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How Ontology Might Be Possible: Explanation and Inference in Metaphysics

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Even people who like philosophy often don't like metaphysics. Ontology in particular, with its arcane discussions of universals and particulars, is frequently cited as a paradigm of desiccated Scholasticism. I don't foresee the day when works on universals top the best-seller list, but I do think that updated versions of many traditional views in ontology can be more responsive to the real world and more interesting than is often supposed. To keep the discussion manageable, I will focus on properties or universals.

My proposal is that we need a reorientation in ontology, one in which we construe arguments for the existence of properties or universals as inferences to the best explanation. I think that many traditional and current arguments for the existence of properties are quite plausibly construed in this way, so the proposed reorientation wouldn't send us back to square one. But the proposal is not simply to attach a fashionable new label to venerable practices; it has three practical consequences.

First, we should acknowledge that there will virtually never be knockdown, demonstrative arguments for (or against) any theory of properties. But this doesn't mean that such theories are empty. They can, if successful, receive *cumulative confirmation* by helping to explain a variety of phenomena. On this picture, the goal is to make one's ontological case by piling up pieces of evidence in its favor. This means that the *unit of evaluation* in ontology should be a research program (rather than a paper or book or even someone's collected works) involving a number of explanations, independent tests, and refinements. Such programs are more likely to prosper if they are pursued by a number of philosophers working toward a common end, rather than by a solitary thinker.

Second, instead of beginning with a detailed picture of the nature of properties, we would gradually come to learn what properties are like by examining the *roles* they are postulated to fill. With luck, various explanations will allow us to triangulate in on the nature of properties. Of course it may turn out that no single kind of entity can perform all of the tasks properties have been invoked to perform. But if this is so, the approach suggested here would help us see that too.

Third, if properties can explain things of interest to philosophers who don't specialize in metaphysics, things like mathematical truth or the logical form of English sentences or the nature of natural laws, then they will appear more interesting. Unlike the substantial forms so derided by early modern philosophers as dormitive virtues, properties will pay their way by doing interesting and important work.

In section 1 I develop these themes in more detail, and in section 2 I quickly sketch a number of traditional arguments in metaphysics and urge that they are very naturally construed as inference to the best explanation. In section 3 I note how several traditional arguments for properties are naturally viewed as inferences to the best explanation, and in section 4 I make several preliminary points about explanation in philosophy. Sections 5–7 are the heart of the paper. Here I present three case studies, mathematical knowledge and truth, semantics of natural languages, and the nature of natural laws, in some detail and show how properties have recently been invoked in efforts to explain them. In the final section I draw several conclusions about inferences to the best explanation in ontology. Along the way I try to respond to the most serious arguments that such inferences are illegitimate, but my conclusions are more aporetic than I would wish. Still, if I am right there is no other metaphysical game in town. So if inference to the best explanation isn't possible in ontology, ontology isn't possible either.[1]

1. SUPERANNUATED IDEALS

There are two reasons for regarding most of the familiar arguments for the existence of properties as inferences to the best explanation. First, on the more traditional construals of such arguments, they are utter failures. Second, many of the arguments look like inferences to the best explanation, and they often make good sense if we interpret them that way. I will consider these points in turn.

1.1. Ontology as Demonstration

The *demonstrative ideal* of ontology as fundamental, first philosophy still enjoys considerable currency. On this picture, ontology is a demonstrative, a priori enterprise that proceeds from secure premises, step by deductively valid step, to secure conclusions. The traditional standards for security were very high, requiring necessary, a priori, self-evident premises. After centuries of failure, philosophers have lowered their standards, and nowadays most would gladly settle for deductions from premises that were uncontroversially true. It's a noble ideal, but it doesn't work. If we judge arguments in metaphysics by these standards they not only fail—*they fail miserably*. Even a philosophical novice, for example, can often spot seven different reasons why the teleological and the cosmological arguments are unsound.

Furthermore, there are always competing answers to the Big Questions in philosophy, and to demonstrate that our favorite answer to one of them is right, we would have to demonstrate that all the competing answers, indeed *all possible competing answers*, are wrong. But when we look at the ways philosophers actually argue against rival positions we find knockdown arguments only in those rare instances where a view can be shown inconsistent (and even here a well-chosen epicycle or two can usually save the day). Instead we typically find arguments that turn on delicate judgments about simplicity, appropriateness of primitive notions, and the like.

