assigned the property *belongs to family Leporidae* without thereby implying that the native has any notion of biological families or even normal physical objects. The many features which distinguish the natives’ use of gavagai from our own “is a rabbit” must be brought out by the linguist using other varieties of linguistic description than my bald property assignment. The dream of traditional linguistic theory has been to collapse all of these descriptive tasks into a unitary assignment of a “concept index,” a goal I regard as chimerical.

(iv)

In this section, I shall briefly discuss attributions of measurement capabilities to instrumentation, as when we say that a thermometer is capable of measuring temperature. This digression is important for our purposes because it will illustrate (a) why we must distinguish concepts from physical properties, (b) why a reasonable explication of “extension” needs to proceed in stages, and (c) how to abstract from the linguistic mistakes of speakers.

Let \( m \) be a concrete piece of laboratory apparatus such as a common mercury thermometer. The knowledge that “\( m \) can measure the physical quantity *temperature*” provides certain useful information about the internal construction of \( m \). Admittedly this knowledge is rather abstract; roughly, we learn that \( m \) has some means of coupling with the gas so that a correlated modification in the state of \( m \) will be amplified to an observable level. In a thermometer, its entering into equilibrium with the gas produces an observable alteration in the length of the mercury column. If \( m \) is a “black box” and we know nothing about \( m \) except that it can measure the temperature of gases, then there are a host of quite different mechanisms which may be housed inside \( m \), one of which is the workings of a mercury thermometer. On the other hand, if we discover that \( m \) cannot measure the percentage of oxygen in the gas, we learn other information about \( m \), although this data is hardly as salient as a positive measurement capability. Let us call the assignment of property to instrumentation a property index of the device.
These attributions are idealized in the sense that m can correctly be accredited with a temperature recognition capability, yet nonetheless in many circumstances give wrong answers or no answers at all. Moreover they are objective in the sense that if “Q” is another name for the physical property P, then m must be capable of measuring Q as well. So if temperature equals mean kinetic energy per degree of freedom, the thermometer m must be capable of measuring mean kinetic energy as well. However, it is important to recognize that sometimes predicates which do not pick out physical properties in our sense are associated with measuring instruments; granting the Devil his due, such attributions may be called concept indices.

For example, consider the sentence “Apparatus m (allegedly) measures the property !contains orgone!” This claim is of a quite different order than those considered above, for little information about m’s internal structure is conveyed, but a historical fact is attributed to m; roughly, “m is built according to specifications left by Wilhelm Reich or his followers, who thought devices of this type could measure the presence of a fictitious substance they called ‘orgone.’” There is little question of classifying arbitrary apparatus, historically unconnected with Reicheans, as potential “orgone” detectors—the theory of orgone is sufficiently incoherent and out of step with modern science that we wouldn’t know how to carry out the classification.

Similarly, one can apply the concept !measures gain or loss of caloric! to the antique calorimeters employed by Lavoisier and his associates, as well as the objective attribution *measures gain or loss of heat energy*. However, it seems inappropriate to classify more modern and sophisticated calorimeters as !capable of measuring caloric loss or gain! since these devices typically operate according to principles at variance with caloric theory. If one accepts caloric theory, it becomes quite difficult to explain why these modern devices behave as they do or what it is that they measure. “Concept indices” do not proceed upon systematic principles and contrast sharply with the objective property attributions. In the latter, a mechanical device can be decided to be a measuring instrument for P simply on the basis of its internal structure.²²

It is apparent that the two types of attribute indices are founded upon quite different criteria, although they frequently become muddled in practice. Moreover it would be quite difficult, if not impossible, to give a unitary account of all these attributions of measurement capacity. Sorting out the disparate motivations for “concept indices” would be quite messy, but the typical objective, physical property indexing procedure is amenable to a fairly simple treatment. The key to its unraveling lies in the fact that such assignments require physical properties and transpire against a background of implicit assumptions (or parameters, as I shall call them). Except in trivial cases, almost no universal detection devices exist;
instruments which can detect the presence or absence of P in any object whatsoever in any context. A mercury thermometer will not function properly in an environment full of shock waves or if applied to objects at extremely high or low temperatures. When we claim that the thermometer measures temperature, we tacitly limit our claim that it will accurately transmit temperature information to a range of appropriate conditions. If we hope to define “m can measure property P” rigorously, such background conditions must be made explicit in the form of extra parameters. For example, consider a calibrated spring balance m₁ (such as a household bathroom scale) and a beam balance m₂ (such as Justice carries) with a set of standard weights. Typically, we are willing to claim that both devices can measure not only the mass of an object, but its impressed gravitational force (“weight”) as well. In other words, the readings of the instruments can be regarded indifferently as reports about either the mass or “weight” of the object measured. If used in suitable conditions, a value of “2 lbs.” in either instrument serves to detect the property *has a mass of .9 kg.* as well as *is under an impressed gravitational force of 9 nts.*. But these remarks hold only if the range of m₁ and m₂’s application is limited to the earth’s surface. If we instead enlarge the field of applicability to the moon, then the beam balance will register only mass and the spring balance only impressed gravitational force. If the range of application is further expanded to include objects found in space stations or in radically nonhomogeneous gravitational fields, then neither m₁ nor m₂ will measure either of the properties mentioned (although there are properties of a more complicated description which they continue to detect).

The moral is that a range of application is required as an implicit parameter in our definition of property indexing. Within these limitations, a given device may be expected to measure many distinct physical properties simultaneously—some of which may be simple from a theoretical point-of-view (*mass*) or more complicated (e.g., *impressed gravitational force plus centripetal pseudoforce*). Such properties will be said to be interchangeable with respect to the implicit parameters. Typically, instruments detect “simple” properties only within a relatively narrow arena of application.

When we pay sufficient attention to these details, we are frequently surprised to find that many common attributions of measurement capability are mistaken. Consider again the familiar mercury thermometer and its alleged ability to measure temperature. In fact, thermometers do not give correct answers about the temperature of gases in ordinary sunlight. This is because their readings depend as much upon the radiant energy reflected from the nearby solids as the absolute temperature of the air. The thermometer is actually responding to some complicated average of temperature plus reflected radiation rather than simple gas temperature alone. Meteorologists actually employ a device consisting of a
thermometer inside a complicated housing to measure true temperature. When one learns it is “90°F in the shade,” one is thereby given the true air temperature measured by this device, rather than the misleading reading of an ordinary thermometer, which in this situation is not measuring temperature at all. The phrase “in the shade” really means “true temperature” and does not refer to fictitious differential in air temperature between a shady spot and direct sunlight. A thermometer can correctly be said to measure temperature only when such radiation effects are not extreme; if this reference class is enlarged to include sunlit gases, it is no longer accurate to say that it measures simple temperature.

In the appendix, I describe more fully the range of parameters needed to make our account of property indexing for measuring devices precise. The net result of the analysis is:\(^{23}\)

A device m (of general type M) can detect P (with range of application R, method of application A and “yes” answer T) if and only if it is a law of nature that if x is any device of type M, v is an object meeting R, and x is applied to y at t in manner A, then x will assume the property T at a time subsequent to t if and only if y has P at t.