1.2. Ontology as Conceptual Analysis

In this century philosophers have sometimes seen philosophy as conceptual analysis, and this might yield secure conclusions without requiring incontrovertible first principles. But quite apart from doubts about whether there is such a thing as conceptual analysis, what concepts could the proponent of properties be analyzing? We don't seem to have any univocal and precise everyday conception of properties, much less of universals. Moreover, none of the familiar arguments for the existence of properties look anything like Socrates's probings about the nature of piety or recent epistemologists' attempts to plumb our intuitions about the conditions under which "*x* knows that *p*."

1.3. Ontology as Reduction

Earlier in this century some philosophers saw the task of ontology as reduction, as showing that some things are really nothing over and above certain other things. The idea here is that there is an ontological bedrock; certain kinds of things are ontologically basic, and everything else somehow derives from them. On this conception the arguments for the existence of certain entities are not deductions from first principles. Rather, a philosopher argues that we can't really reduce certain sorts of things away, but that we can reduce many other things to them. Perhaps, for example, we can reduce physical objects to bundles of properties or numbers to properties.

At one time the typical reductionist's aim was epistemological security. But hopes for a foundationalist epistemology have faded, and nowadays the most common motivation for ontological reduction is ontological economy. The goal is to effect a *purge*, liquidating as many would-be items in our ontology as possible. But although no one wants metaphysical Rube Goldberg machines, reductionist projects typically award parsimony a disproportionate role, making it the most important thing when it is just one good thing among many. Quite apart from this, however, the fact is that reductionist programs don't work. There are no good reasons to think that such projects *can* succeed and countless failures to suggest they can't. Finally, even if one reduction comes close to succeeding, there will be many others that work equally well, and there will typically be no principled way to choose among them (we will return to this issue in section 5.4).

1.4. Applications of Theories Confirmed Elsewhere

Nowadays philosophers sometimes propose an account of some phenomenon, say mental causation or measurement, that relies on properties. Frequently they help themselves to properties with the causal remark that there are good independent reasons to believe that properties exist, so they will be using them without defending them. They can't be faulted for this; life is short, and a philosopher can't be expected to rehearse a detailed defense of properties each time she wants to make use of them. Still, support for the claim that properties exist must originate *somewhere*. On the view I am urging, it comes, a bit at a time, from *each* project that uses properties in a plausible explanation.

Often philosophers agree, since after their claim that there are good independent reasons to think that properties exist, they slip in the remark that if their current project is successful it adds one more reason to the list. My recommendation is that we take this addendum seriously. Projects that employ properties to explain something are, *in the very process of doing this*, arguments that properties exist. This much shouldn't be controversial. But I will also be defending the stronger thesis that this is the *only* plausible kind of argument for the existence of properties.

In short, many of the traditional conceptions of ontology just don't wash. At best they fit uneasily with philosophical practice, and often they make nonsense of it. But to dislodge such ideals, even when our practices rarely match them, we need an alternative. The claim that the most plausible arguments for properties are inferences to the best explanation, that the existence of properties is the best explanation of the success of the projects that employ them, is meant to provide just that.

2. A NEW IDEAL: ONTOLOGY AS INFERENCE TO THE BEST EXPLANATION

The style of argument that Peirce calls *abduction* and that more recent writers call *inference to the best explanation* is far more modest and fallibilistic than traditional pictures of metaphysical argument. As with explanation in general, there is no generally accepted account of inference to the best explanation. As we proceed I hope to shed some light on it, but to get things started we can think of it like this: Some phenomenon is noted. A hypothesis is proposed that, if true, would explain it. Then, to the extent that the hypothesis offers a better explanation than its competitors, we have some reason to suppose that it is true and that any entities it postulates really *do* exist. In this section I will say a bit more about the consequences of taking this seriously.

2.1. Cumulative Support

In many types of inquiry, from the courtroom to the laboratory, we marshal support for a hypothesis by painstakingly piling up pieces of evidence of its behalf. No single bit of evidence establishes our case, but the cumulative weight of the evidence often makes a hypothesis quite plausible. If this is true of arguments for the existence of properties, we shouldn't evaluate them in an all-or-none way, as though they must prove their case if they are to be worth considering. Instead we should consider the contribution each argument makes to the sum total of evidence supporting a given hypothesis about properties.