This treatment applies only to completely reliable instruments, but the possibility of error within the range of application can be introduced by techniques (involving the ensemble M) described in the appendix.

The notion of property indexing just defined cannot be happily regarded as a “meaning analysis” (in the traditional sense) of the original locution. After all, we do talk about the measurement capabilities of orgone boxes! My definition certainly captures some of the empirical basis that underlies our talk of measuring devices, but it would be hard to specify when this account shades from explication into critique of vernacular use. Moreover, in ascribing a given measurement capability, we seldom attend to the underlying implicit parameters, although they are clearly necessary. Why is this so? In the first place, we are often totally incapable of specifying them, even if we are relatively confident that m is objectively measuring a certain property in familiar use. In particular, the fact that devices of a certain type act as if they detect a physical property may provide good evidence that various undiscovered laws or structural facts about those devices are at hand. For example, the early inventors of the thermometer possessed no valid theories about how their devices worked; their efforts towards design improvement were motivated largely by considerations of repeatability of results in an ever increasing class of thermal apparatus employing different working substances. This collusio of instrumentation provided strong evidence that they were all roughly measuring an important new physical property called
“temperature,” but the physical processes underlying the transfer of information from object measured to thermometer reading remained largely unknown. Moreover, the implicit parameters limiting valid applicability of their thermal devices were not well understood either; there were few standards for judging the temperature of substances except by thermometer. Contemporary evidence thus justified early theorists in making claims like “this thermometer measures temperature” and “this calorimeter measures caloric gain or loss,” even though only the former proved to be correct. Even if the working principles and implicit parameters of a given device are presently understood, a working scientist may have no interest in these factors beyond the truth of “m can detect property P.” An industrial chemist will probably be quite ignorant of the theory of his NMR machine; he will be content to read in its instruction manual that, under suitable programming, it can detect a given trait and it won’t occur to him to wonder how it might operate in bizarre environments.

These pragmatic considerations explain why in practice apparently objective property indices may drift into becoming “concept indices” of the historically derived variety. In the absence of an objective capability, the claim that “thermometer m measures temperature” may persevere because of our ongoing tendency to treat temperature as whatever a thermometer measures. Thus the average citizen’s attributions of measurement capacities typically reflect a motley of motivations. Nonetheless, property indexing clearly constitutes the central empirical core of our talk of measuring abilities, from which the various looser forms of measurement talk exude as a confusing exhalation. I think that similar tangled purposes have led to the “concepts” and “extensions” of traditional theory. In the following section, I shall isolate a notion that I believe serves as the empirical backbone for our intuitive talk of “extensions.”

(v)

If we accept a need for implicit parameters, we can bind properties to predicates in the manner of the last section.

Property Q indexes predicate “P” in S’s language (with range of application R, method of application A, S’s general type being M) if and only if it generally holds that for any person x of type M, any object y meeting R, then if x interacts with y at t in manner A, x will assent to the sentence “Is this P?” at some time subsequent to t if and only if y is Q at t.24

The transition to a type of “extension” is immediate:
Predicate "P" has (timeless) extension \(\alpha\) in S’s language (with range of application R, method of application A, S’s general type being M) if and only if \((\exists \varphi)\) (\(\varphi\) indexes "P" in S’s language (with respect to R, A, M) and \(\alpha = \{x | x \text{ is } \varphi \text{ at some } t\}\)).

Roughly speaking, a property \(^*Q^*\) will be assigned to predicate "P" (as used by S) in those cases where the counterfactual "if speaker 5 were confronted with objects of type Q, S would classify them as ‘P’" will be true. Instead of appealing to an "ideal observer," extra parameters have been introduced to convert this somewhat vague counterfactual into a straightforward, albeit complex, scientific claim about what will transpire when the given system (the object to be classified) interacts with an external detection system (human being cum measuring devices). Classificatory error or incompetence on the part of a particular observer a is to be factored out through a judicious selection of appropriate parameters (especially the ensemble M).

Thanks to Putnam’s and Kripke’s work, we have learned that the practical assignment of extension to a predicate like "is gold" often requires an initial isolation of those objective properties (of the objects catalogued) that are "responsible" for the term’s successful employment. On the other hand, the Frege-Russell account holds that when a child learns a predicate and grasps its associated universal, this "concept" correlates with the child’s preparedness to use the term. Our reflections on thermometers et al. have shown how the Putnam-Kripke objective features can be understood as measures of the speakers’ internal "preparation" relevant to the predicate’s use. Our "adequacy condition" was imposed precisely so that these indices properly reflect this linguistic prescience. In this way, our new approach is brought into partial alignment with the old "concept" story. The restriction in my definitions to the native employment of simple combinations of the predicate with indexicals, which might otherwise appear to be errant operationalism, rests upon the premise that the external traits which underlie simple classificatory behavior also serve to underwrite the successful employment of sentences of a more complicated grammatical form as well. The advantage of the simple indexical sentences is that "traits responsible for their successful employment" can be unpacked in a fairly elementary fashion. However this working assumption is only approximately correct, for a community’s use of sentences of a more complicated grammatical type (e.g., with quantifiers) can properly influence our ultimate choice of extension assignment. I ignore these factors at present because I believe that most of our pre-analytic extension assignments are based upon simple classificatory skills and that the typical "corrections" to these ascriptions often introduce unsystematic violations of our adequacy condition. We shall return to these
matters in Section x.

My treatment of "extension" can be easily extended to a theory of truth for L in the manner of Hartry Field or Kit Fine. However, I find the ascription of truth-value to a language, especially of a primitive tribe, to be a quite complicated affair. I doubt that the simple modifications of Tarski proposed by Field and Fine neatly capture any familiar valuation of native assertion. *Pace* Donald Davidson, we can possess a good feel for the extension of a predicate in the absence of a developed truth-theory for X. In the Karam language of New Guinea, the "color" word *pk* is applied in different color ranges for different classes of object, *e.g.*, foliage and fruit versus human skin. The class of objects of which *pk* is true—its extension—can be approximately delineated as \{x \mid (x \text{ reflects light in Munsell range 2.5-5YR4-5/4-6} \& x \text{ is human skin}) \lor (x \text{ reflects light in range 5YR-5Y 6-8/7-8, otherwise)}\}. But once we voyage beyond simple classificatory sentences into the dark heart of *pk*’s taboo structure (and the sentences which express it), my own sense of Karam truth and falsity begins to wither. So I propose tabling the question of native "truth" for independent study.

Qua measures of classificatory ability, I hold set and property indices on a par (although the latter typically embodies a little extra information). If it can be assumed that all of a predicate’s potential positive instances will actually be examined and classified by a portion of the linguistic community (as happens for predicates like "is Bix Biederbecke"), then intervening properties may not be needed to delineate an appropriate extension. The set can be simply collated from the actual classifications. Properties are needed mainly to support the counterfactual "If speaker S were to examine a, S would classify it as ‘F’" for predicates with open-ended application.

Our implicit parameters were introduced as a hedge against the complications introduced by unexpected objects. In this section, I shall illustrate their use in the Druid example.

We saw that a linguist studying the semantics of parochial Druid has no warrant for choosing either \{x \mid x \text{ is a member of } aves\} or \{x \mid x \text{ is a flying device}\} as the correct extension for "bird," since such a choice is tantamount to predicting how Druids will classify aircraft in the cosmopolitan world. These two sets are *interchangeable* within the range of application parameter appropriate to pristine Druids. A prediction about how they will classify when placed in circumstances outside of that range of application is not warranted by any linguistic facts about pre-landing Druids, since later behavior depends as much on the subsequent accidents of history (how B-52’s came to the island) as their prior linguistic training. The properly conservative linguist will hedge this prediction by stressing a limited range of applicability; "‘bird’ in parochial Druid dialect has extension \{x \mid x \text{ is a member of } aves\} with a range of applicability limited to objects similar to
those found in the environs of the Druid isle.” She prudently demurs from making any univocal prediction via her extension assignments about how Druids will react to B-52’s. Of course, the linguist may make some predictions on this score—it surely reflects a “semantic” feature of Druidese that a plane appearing in the sky will be dubbed a “bird” if it is the first piece of aviation spied—but these predictions must be described directly and cannot be encoded in a single property or extension-index.

Contrast the Druid term “bird” with their term “water.” In English, “water” possesses more “border-line” cases than “bird;” it is uncertain why sugar water counts as “water” but lemon-lime soda pop does not. Naturally we expect that the Druids may disagree with us on these “border-line” classifications, although we expect that they should consider them quasi-conventional as well. Nonetheless, no likely history of introduction to our modern world should materially affect how the Druids divide the bulk of earthly furniture into “water” and “non-water”—usually they will agree with the average American speaker on these matters. So whatever constitutes the complicated physical property that the various hunks of stuff we call “water” share, it can serve to index Druid “water” equally well. Hence, the field linguist may leave the range of application tacit in her property indexing, since there is essentially only one way the Druids will adapt to the contemporary world vis a vis this predicate.

Somewhat intermediate is the ostrich and kiwi case. Previously we assumed that when the Druids eventually embrace modern science, they will override their initial rejection of these creatures as “birds.” If a linguist can confidently predict this reversal, then she is warranted in allowing “bird”’s range of application to include kiwis. The linguistic data needed will not require discovery of the true Druid “meaning” of “bird,” but study of the tribe’s general receptivity towards neologism and linguistic borrowing. If other vocabulary can be readily manufactured to cover zoology’s needs, Druid “bird” may forever exclude the kiwis, but in a syntactically conservative society scientific requirements will overpower these original tendencies. If we cannot predict, with reasonable certainty, a unique evolution, then the range of application parameter must exclude nonstandard fowl and both *is a member of aves* and *aves not of order Struthioniformes, Rheiformes, Casuariformes or Apterygiformes* should be among the interchangeable indices for “bird.”

Such non-unique linguistic development seems an unavoidable facet of human behavior. As such, implicit parameter limitations will be required if we expect extension assignments to meet our earlier adequacy condition. None of this entails that the predicates in question have “changed their meaning” during their “evolution.” I have already stressed that the Druids themselves won’t feel that they have altered the sense of “bird” when they apply it to the aircraft. The willingness
to dub it “bird” occurs spontaneously to all members of Druid society and their 
surprise at encountering this unexpected object may be no greater than the shock 
of meeting the stuff in Lake Erie, likewise unreservedly called “water” despite its 
unexpectedly awful characteristics. From the Druids’ own point of view, the 
meaning of “bird” has not altered, nor is there reason for the field linguist to 
describe matters in this fashion either. Attribution of change of meaning seems 
best tied to recognition by the linguistic community of a need for conventional 
decision and, *ex hypothesi*, this is not the case here.

(vii)

Real life examples of the Druid phenomenon occur in virtually every case of 
enlargement of our world view through scientific progress. Should the extension 
of “electron” in 1900 English include positrons? Its extension in present day 
English does not, but easily could have if the phrase “positive electron” had 
prevailed in common use. In short, the present day extension of “electron” was 
partially settled by a matter of phonetic convenience. What then was the term’s 
extension when positrons were totally unconceived? The answer is that the 
extension indexing of “electron” in 1900 English needs to be limited by a range of 
applicability (roughly, non-relativistic quantum effects).

The term “Grant’s zebra” was originally (circa 1820) applied to a strain of 
zebras native to Kenya. A set of morphologically distinct animals from Rhodesia 
was likewise called “Chapman’s zebra.” Later exploration showed that the two 
animals interbred near the Zambezi River and constituted one species *Equus burchelli*. 
Thus the term “Grant’s zebra” in present day English is indexed by 
*belongs to *E. burchelli* Grant*. On the other hand, if zoological exploration of 
Africa had begun instead near the Zambezi, “Grant’s zebra” would have naturally 
evolved to become a vernacular title for the entire species, with property index 
*belongs to E. burchelli*. In discussing the original 1820 semantics of “Grant’s 
zebra” it seems inappropriate to choose between these two indices and their 
corresponding extensions. These attributions should rather be limited by the 
parameter *found outside the Zambezi region*. Examples of this nature are rife in 
any taxonomic science.30

Consider the phrase “weighs 2 lb.” in the English of 1600, when the 
peculiar behavior of spring and beam balances on the moon was unknown. Should 
the property index of “weighs 2 lb.” have been *has mass .9 kg.* or *is under an 
impressed gravitational force of 9 nt.?* Again the range of applicability must be 
restricted, here to objects located near the surface of the earth (in which case both 
property-indexes are interchangeable). Unlike the previous cases, we have no 
resolution in present-day English, since there are actually two official English
systems of weights and measures in which the pound is a measure of mass and of
force respectively (the latter system is generally preferred however). If semantics
attributes the mass property or the gravitational force property tout court to 1600
“weighs 2 lb.,” it has outstripped the sort of predictions warranted by
considerations of English speakers’ linguistic preparation in 1600.

If my argument is correct, almost no predicate of English possessing any
property index at all is immune to multiple property-indices which coincide only
within a restricted range of application. Apparently stalwart predicates like “is
water” or “is red” differ only in requiring discussion of more extraordinary
environments to elicit this feature, and thus seem mere “science fiction” to the
skeptic. However, at the present day “is red” may be close to demonstrating the
“weighs 2 lbs” behavior. Consider the beautiful colored pictures of microbes
found in textbooks and assume that these are natural and are not due to staining
(as is usually the case). In point of fact, these photos have all been taken in
ultraviolet light because visible light cannot be focused at such small diameters.
Should we say that (1) a given bacillus is red because all of its photos show it to
look red on ultraviolet film, (2) it is green because it reflects visible frequency
“white” light strongly in the “green” middle spectrum (although we cannot obtain
a clear image in this color due to resolution problems), or (3) it has no true color at
all? I don’t know whether biologists consistently pursue one of these three
policies of color talk. However, if all microscopists routinely employ a
standardized ultraviolet film, the first alternative will possess immediate
classificatory utility. But it seems clear enough that, in appropriate framing
circumstances, any of these three courses of action could be pursued without any
awareness on the part of biologists that they had settled upon a new “convention”
for ascribing color to microbes. Nonetheless, a linguist assigning an extension to
“is red” in 1850 English should not allow his indexing to reflect just one of the
three possibilities outlined, because that is tantamount to predicting what varieties
of ultraviolet film will be marketed in future years!