2.2. Explanatory Roles: Properties Are as Properties Do

Viewing arguments for the existence of properties as inferences to the best explanation also provides a principled way to learn what properties are *like*. If they are invoked to play definite explanatory roles, we can ask what they would *have* to be like in order to play the roles they are called on to fill. What, for example, would their existence or identity conditions have to be for them to explain causation? The answers to such questions won't come easily, for there are bound to be disagreements about the merits of various explanations. Still, if properties can explain a number of different things, this would enable us to triangulate in on their nature using a metaphysical counterpart of Whewell's method of the *consilience of inductions*.

Just over a century ago Bradley characterized metaphysics as the finding of bad reasons for things we believe on instinct (adding that to find such reasons is no less an instinct). Nowadays it would be closer to the truth to characterize it as the formalization of things we believe on instinct (with formalization perhaps on its way to becoming an instinct itself). But if we learn about properties bit by bit, then the plodding work of a detective is a better model for the development of an account of properties than the axiomatic projects of set theorists or topologists. Formalization is often useful, but it should be judged by its fruits rather than the intuitive plausibility of its axioms.

It may turn out that no single kind of entity could play all the roles properties have been invoked to fill. It may be, for example, that the identity or existence conditions of entities well suited to one task are ill suited for entities with a different job to do. If so, what we thought of as properties may fragment into several different kinds of entities. If this is how things turn out, it's how they turn out. But as fragmentation increases, cumulative support and consilience will begin to slip away.

2.3. Making Properties More Interesting

Discussions or properties sometimes seem boring or barren because they are so isolated from other topics. But if we can use properties to help solve problems about the nature of mathematical truth or the semantics of natural languages or the nature of natural laws, they become more interesting because they bear on issues that are interesting.

2.4. Theories of Properties

Properties alone can't explain much. What does the explaining is a *theory* of properties, an *account* of what they are like and how they do the things they are called on to do. In some cases the account might be rather minimal, but in others (e.g., in accounts that use properties to explain mathematical truth or logical form) it will have to be much more detailed, and it will also require the aid of auxiliary hypotheses.

2.5. Nobody Does It Better

A theory doesn't get top billing for explaining something if a competing theory explains it better. Hence, a champion of a theory of properties will have to buttress her explanations with arguments that rival accounts, both competing realist theories as well as the going versions of nominalism and conceptualism, cannot explain some phenomenon or that they cannot explain it as well as her account can. If the demonstrative ideal for ontology were sound such arguments should aim to be knockdown, but in fact almost none of them come close. Once the weakest theories have been eliminated, disputes among the survivors often turn on subtle trade-offs between things, like ontological parsimony or simplicity of primitive notions, that everyone agrees are desirable. Indeed, it is hard to see how they could proceed in any other way.

2.6. The Fundamental Ontological Trade-Off

We will see several such trade-offs below, but one occurs so frequently that it is worth noting now. I will call it *the fundamental ontological trade-off*. It is the perennial trade-off between a rich, abundant ontology with what looks like great explanatory power, on the one hand, and a more modest ontology that promises more epistemological security, on the other. The tension is reflected in the frequent charge that with so much machinery, all those properties or propositions or possible worlds, it's not surprising that an abundant theory can explain a great deal. But, the worry continues, it is difficult to believe in the existence of all that machinery. We will see that this skepticism can be backed by arguments that rich ontologies often require entities we couldn't know about or talk about and, ironically, that this undermines their ability to account for the very things they were introduced to explain. Of course the choice needn't be all or none—feast on an abundant realm of properties of famine with few or none—and a principled middle ground is always worth striving for. But a trade-off here can seldom be avoided.

3. HISTORICAL PRECEDENTS

In this section I will gesture, quite superficially, toward several traditional arguments in metaphysics and note how they are plausibly construed as inferences to the best explanation. I won't go into detail, much less urge that all of these explanations are compelling. The point is simply to indicate how a wide range of arguments that look weak when judged by the demonstrative ideal look much stronger when construed as inferences to the best explanation.

3.1. Substance, God, and Senses

Various philosophical entities have been defended on the grounds that they explain one thing or another. For example, some of the traditional arguments for the existence of God aim to show that His existence would explain what would otherwise be puzzling features of the world, including its intricacy, its order, and even its existence. The concept of substance has also been introduced to explain such things as the persistence of things through change or the individuation of persons and physical objects.

In more recent times facts have been introduced to explain truth (construed as correspondence to the facts), and Fregean Senses, propositions, and possible worlds have be postulated to explain a host of phenomena involving meaning and modality. For example, it has been argued that if words have senses we could explain why some identity statements are informative and account for certain puzzling features of sentences ascribing propositional attitudes.

None of the arguments for (or against) the existence of such entities look like the last word on any of these matters (the arguments against senses come the closest, though even here there is room to maneuver). And once we abandon the demonstrative ideal, it is difficult to see how to view these arguments except as attempts at inference to the best explanation.

This is not to say that the champions of these (putative) entities actually viewed themselves as proposing inferences to the best explanation. Often they construed their argument as an inference to the *only remotely plausible explanation* or an inference to the *only explanation anyone in their right mind would accept* or, even, as an inference to the *only possible* explanation.

In a famous passage Paley describes a watch washed up on the shore. He urges that its intricate workings would naturally lead us to infer that it had been designed by a being with intelligence and skill. It now seems plausible to view this as a proposed inference to the best explanation. The best explanation for the watch is an intelligent designer; analogously, the argument continues, the best explanation for the endlessly intricate world around us is a designer with incomparably more intelligence and skill than the watchmaker. Such an argument faces formidable difficulties, many of which had been noted by Hume (unbeknownst to Paley) before Paley set pen to paper. Still, even those of us who reject Paley's conclusion can, I think, view his discussion as a serious abductive argument that might form part of a cumulative case for the existence of God. This isn't how Paley sees it, though, for he goes on to urge that the existence of God is the *only possible explanation* for the intricacy and order of the world. He tells us that we think this inference to be "inevitable, that the watch must have had a maker" who designed it to tell time (Paley 1802, chap. 1).

In short, my proposal is not that the historical figures who gave the sorts of arguments alluded to here saw themselves as proposing inferences to the best explanation. It is instead a claim about how *we* should judge and evaluate these arguments *today*, in trying to decide whether they point in the direction of accounts that could be plausible for us, here and now. The reason for this is that none of these arguments look very good when judged by the demonstrative ideal. But some look much better when viewed as inferences to the best explanation, and they look better still if they are part of a cumulative case for the conclusion that God or senses or facts exist.

3.2. Universals: The Thirteen Ways

In this subsection I will note thirteen arguments for the existence of properties that are quite plausibly construed as inferences to the best explanation. The arguments vary greatly in plausibility, and they are not intended to indicate a golden, thirteen-way path to platonism. But a mixed bag like this usefully illustrates the range of things that properties have been invoked to explain. In sections 5–7 I will consider several of these cases in more detail.

1. *Resemblance and Qualitative Recurrence*. Some things are alike in certain ways—they have the same color or shape or rest mass—and other things differ. Possession of a common property, for example, a given shade of red, or a mass of 3 kilograms, has often been thought to explain such resemblance, whereas possession of different color properties or mass properties explains their

differences. This has been a traditional motivation for realism with respect to universals, and it continues to motivate many realists today (e.g., Armstrong 1984, 250; cf. Butchvarov 1966).

2. *Recognition*. Many philosophers have argued that an organism's ability to recognize and classify new and novel things as red, circular, or the like is best explained by the hypothesis that the things have a common property, for example, *redness* or *circularity*, and that the organism has somehow learned to recognize it.
3. *A Priori Knowledge*. Some philosophers have argued that the possibility of a priori knowledge is not easily explained unless it is viewed as knowledge of relations among universals (e.g., Russell 1912, chap. 10).
4. *Knowledge versus Belief*. Plato attempted to explain the difference between knowledge and belief by arguing that universals (the Forms) are the objects of the former but not the latter (e.g., *Timaeus*, 51d3ff).
5. *Change*. From Parmenides on, the problem of flux vexed Greek thinkers. Plato argued that change is only possible against a background of things that do not change, and he urged that the Forms provided this (*Theaetetus*, 181c–183b; *Cratylus*, 439d3ff). Nowadays we are likely to reject the demand for some permanent backdrop for change, but properties may still be cited in a quite different account of change. If an individual *a* is red all over at one time and green all over later, then *a* alone can't explain the change. After all, the object *a* persists throughout. But we can explain the alteration by noting that *a* exemplifies the property *redness* at an earlier time and the property *greenness* later.
6. *Causal powers*. Objects have various powers or dispositions, and their properties are often cited to explain these. The liquid in the glass caused the litmus paper to turn blue because the liquid is an alkaline (not because the liquid also happens to be blue); the Earth exerts a gravitational force on the moon because of their respective gravitational masses; smoking tends to cause cancer. Explanations frequently advert to properties, often because they cite causes: the liquid's being an alkaline explains why it turned the litmus paper blue.
7. *Mathematics*. Many philosophers have believed that numbers could be "reduced" to sets, but in the last couple of decades several philosophers have argued that a reduction of mathematics to property theory has various advantages over this more traditional approach. On such accounts we explain things like the truth conditions of the sentences of number theory by construing their subjects and predicates as referring to properties and relations of a certain kind (e.g., Bealer 1982, chaps. 5–6; Jubien 1989; Pollard and Martin 1986). We will return to this example in section 5.
8. *Semantics of General Terms*. General terms like "red" apply to some things but not to others. Many thinkers, ancient and modern, have argued that the possession of a common property (together with certain linguistic conventions) would explain why general terms apply to the things that they do. Thus, Plato noted that "we are in the habit of postulating one unique Form for each plurality of objects to which we apply a common name" (*Republic*, 596A; see also *Phaedo*, 78e; *Timaeus*, 52a; *Parmenides*, 133d; Russell 1912, 93).