(viii)

Let us now peruse effects of the second implicit parameter for property
indexing—the traits which form the ensemble of permissible classifiers. Consider
the phrase “weighs 2 lb.” in present-day English. Should its index now be *mass*
or impressed gravitational force*? For most of us, our daily usage of the term is
totally indifferent to any choice between the two physical properties, because in
our comings and goings with the butcher and the health spa, we seldom need to
measure nongravitational forces. In this regard, our daily employment of “weighs
2 lb.” closely resembles that of Elizabethan Englishmen. It is true that we have all
read accounts of the peculiar effects that happen away from the surface of the earth (and are more in tune with the mysteries of the world than the citizens of 1600), but most of us have never faced these features in daily life and our discussions of other-worldly “weight” remain charmingly contradictory. Consider, for example, the assertion, “An astronaut in a space station is weightless (weighs 0 lbs), but if she doesn’t eat her rations for a week, she’ll lose 5 lbs.” Admittedly, we never assert such a sentence in one breath, but most of us have uttered such inconsistencies in more widely separated breaths. Serious confrontation (say, through frequent space travel) with the novel environment away from the earth would force us to repair these inconsistencies and nothing in present-day English absolutely determines how usage should be improved. Present-day physical practice prefers to understand the pound as a unit of force, but I predict that the average American would likely wind up employing the term as a measure of mass in his interplanetary trips to butcher and health-spa. In this sense, the semantics of “weighs 2 lb.” for most of us differs somewhat, and is partially independent of, that for physicists. Thus if the ensemble M excludes the physics experts, “weighs 2 lb.” will permit the noted double-indexing even in present-day English, whereas if M includes mainly physics experts, *has a mass of .9 kg.* drops out as a possible index. The odd facts about the usage of “weighs 2 lb.” encapsulated in this complicated array of indices clearly belongs to the domain of “semantics” for present-day English.

The term “is 90°F” demonstrates this behavior in an even more unusual manner. As I remarked above, the true temperature of the air in the sun and under a shady tree are approximately the same, but thermometers read different values in the two locales and it certainly feels cooler in the shade (as every fixit man knows). For most of us, “is 90°F” does not denote a temperature proper, but rather a complicated average of true air temperature plus the radiant energy available in that air from other sources. The linguist can capture this interesting behavior in English by stating which property indices are justifiable when the ensemble of human types includes the experts, and when it does not. This odd fact about English is as much in the proper province of the semanticist as the fact that a certain term in Eskimo denotes male siblings and seals. This example shows that discussion in English of the semantics of English language predicates is not always trivial. It also suggests qualifications to Putnam’s “Principle of the Division of Linguistic Labor.”32 We can meaningfully ascribe an extension (with certain implicit parameters) to the everyday use of “is 90°F” which differs from that appropriate to the temperature experts in our society. There is a natural temptation to claim that the experts assign a somewhat different meaning (or sense) to “is 90°F” than the rest of us. The fact that “is 90°F” corresponds to two fairly clear-cut ranges of application represents an interesting aspect of English
linguistics, but this common phenomenon should be regarded as \textit{sui generis} and not lumped with ambiguities of "meaning" such as the word "bank" displays. Intuitive talk of the "varying senses" of "is 90°F" is unexceptionable if understood merely as a description of the double range of application, but it should not mislead us into supposing that the experts "grasp" a distinct concept (especially when physicists employ the term in the same way as the rest of us in ordinary conversation with no sense of disharmony with their laboratory practice).

(ix)

Successful application of the foregoing model requires a certain stability in classificatory behavior with respect to the predicate indexed. Human beings, unlike thermometers, are \textit{self-correcting} measurement devices with memories. Any such device, mechanical or biological, is affected by the \textit{history} of its earlier classifications. A sophisticated, self-correcting egg candling machine might accept eggs a and b and reject c if presented in the order (a, b, c), yet accept b and c and reject a if presented in the order (c, b, a). The utility of our extension assignments (which are modeled upon thermometer type cases) require that almost all objects within an appropriate range of application will be eventually classifiable as "P" or not \textit{irrespective of the order in which they are tested}. As an example which lacks this "stability," consider the 1780 employment of "has lost 1 BTU of caloric." Within a suitably limited range of application, can we profitably assign this predicate a property-index, e.g., "has lost 1 BTU of thermal energy"? The task is to find a reasonable account of this range, which is not as easily produced as in the foregoing cases. The difficulty is simply that cannon boring and other mechanical sources of heat (Rumford's classic work in overthrowing caloric theory centered around such observations) constitute fairly unavoidable thermal events. Serious reflection on these phenomena will totally confuse anyone about how to apply the predicate "has lost one BTU of caloric" (granted that classical caloric theory postulated that caloric loss can be determined by both temperature loss and change in specific heat capacity). Accordingly, prior observations of cannon boring will generally affect the determination of caloric content one might otherwise make on other physical systems. Thus there is no reasonable range of application in which the use of "caloric" will be stable.

The problem is even more pronounced in the case of "contains orgone." Although Reicheans classified an odd variety of objects as pure orgone (e.g., the reflection mirages seen on a warm highway), it seems impossible to find a suitable range of application or ensemble of nonexperts to satisfy our model. Only over-zealous Duhemians doubt that serious study by rational agents of quite humdrum objects in hopes of determining their orgone content will lead instead to
a rejection of the theory. Here the only reasonable extension for "is orgone" is the null set, because we can predict that, in time, further organic research will lead to the term's abandonment. General philosophic practice agrees that "caloric" and "orgone" should be assigned empty extensions. However, in related cases our "intuitions" are less clear and closely connected with problems of classificatory error. As indicated above, an object a classified as "P" by subject S should not be reckoned in "P" 's extension, if a would not be so classified by other members of S's ensemble or if S could be led to change his mind through permissible scientific and technological developments. Often, however, observation of an unexpected object will radically affect the society's linguistic behavior, possibly in a quite unpredictable sort of way. Imagine a primitive tribe that believes all large objects which move through the sky in apparent disregard of gravitational influences do so because of a special kinematic ability correlated with wings. They employ a term oneymey to apply to some of these objects, in particular, all birds and the sun. How will they react when some visiting pedagog exposes them to the telescope and more detailed ornithological observations? The natives may stop calling the sun an oneymey or they may continue in their labeling, yet with a chastened sense of kinematics. Such enlightened natives would employ oneymey as we would if we had an atomic predicate meaning "is a bird or the sun." Recognition of new scientific fact alone needn't force alteration of classificatory behavior, as long as the misleading implications of that practice can be somehow defused. (We continue to employ "weighs 5 lbs." in a jolly, 1600 sort of way, despite our heightened appreciation of the difference between force and mass.) If the range of applicability and permissible technological development is explicitly limited to the stable range appropriate to Iron Age peoples, oneymey can be granted the extension \{x| x is a bird or the Sun\}, but within a wider compass we may possess no rationale for assigning an extension at all if it cannot be predicted whether the enlightened tribe will continue to apply oneymey to birds and the sun, restrict it to birds only or abandon its use altogether.