9. *Logical Form*. Certain sentences appear to quantify over properties ("There are no acquired characteristics") or to contain singular term in subject position that seem to be anaphorically linked to predicates earlier in the sentence ("John is tall, and that is a good property for a basketball player"). Some philosophers and linguists have tried to explain the semantic behavior of such sentences, including the logical relations (like entailment) among them, by ascribing truth conditions to them in which linguistic expressions (predicates, abstract singular terms, some pronouns) denote or express properties. We will return to this example in section 6.
10. *Laws of Nature*. Some philosophers have argued that viewing natural laws as relations among properties provides the best explanation of various features of laws, including their ability to be confirmed by their instances, support counterfactuals, explain empirical phenomena, and be discovered rather than invented (Armstrong 1978; Dretske 1977; Tooley 1977; Swoyer 1982). We will return to this example in section 7.
11. *Measurement*. The view that what we directly measure are the properties of things has been held to explain why alternative procedures can be used for measuring the same magnitude, the possibility of measurement errors, the use of properties (e.g., a given wavelength of light) to provide basic units of measurement, and to show how to integrate facts about measurement into a realist account of laws and causation (Swoyer 1987, §1; cf. Mundy 1987).
12. *Intensional Logic*. It is often argued that a semantic account of linguistic contexts containing intensional idioms like *believes*, *imagines*, and *desires* requires properties (e.g., Bealer 1982; Menzel 1993; Zalta 1983, 1988).
13. *Cognitive Phenomena and Content*. It has also been urged that philosophical explanations of such mental states as beliefs, imaginings, and desires require properties (e.g., Zalta 1988).

In some cases, for instance, 4, the arguments may seem weak or even pointless. Some seem weak because they are, but the appearance of pointlessness is more interesting. Perhaps one reason for it is that judgments about the relative importance of the things needing explanation alter over time. During the Middle Ages, for example, theological phenomena were very important, and the Trinity and the Eucharist were high on the list of things a philosopher needed to explain. Nowadays far more philosophers yearn for naturalistically respectable explanations of things like causation or the nature of natural laws. But my point here is concerns the form of these arguments (construed as charitably as possible) rather than their plausibility. In sections 5–7 we will consider three of these cases in more detail, but it will be useful to note two points first.

4. CURRENT EXPLANATIONS

4.1. Synonyms of "Explain"

The word "explain" often figures explicitly in arguments for the existence of properties. One reason, we are told, to think that there are properties is that their existence would *explain* qualitative recurrence or some tricky feature of logical form. But even when the word “explain” is absent, we often find claims that some phenomenon holds *in virtue of*, or *because of*, this or that property, that a property is the *ground* or *foundation* of the some phenomenon, or that a property is (in part) the *truth maker* for a sentence describing the phenomenon. The role of such expressions is to give reasons, to answer why-questions, and this is a central point of explanation.

4.2. Preliminary Doubts

Various doubts can be raised about inference to the best explanation in philosophy. We will be in a better position to evaluate them once we have inspected the case studies in subsequent sections, but I want to acknowledge several of them here.

4.2.1. *First challenge: There is nothing to explain.* The first challenge is that the things the realist wants to explain are illusory. For example, very able philosophers have denied that the sentences of mathematics have truth values, that words have determinate semantic values, and that there are any natural laws. Some of these challenges may be more plausible than others, but all three represent minority views, and to keep things manageable I will simply assume that various features of arithmetic, the semantics of English, and natural laws are genuine things that might be capable of philosophical explanation.