If I understand correctly, the Kripke-Putnam view discussed in section iii would probably maintain that the only proper extension for "oneymey" should be \{x| x is a member of aves\}. The preference for this class rests upon a doctrine of natural kinds. I have never fully grasped what these are supposed to be; presumably they are physical properties (in my sense) which are somehow prominent or privileged in nature. My understanding is that *is a member of aves* constitutes such a kind, whereas the disjunctive *is a member of aves or the sun* does not. I lack space to discuss this metaphysical (or epistemological?) view here, but I firmly believe that such notions are indefensible and based upon naivities about the complexity of the physical world. Certainly the class of stuff we call "water" is not a "simple" category at all—I challenge the natural kinds
enthusiast to clearly explain why a glass of Lake Erie belongs to the same “natural kind” as distilled water, whereas a glass of celery juice or soda pop (which usually contains more H₂O by volume) does not.

In any case, Hilary Putnam presents a view like the following: 33

Predicate “P” denotes property φ in L if and only if “P” was introduced into L by the baptism “‘P’ will henceforth denote whatever property is causally responsible for this physical behavior” and φ is the natural kind responsible for the behavior indicated.

Thus Fahrenheit could have pointed to his thermometer and said, “Henceforth, ‘is 5°F’ will denote whatever property of an object is causally responsible for making my device read ‘5’. “ 34 According to Putnam, this singles out a certain thermal property which becomes the denotation of the predicate. The “natural kind” doctrine makes the uniqueness of this property seem more likely than is reasonably plausible (in fact, concepts of “temperature” bifurcate according to the variety of Gibbsian ensembles to which the system under study may be assigned). Such unanalyzed appeal to the notion of a property being “causally responsible for certain behavior” should be viewed with some suspicion. In philosophy of science, phrases like this occur most naturally in the context of measurement interactions and the present paper grew (like Topsy) from musings on the justification for such locutions within purely physical contexts. Almost no measurement instrument can succeed in responding to only one physical property and there is little reason to suppose that we, as hydrocarbon detection devices, can isolate physical attributes by our classificatory predicates either. But measuring implements work perfectly well even if they are not universal and human beings may use language perfectly comfortably even if their predicates don’t correspond uniquely to physical properties—as long as both stay within their appropriate ranges of applicability.

The “natural kind” picture, while commendably pointing to the predictive aspects of extension assignments, overstates its case by neglecting the complicated phenomena associated with our implicit parameters and postulating far too many unique linguistic evolutions. Within our own language, its presumptions of univocal development are encouraged by a peculiar form of historical parochialism due to a faulty association of extension with intuitive “meaning.” Putnam has quite rightly and wisely stressed that there is little reason to hold that “weighs 2 lbs,” “has momentum 2 kg-m/sec” or “is an electron” have changed their meaning during their respective terms of scientific employment, for the utility of “meaning” talk does not lie in this direction. However, one should not conclude from this “meaning” invariance that the predicates’ extensions have
remained likewise constant. In truth, the *implicit parameters* appropriate to these predicates will have widened enormously over the past four centuries and no linguist could have legitimately predicted how their application was to be extended in the new circumstances. We observed this earlier for “weight” and “electron”; the same moral holds for “momentum” as well. Given this change of parameters, it becomes misleading to say that the extensions of these predicates haven’t changed over time (although it is equally inappropriate to claim that they have).

Like anachronism surrounds popular conceptions of the extension of “gold” in, e.g., Locke’s usage. The idea that all Au-atoms should indubitably belong to this set ignores many of the complexities and vicissitudes in the history of “element.” Given the complicated intertwining of “chemical” (combination properties) and “physical” (optical and mass spectroscopy) experiments in our actual scientific development, our final identification of “element” with atomic number was perhaps historically inevitable. However I fail to see that this scheme is the only rational one. Certainly proof of its uniqueness would require a more careful study of alternate historical developments than “natural kind” proponents typically provide. Neutrons are often best regarded as excited (isospin) states of protons. The transition from Pa$^{234}$ to U$^{234}$ through β-emission can thus be viewed as the collapse of an “element” into a lower energy state. In fact, older writers wrote this decay as “Uranium X$_{11}$ $\rightarrow$ Uranium II + β” and this old-fashioned terminology does not represent a simple “mistake.” Moreover if chemical behavior is the key criterion for elementhood, why couldn’t the rare earths be labeled as one “element?” So while we can safely assign samples of the stable isotope of Au to Locke’s “gold,” there is no reason to insist that the twelve radioactive forms of Au be so apportioned. For classificatory convenience, we will prefer to assign *is Au* to Locke’s “gold” because that particular property, among all its interchangeable indices, has the shortest label in present-day English. But the convenience of this description should not bewitch us into historical parochialism.

\[(x)\]

Thus far we have restricted our attention to the community’s employment of sentences like “this is P.” However, within a linguistic community there are many predicates “P” which are not used to classify anything positively as “P,” simply because the relevant objects are too small, too large or otherwise unapproachable to be easily “presentable” through available technology. Consider the predicate “is an atom” as employed by Daltonians circa 1840. Certainly it seems appropriate to assign \(\{x \mid x \text{ is an atom}\}\), understood in the modern sense. On the
other hand, consider Newton’s “is a (single) light corpuscle.” No object was ever classified as such by Newtonians. Rather, beams of light and so forth were classified as “aggregates of light corpuscles” and it seems permissible to correlate the latter term with the property *is a collection of photons with energies in the visible range* and its analogous extension. Yet it does not seem so appropriate to index “is a single light corpuscle” by *is a photon with an energy in the visible region*. Our simple model of property indexing fails in this case and requires supplementation if we are to discuss property-indexing for such predicates. A wide range of other examples exhibit this same character: “contains 10 BTU’s of caloric” (total amount of caloric in a substance was never determined), “is a Mendelian gene” (as opposed to “this plant expresses a Mendelian gene”), “is a Thompson electron” and so forth. A better understanding of when such predicates can be profitably indexed by non-null properties would be desirable.

The fact that the community holds more complicated sentences true suggests a strategy. The atomistic tenets of kinetic theory justify a certain mathematical treatment of macroscopic gases. As long as the mathematics seems appropriate and fruitful in application, the scientific community will cling to the sentence “gases are composed of molecules, which don’t interact strongly except on collision, etc.” “Molecule” can then be assigned an extension consisting of whatever partitioning of the gas allows that mathematical treatment to work. It is this sort of consideration which underlies many of Putnam’s remarks. It remains a challenge to develop such examples into a clear model on a par with that we have supplied for classificatory behavior. By combining these various factors, we may obtain a better reconstruction of the intuitive notion of “extension.”

However we might proceed to extend our model to cover such predicates, we must be careful to insure that our adequacy condition is met. Otherwise we cannot guarantee that our extension assignments have much connection with the current linguistic competence of the speakers, as seems necessary for the subject of semantics. Although most of us are inclined to assign Newton’s “is a light corpuscle” the null extension, I wager that if Einstein, in tribute to Newton, had resurrected this phrase in lieu of “photon,” then we would presently be more willing to grant Newton’s “light corpuscle” an extension consisting of the things we call “photons.” Obviously a system of extension assignments designed to reflect only facts warranted by a Newtonian speaker’s linguistic training in the 1700’s should not be dependent upon this later action of Einstein’s. Hence, any development of the present theory of property-indexing must avoid smuggling in appeals to unsystematic intuitions of the “light corpuscle”/*photon* sort.

Such temptations towards semantic myopia are so prevalent that we must proceed with considerable care for rigor if we seek to extend our one-strand explication of “extension” in further ways. We have already seen that we must
likewise be circumspect in our "correction" of extension assignments to native languages in connection with classificatory error. In a rough characterization of a native predicate, we shall employ the most convenient of its interchangeable English labelings, but this selection should not be canonized into a mythology of "natural kinds." In these ways, this paper is content to disagree somewhat with common "intuitions" about the correct extensions for various specimen predicates. Hence if this paper errs towards the "operational," it is only because the Scylla of anachronism represents a vastly more imminent danger.

However our model is extended, implicit parameters will still be required as prophylactics against unwarranted linguistic prediction. In the molecule case, the underlying mathematics works profitably only for dilute gases and forces no decision as to what a "molecule" should represent in a typical solid (where present practice is rather unpredictable).

(xi)

For most physical quantities φ, at most historical moments in time, it is extremely unlikely that a linguistic community should be prepared, even collectively, to recognize all proper objects possessing φ. This follows, I believe, as a corollary to the general difficulty of constructing measuring instruments to correctly detect the presence of φ in all circumstances. Frege's hope for a "logically perfect language," where the application of every predicate is well determined, must represent an impossible dream; a society's best preparation against unexpected classifications is a detailed scientific account of the world.

There are two major factors which lead to underestimation of this underdetermination. First, a schedule of linguistic training can easily minimize the psychological surprise (and subsequent linguistic disruption) occasioned by the discovery of an unexpected object, so that its essential novelty may pass unnoticed. The Druids, for example, believe that virtually everything they will discover can be classified appropriately as a "bird" or not, without significant qualms or need for conventional legislation by a Druid kingpin. We possess the same sanguine attitude towards our own "bird," "is red," etc. This optimism helps explain why the Druids and ourselves often guide smoothly through delicate periods like B-52 landings without linguistic tremor. Indeed the genuine novelty of a previously unmet object will typically be recognized only long after linguistic practices concerning its classification have ossified in the language. In Wittgensteinian fashion, we should accordingly distinguish two senses in which linguistic indoctrination can determine the subsequent classification of an object a.

1.) The speakers in the society generally agree, when a is ultimately confronted, whether it is "F" or not. 2.) It can be predicted from knowledge of the initial
training alone, without data about the intervening history of the speakers, how this classification will proceed. Our case studies illustrate how these two senses of “determine” often diverge.

Generally, a society will be satisfied with a linguistic training just in case it determines 1 classificatory behavior. Bombers were not upsetting to the Druids in this regard. Nonetheless, it was not determinate that a B-52, however presented, was a “bird,” but this lack of foresight did not bother the Druids in the least. Confusion of these two senses makes “determination,” appear a more common feature of language than it really is.

Second, we will sometimes grant that a particular object a is determined to lie in the extension of “P,” although none of the “P”’s employers will in fact be able to so classify a, for much the same reasons that similar allowances are provided for the “mistakes” of measuring instruments. The positive theory of this paper has tried to delineate reasonable guidelines for this exculpation of “mistakes.” Whether one fully acquiesces in the details of this analysis or not, our case studies clearly show that all lack of determination should not be pardoned as a linguistic “mistake.” The fundamental distortions of the traditional theory of meaning, it seems to me, lie in this direction. Certainly, talk of “concepts” in itself can be harmless, as when we absolve speaker S from a routine “misclassification” by the description “S possesses the correct concept for T,” but doesn’t know how to test a for this trait.” But we are led to a mystifying view of language if we demand (as Fregean theory does) that such “concept” talk be applicable in more extreme linguistic situations. As an example of how a parallel form of description can be pushed beyond its useful limits, consider an automated ore gathering device which can be programmed via a punched card to select specimens of an assigned mass. Thus the current program of our machine might express: “Gather samples of mass 1 kg.” Occasionally, the machine will misclassify stones according to this program, either because of machine malfunction or oddities in the ore tested. But if we ship our apparatus to the moon, without changing its card, it will routinely gather stones of considerably larger mass. Is the machine now “misclassifying” the lunar rocks “relative to its program?” The question seems peculiar, because the assumed stability of environment which underlies fruitful “programming” talk has been transgressed.

Likewise, if one attempts to depict the Druid classifications in terms of the idiom of traditional theory—i.e., delineate the “concepts” which the Druids at various points in our various histories have assigned to “bird”—one is led to implausible and strained descriptions of the phenomena. I won’t run through the alternatives in detail, but the upshot will attribute quite peculiar mental states to the Druids (e.g., spells of mass amnesia or ineffable meanings for “bird”). In this way, Putnam’s “Twin Earth” argument against Fregean theory can be
reconstructed based on the data of linguistic evolution presented here.

Classical theories of meaning must represent the Druid classifications as freakish and aberrant behavior, whereas there is every reason to suppose that theirs is the normal way we should expect a linguistic community to function in a novel environment. One should accordingly beware of inflating innocent “concept” talk into a theory which attempts to explain all major aspects of language learning and use in terms of “grasp” of a special entity called a “sense” or “concept.” The relevant difference between the Druids and ourselves is that they are more ignorant of the world’s variety than we. Fregean theory attempts to distill this ignorance into a distinct concept-index for “bird.” In truth, the only way we can recapture for ourselves the blissful frame of mind the Druids enjoyed when they employed the term “bird” in pre-B-52 days is to forget a lot of what we know about the world. Entertaining a novel concept does not make one ignorant, but forgetfulness is the only possible route to employing a predicate with the same “semantical” properties as Druidese “bird.” In short, we don’t need to acquire something here (a novel concept); we need to lose something (general knowledge). Nor is it useful, in the absence of other peculiar features in Druid society, to suppose that the Druids possess a different “conceptual scheme” from us—a phrase which often conveys a very misleading picture of the difference between cultures. The Druids don’t think in any mysterious way; they are simply unaware of machinery.