4.2.2. *Second challenge: No explanation is required.* Some philosophers agree that such phenomena are genuine but deny that they require any special, philosophical sort of explanation. Deflationary accounts of reference and truth often have this consequence; for example, on such views sentences or arithmetic do have truth values, but there are no deep philosophical explanation of their truth conditions. This line may be more plausible in some cases than in others, but these issues will be easier to evaluate once we have examined some concrete cases.

4.2.3. *Third challenge: Philosophical explanation is impossible.* Finally, there can be doubts about the nature of ontological explanation itself. Is it like scientific explanation, or is it somehow unique? Whether it is much like scientific explanation depends on what scientific explanation is like, and there is nothing like a consensus about this. I think that many discussions of scientific explanation involve false dilemmas and that there are a number of distinct explanatory virtues. (See Salmon 1989, 180ff, for one way of defending this claim.) Often these virtues accompany each other, but like most good things they are sometimes in tension. Some of the explanatory virtues in science, for example, pinpointing causal mechanisms or citing statistically relevant information, are not likely to be found in ontology, but others, like unification, might be. The only way to get clearer on the matter, though, is to consider examples.

Some of the realist’s traditional *explananda*, for example, resemblance and qualitative recurrence, are still with us. But taken alone, the explanations properties provide for such things are rather thin, and they bear on few topics outside of ontology itself. In the next three sections I will examine three topics—arithmetic, semantics, and natural laws—that seem to require more elaborate explanations that do bear on topics of wider philosophical interest.

5. MATHEMATICS

5.1. Mathematics: What Is to Be Explained

Number theory (arithmetic) is only a small portion of mathematics. It is the part that has received the most philosophical attention, however, and many of the philosophical issues in other parts are similar to the problems that arise here, so I will focus on it. There are disagreements over which features of number theory require explanation, but many philosophers would accept something like the following list.

1. At least many of the statements of arithmetic are either true or false.
2. Statements in number theory have the truth values they do quite independently of human language and thought. Fermat's last theorem was true before Andrew Wiles proved it, and it would still have been true even if no one had ever discovered a proof.
3. The surface syntax of many sentences in arithmetic strongly suggests that they contain singular terms that refer to things and predicates that express properties and relations. For example, the surface form of "6 > 2" looks a lot like that of "Sam is taller than Ted," which at least suggests that "6" and "2" refer to objects and that ">" expresses a binary relation.
4. Claims about mathematics must be capable of justification by proofs. (In its more recondite regions this is the only method of justification.) Proofs employ inference rules that are in turn justified by the fact that they are necessarily truth-preserving. So a philosophical account of number theory should explain how standard modes of inference (from *modus ponens* to mathematical induction) can legitimately be applied to arithmetical claims.
5. The statements of number theory necessarily have the truth values that they do.
6. It is possible to have reliable and justified beliefs and, indeed, knowledge in mathematics.
7. It is possible to have a priori knowledge of many mathematical truths.

Some of these items (like the claim that sentences of number theory can be true or false) are more central than others (like the claim about apparent logical form). But other things being equal, most philosophers would agree, the more of them a theory can explain, the better.

5.2. Mathematics: How Properties Explain

My aim now is to indicate how recent theories of properties have been mobilized in attempts to explain the items on this list. I will consider questions about the plausibility of these explanations later in the paper.

The dominant program in the foundations of mathematics for over a century has been what might be called *identificationism*. The idea is to *identify* the natural numbers with some other sort of things (or, better, with things that we hadn't realized were really the numbers). Frege and Russell in effect identified numbers with sets (though neither thought of their enterprise literally in terms of sets), and Zermelo, von Neumann, and many others since identified numbers with sets quite explicitly.

But there is nothing about identificationism that requires that numbers be identified with sets, and in recent years several philosophers (e.g., Bealer 1982, chaps. 5–6; Pollard and Martin 1986; Jubien 1989) have argued that we should instead identify numbers with properties.

As we will see in section 5.4, there can be various motivations for a property-based identificationism. But whatever the rationale, the goal is to define property-theoretic proxies of arithmetical creatures (like zero and successor), and then to prove that these induce translations that carry truths of arithmetic to truths of the reducing property theory and carry falsehoods to falsehoods. The basic recipe goes as follows.

First, find a realm of properties to be the natural numbers. Since there is a countable infinity of natural numbers, we need a realm with at least a countable infinity of properties.

Second, the sequence of natural numbers is structured in a very special way (it's called an ω-sequence). Sequences with this structure have a unique first member and no repetitions, and each member has a unique member coming right after it. So we must postulate some structure in our realm of properties so that they form (or contain) an ω-sequence.

Third, identify some particular property in our realm of properties (the first in the sequence) with zero and some relation with the successor relation, and then identify the natural numbers with all of the objects in the realm that bear the ancestral of this relation to the object we paired up with zero (much as von Neumann identified 0 with the empty set and the successor of x with $x \bigcup \{x\}$).

Fourth, the relevant features of the natural numbers are distilled in Peano's Postulates. So we must prove that we can derive our property-theoretic translations of Peano's Postulates (or their equivalents, or at least a first-order approximation) from (definitional extensions) of the first principles of our theory of properties.

There are two very general ways to proceed. The first employs a very powerful property theory that includes axioms analogous to those of familiar set theories (minus the axiom of extensionality, and perhaps with other minor emendations). On this approach the above steps are straightforward, since they retrace much of the same ground as set-theoretic versions of identificationism.

The second approach identifies numbers with properties, at least some of which are exemplified in the actual world (e.g., Armstrong 1989, chap. 9; Bigelow and Pargetter 1990). Champions of this approach must work harder to find all the properties they need to serve as the natural numbers (to say nothing of the real numbers or transfinite cardinals), since they cannot simply postulate them with a set of axioms at the outset. The two approaches have different strengths and weaknesses (I have discussed the second approach in Swoyer 1996, §5), but their explanations of most of the items on our list proceed in similar ways.

5.3. Mathematics: The Explanations

In addition to the claim that there is a realm of properties of the appropriate size with the appropriate structure, property-based identificationism requires several auxiliary hypotheses in order to explain anything. The central auxiliaries are (i) the *metaphysical* hypothesis that the natural numbers really are just the properties our identificatory scheme says they are, and (ii) the *semantic* hypothesis that the numerals and arithmetic predicates of natural languages refer to or express the appropriate properties ("0" refers to the property we identify as zero, etc.).

Once this machinery is in place it is straightforward to explain the first four items on our list. The syntax of the simple sentences of arithmetic seems to involve singular terms that refer to numbers (item 3) because that is precisely what they do. Moreover, since the terms are correlated with mind-independent properties standing in the appropriate mind-independent relations, we can explain the mind-independent truth values of sentences of number theory (items 1 and 2). And since we can give a standard account of the truth conditions of the sentences of arithmetic in first-order (or, if you prefer, second-order) logic, we explain the applicability of standard rules of inference (item 4) by noting that the rules necessarily preserve truth so defined.

Many philosophers hold that the sentences of number theory *necessarily* have the truth values that they do (item 5). In the present context this requires an infinite collection of properties that *exist necessarily*. So accounts like Armstrong's that treat properties as contingent beings will either have severe problems explaining this putative datum or else they will have to explain it away.

The last two (putative) *explananda* are epistemological. We can have reliable, justified beliefs about arithmetic, for example, that 1 + 1 = 2 (item 6). Furthermore, according to many philosophers we can have a priori knowledge of mathematical truths (item 7). Accounts like Armstrong's that identify numbers with properties exemplified in the natural world have an edge with item 6, since it is a bit easier to see how we might come to know something about them, but this gives them a harder time with item 7. But any account of these two *explananda* will require substantive empirical auxiliary hypotheses about human cognition, and there are no well-confirmed hypotheses of this sort available today.

5.3.1. *Best explanations versus indispensability arguments.* It is worth pausing briefly to contrast such accounts with Quine's influential indispensability argument. Quine develops his argument in the context of a holistic account of theory confirmation. Our beliefs—our total body of theory—confront the tribunal of evidence as a whole, and since our scientific theory incorporates claims that seem to quantify over numbers (or sets, to which Quine thinks numbers can be reduced), the claim that numbers exist is confirmed every time we confirm any part of our overall theory about the world.