The purpose of this essay has been twofold: to uncover data inimical to Fregean theory and, through construction of a simplified model, show that the undeniable utility of extension assignments can be retained while abandoning the rigid guidance of language, independent of historical happenstance, required by the traditional theory. That view conceives of language rather as a railway line designed by a corps of engineers (the advance party sent out at the “setting up” of the language) and the process of employing it consists in sitting in the observation car and remarking upon the scenery passed en route. I advocate thinking instead of those comical locomotives in children’s literature which unroll their tracks before them as they move through a terrain. In the short run, the path of the train responds to the hills and gullies of the landscape virtually as well as the better designed line and the view from the observation car may seem practically identical. In the words of the old song, “she gets there just the same,” partially because the passengers are along only for the ride and have no clear conception of a long term destination anyhow.39

APPENDIX: FURTHER REMARKS ON MEASUREMENTS

To simplify discussion, I introduce the notion of a detection device, an
instrument which will correctly answer "yes" or "no" whether the object tested has the property P or not. A measurement device, on the other hand, typically supplies a numeral which has some correlation with the degree to which the measured object possesses a physical quantity \( \phi \). Many detection devices (e.g., a thermostat) are not measuring devices, but every measuring instrument constitutes a family of detection devices, depending upon which numeral is selected as the "yes" answer. Thus a centigrade thermometer can detect the properties \( * \) is 5\(^\circ\) C, \* is 6\(^\circ\) C, etc., by selecting \( * \) the mercury rests on the '5'*, \* the mercury rests on the '6''*, and so on, as a "yes" answer. The notion of a detection device is simpler to analyze, because there are a variety of ways in which a scale of measurement may reflect facts about the relationships of the objects measured, as indicated by an associated transformation group. The reader may easily erect a suitable theory of measurement indices based on the following and standard literature on scales of value.\(^40\) It is worth remarking that the knowledge that a device \( m \) can measure a given physical quantity supplies much more information about \( m \) than the simple fact that it can detect a related physical property. A somewhat richer theory of indexing by physical quantities in language can be evolved along these lines, but we shall not pursue the matter further.

The four parameters our theory requires are:

1. \textit{Range of Applicability} (R). This is illustrated in the text by the fact that a beam balance detects mass and "weight" properties indifferently if used on earth.

2. \textit{Manner of Application} (A). This parameter is closely related to the foregoing and probably cannot be sharply distinguished from it. A medicinal thermometer may measure internal body temperature, but only if the device is inserted in the proper orifice and not, e.g., balanced on the top of the subject's head. Under this heading the various standing conditions necessary to the measuring instrument's proper functioning may be placed. In foundational studies, such problems of application are often simplified by assuming the measuring instrument and its objective are initially closed, non-interacting systems which come to interact in time via the definite process \( M \), and I have tacitly made a similar assumption in the language case. Our understanding of this parameter could be much improved.

3. \textit{The "yes" answer} (Y). We have already noted that a thermometer may serve as a detection device for many distinct properties, depending upon which numeral is selected for the "yes" answer. I have allowed the absence
of a "yes" answer to be a "no" answer, but other approaches are possible here.

4. General type of the device (M). The production of a correct "yes" or "no" answer in \( m \) for \( P \) must not be the result of accidental coincidence; rather the measurement event should be, in principle, repeatable. In the jargon of the physicists, this requires reference to an ensemble of devices. \( m \) cannot require simply that \( m \) give repeated answers under repeated trials, because many common testing devices may be employed only once. \( m \) ask instead that devices of the same type as \( m \) provide statistically regular answers under exactly similar test conditions. Hence we need to know the properties which determine the general "type" of \( m \) as a fourth implicit parameter for property-indexing. In practice, we usually allow a broader class of instrumentation to count as the "same type" as \( m \) beyond the narrow class of devices macroscopically indistinguishable from \( m \). For example, we are inclined to credit some of the early "thermoscopes" with the ability to measure temperature (rather than, e.g., barometric pressure) because we allow the family of thermometers to include these devices and the group as a whole reliably indicates temperature. In such cases, the attribution "\( m \) detects \( P \)" really doesn't tell us much about the internal structure of a device \( m \), but only about the internal structure of most of the systems macroscopically similar to \( m \). So wide tolerances about the type of a machine may allow us to claim that a particular instrument \( m \) can detect a certain property \( P \) even though \( m \) usually gives wrong answers! Perhaps this example depends upon casting our ensemble net too widely, but this problem can theoretically surface no matter how narrowly we restrict the type of \( m \)—a possibility always remains that \( m \) is an unrepresentative member of the ensemble and lacks the internal characteristics of the others (vide the analogous properties of "temperature" analyzed in Gibb's fashion). Thus a slight cavil must attach to our claim that property indexing always indicates structural information about the device indexed; it may only convey such information about most members of \( m \)'s ensemble.

Although our definition strictly applies only to completely reliable instruments, error may be accommodated by appeal to the ensemble \( M \). Roughly, \( m \) can detect \( P \) with 90% accuracy with respect to \( M \) if and only if for every suitable test object \( x \), 90% of \( M \)—devices give correct "yes" or "no" answers on \( x \). (We will not pursue the standard problems of applying percentages to infinite ensembles). When an ensemble ranges over a developmental history (as in most linguistic cases and the thermometer/thermoscope example), it is natural to weigh
the contribution of the later members of M more heavily. As pointed out in the
text, the utility of the objective property indexing format breaks down if M lacks
suitable stability to provide a natural standard of weighting.

P and Q will be interchangeable as indices if and only if no device in the
ensemble M can discriminate P objects meeting R from Q objects meeting R. The
most typical case is where it is a law of nature that any object fulfilling R will have
P if and only if it has Q. Thus *has mass .9.kg* and *is under an impressed
gravitational force of 9 nts.* are interchangeable with respect to the parameter * is
located on the surface of the earth*.

Endnotes:

1. This paper is partially intended as a commentary upon Hilary Putnam’s “The
   Meaning of ‘Meaning’” (in his Mind, Language and Reality, Cambridge
   University Press (Cambridge, 1975)), to which I am deeply indebted. Thanks also
to George Wilson for extensive discussions essential to the paper’s development
and to Bob Pippin and an anonymous referee for their helpful comments.

2. Actually there are several related types of extension: the set of things presently
P, things which are P at some time or other, spacetime slices of things while they
are P, etc. I ignore these distinctions here and the problem of making these
notions relativistically acceptable!

3. I ignore the pterodactyls present in the original movie. Also, by fiat, insects,
boomerangs, etc., are not to be considered “flying devices.”

4. Journal of Philosophy 70, August 16, 1973. See also Kit Fine, “Vagueness,
Truth and Logic,” Synthese 30, 1975. There is some overlap in spirit between the
Field piece and my own, although his motivating examples are drawn entirely
from Kuhnian “scientific revolutions.” As J. Earman and A. Fine point out in
“Against Indeterminacy,” Journal of Philosophy (Sept. 1977), the subsequent
employment of a term like “mass” is usually uniquely predictable from its prior
usage in such cases (partially because the new equations of motion are derived
through explicit ties to the old). My focus is rather on the silent linguistic
evolutions which may transpire in the course of the most humdrum scientific
research. Kit Fine’s examples are all of the “borderline” case type.

It is quite important to distinguish sharply between the expected vagueness
of a term like “red” where one has been taught (as part of one’s linguistic training)
to anticipate the “borderline cases” and the unexpected vagueness studied here. I
think the two phenomena have quite distinct places within semantics (which
manifests itself clearly when one provides a semantic justification for the
derivation roles of a language). I hope to discuss these matters on another
occasion.
5. *Formal analogy*: extension is to implicit parameter as scale of measurement is to transformation group.

6. For some interesting data on this very matter, see R. Bulmer’s “Why is the Cassowary not a Bird?” *Man* 2(1), March 1967.

7. “The rigidity of zoological nomenclature forces the taxonomist to record borderline forms either as subspecies or as species. An outsider would never realize how many interesting cases of evolutionary intermediacy are concealed by the seeming definiteness of the species and subspecies designations.”—E. Mayr, *Populations, Species and Evolution*, Harvard (Cambridge, 1970), p. 286.


9. An example of a classical theory without extensions might be a Katzian account of “semantic markers.” I do not intend this division of explanatory role to be very precise.

10. Vague predicates like “is red” are best treated in the classical mold as follows: the concept intermediary for the predicate is likewise imprecise, yet conceptually linked to a non vague relation such as ... is redder than ... This associated ordering will provide a measure \( r \) (not necessarily numerical) of a’s nearness to a core. From this measure, a “fuzzy set” of pairs \(<a, r>\) can be assigned to “is red.” Thus Dummett’s ideal observer should be able to assign borderline cases of “is red” to an appropriate ordering from her grasp of the correlated relation.

11. Wittgenstein’s discussion of “following a rule” can be profitably viewed as an attack on this submerged explanatory aspect of classical theory. Incidentally, I feel that much of this paper, especially the treatment of “determine” in section xi, bears close ties to Wittgenstein’s views, but since the *Investigations* have so often served as a Rorschach pattern to elicit the most diverse philosophic opinions, I won’t press the point further.

12. To explain the taxonomy/explanation distinction further: measuring devices can be segregated according to the properties they detect. Such attributions represent a pure taxonomy of measuring instruments, for they provide no explanation at all of how the devices, qua “blackboxes,” work. Nonetheless, such facts can prove valuable parts of other explanations, e.g., “Scott found his way back to camp, because he had a device which could detect magnetic north.”

13. Op. cit., pp. 223-27. This is his well-known “Twin Earth” argument. We shall visit these basic themes again in section xi, purged of “ideas in the head” identifications or kriptic appeals to “indexicality.”


16. Predicates will denote physical properties if they can be "reduced" to purely physical notions. Thus we can expect the special vocabulary of chemistry, biology and so forth to constitute "physical property predicates."


19. At least this is how I shall interpret the natural kind theory, although the originals are not entirely explicit. Putnam views "reference" (the connection between predicate and set) as irreducibly "theoretical," without clear warrant.

20. However adequate understanding of such examples would require a lengthy discussion of definability in physics, which I will not pursue here. Cf., my forthcoming "What is this Thing Called 'Pain'?"

21. It isn't!

22. The requirement that a measurement attribution reflects only the internal composition of the device is the analogue of our earlier adequacy condition for extension assignments.

23. For an explanation of the switch from "measure" to "detect," cf. the appendix. In Nelson Goodman's terminology, "relevant conditions" are needed to convert a counterfactual into a straightforward statement of scientific law (cf. *Fact, Fiction and Forecast*, Bobbs-Merrill (Indianapolis, 1965), p. 5). My implicit parameters can be viewed as appropriate "relevant conditions" for the rather vague counterfactual "if m were applied to object n, m would answer 'yes' if and only if n has P."

24. Some predicates should be indexed by entities which are not true properties in the sense of "Physical Properties," op. cit., but rather ordered n-tuples of a relational property plus particular physical objects. *Is Earthbound* is a case in point. The above definition can be easily expanded to fit these situations, as can
the earlier account for detection devices. Except in English, we require a translation of “Is this P?”

25. If α associates “P” with a relational predicate “T” then “P” can be granted a “fuzzy” extension a (w.r.t. R,A,M, “T”) if (β) (β is the timeless extension for “T” (w.r.t. R,A,M) and α is any directed set determined by (3). Cf. footnote 10. Objects in the “fuzzy” portion of a “fuzzy” extension I call expectedly vague; objects outside the range of application parameter R are unexpectedly vague.

26. Data drawn (with slight simplification) from R. Bulmer, “Karam Colour Categories,” Kivung (November, 1968). The normal dictionary entry for pk is “red,” but it’s extension is clearly not {x| x is red}. This suggests that the relationship between a predicate’s “translation” (in the sense of a dictionary entry) and its extension is not always straightforward.

27. A predicate like “is a chair,” whose instances we may assume will be manufactured by humans, probably represents a mixed case. Its extension, in so far as it is determinate, will consist roughly of those objects possessing objective traits of resemblance to what will happen to be labeled “chairs” by their designers.

28. Throughout this paper, I will suppress the method of application parameter A (cf. appendix), by assuming that the examining agent x is brought from infinity into object y’s spatial vicinity at t with whatever collection of apparatus x might have at hand in his society. This parameter merits more rigorous scrutiny, however.

29. For a fascinating study of these divergent tendencies with respect to terms like “salt,” “acid,” and “butter,” cf M. P. Crosland, Historical Studies in the Language of Chemistry, Dover (New York, 1978). It seems to me that the long vexed problem of whether color properties can be properly identified with quantum structural traits is intimately tied to these considerations. The only legitimate notion of “property” I accept is that of a physical property, but a predicate like “is red” or “weighs 5 lbs.” can be insulated from the pressures to align with a unique physical property through a variety of compensative linguistic factors.


31. To provide an example for “water”: Macroscopic “heavy water” (fluids containing large concentrations of D2O) will not quench thirst or otherwise satisfy biological needs. If, contrary to fact, heavy water had been known since antiquity to occur in natural pools, such stuff would probably not be considered” (macroscopic) water” now, but instead some form of “fool’s water” (although D2O molecules might still be considered “water molecules”).


34. Actually Fahrenheit's "5" was in the wrong place, but Putnam's theory can be clarified to handle this. On the other hand, his account apparently supplies no reason why "has lost 1 BTU of caloric" should fail to denote a property, since presumably some "natural kind" will have been responsible for the physical behavior present at its baptism.


36. Thus a compound term may possess an extension, although some of its components do not. Cf., Philip Kitcher "Theories, Theorists and Theory Change," Philosophical Review (October, 1978), on "phlogiston" versus "dephlogistonated air."


38. Suppose that the rubies on Pluto are such that their present environment permits a peculiar crystalline structure which reflects the ambient low intensity "white" light strongly in the "green." Bombarding the rubies with sufficient radiation to activate the cones in our eyes alters the molecular arrangement to the familiar terrestrial forms. If asked "what color are the rubies presently on Pluto?" we might say, "well, I can't decide on the basis of your description of the case whether they are red or not, but we would be able to tell when we get there." Our overwhelming tendency to respond to science fiction cases in this manner is worth noting—it is an expression of our confidence that our training determines, our classificatory behavior. In truth, we are not awaiting further subtle facts about the objects per se (my description supplied all relevant facts about the rubies' scientific behavior) but for a history of our approach to the rubies. Thus if they are first discovered by a Plutonaut turning her light upon them, the practice of considering them "red" will probably arise, whereas they will treated henceforth as "green" if they are instead first uncovered via a time exposure at low temperatures! What, on the concept view, explains why we adopt this peculiar "wait and see" attitude?

39. Either Wittgenstein or railroad nostalgia inspired Barry Stroud, quite independently, to like imagery. The points of our similar similes are different however. Cf his "Wittgenstein on Logical Necessity," Philosophical Review 74, October, 1965.