Quine's account *can* be reconstrued as a inference to the best overall explanation, but one needn't endorse his sprawling holism to conclude that numbers or sets or properties exist because their existence explains various things. In science and in daily life we certainly do bring different bits of evidence to bear on different subsets of our beliefs or different parts of our general theories. (See Glymour 1980 for an account of one way this might work.) It is not clear why things should be different in philosophy. At all events, the seven *explananda* on the list above are quite specifically about mathematics, and one can try to explain them without any commitment to holism whatsoever.

5.4. Mathematics: Why Explanations Using Properties Are Best

Thus far we have examined the property theorist's claims that properties, together with several auxiliary hypotheses, can explain the various items on our list of *explananda*. Her next step in constructing an inference to the best explanation is to argue that her account provides a *better* explanation than the available alternatives.

5.4.1. *The competition.* The word *available* is important. There is no general way to show that a property theorist's account of arithmetic provides better explanations than all possible rivals. Indeed, arguments that one theory provides a better explanation of mathematical phenomena than another does often turn on quite detailed and specific features of the two accounts.

Later we will consider cases where properties have features, for example, intensional identity conditions, that might enable them to explain phenomena that extensional creatures like sets cannot. But mathematical phenomena are extensional, and there are two serious realist alternatives to property identificationism. The first is the view that the natural numbers are unique abstract objects that aren't identical with sets or properties or anything else. The second is a family of views whose members identify numbers with sets in one way or another.

Like property identificationism, both of these views seem well suited to explaining the early items on our list involving truth and objectivity, whereas all three rivals fare less well in explaining the later items involving epistemology. Moreover, both of property identificationism's rivals have advantages over it. The view that there are natural numbers, period, doesn't require any formal account of properties (or, for that matter, sets), it's extensional, and it takes many of our naive intuitions about numbers at face value. And the view that the natural numbers are sets, though less intuitive, has its natural home in an extensional theory of sets that has been developed and explored over many decades, and that now provides a powerful and unified framework in which most of mathematics can be developed. So a property theorist must argue that the apparent strengths of these views are illusory or else that properties offer enough advantages to compensate for these disadvantages. The first response is difficult for a realist to defend, but the second is more promising.

5.4.2. *We need them anyway.* It is difficult to argue that properties are better than numbers or sets as long as we focus solely on mathematics. The best arguments for property identificationism are those that claim that we need properties for tasks outside of the philosophy of mathematics; since we need them anyway, we should use them in our philosophy of mathematics. They can do all of the work of sets (or numbers) and more besides. At this point the property theorist might argue sets and numbers don't exist (on grounds of ontological parsimony), or he might argue that sets are derivative, constructible from certain sorts of properties (cf. Bealer 1982, chaps. 5–6).

In short, the argument goes, the view that sets (or just plain numbers) afford better philosophical accounts of arithmetic results from a metaphysical myopia. If we step back from mathematics and consider the bigger picture, we find that we need only one sort of entity, properties, to explain things in a variety of domains. So properties provide the best global, overall explanation. This does mean that champions of properties have little hope of making their case by focusing exclusively on mathematics. The arguments in this realm will need buttressing by arguments from other areas, which of course fits nicely with the claim that the case for the existence of properties will be cumulative. Still, arithmetic is a good place to begin, since it provides especially clear *explananda* and explanations.

5.4.3. *Other fronts: Family quarrels.* To streamline exposition I have treated property identificationism as a generic view, but different philosophers develop this approach in different ways, and there are family quarrels among them. The important point here is that the arguments each side gives for thinking its explanations better than its rival's are far from demonstrative. Indeed, there will typically be limiting cases in which it will be difficult to give *any* argument that one account is better than certain of its rivals. For if there is one way to pair numbers with the properties postulated by a given theory of properties, there will be many ways, and it will often be difficult to make any case that one out of the many possible pairings delivers the Metaphysical Truth. (This point was stressed by Benacerraf [1965] about attempts to identify numbers with sets, but it arises equally for attempts to identify numbers with properties, cf. Swoyer 1996, §5.)

5.4.4. *Other fronts: Antirealists.* The property identificationist also has to fight on a broader front against various antirealist views of mathematics. Here the disputes are more about what the phenomena are. For example, many people agree that the sentences of arithmetic certainly *seem* to have truth values. The realist will insist that we take this appearance at face value, whereas the antirealist will try to explain it away. But here again, it is difficult to see how either side could give a demonstrative argument that the other side is wrong. As always, there are pluses and minuses.

To begin with, there is the fundamental ontological trade-off, the recurring tension between an opulent ontology (that aims to account for a host of things) and a more modest ontology with greater epistemological security. The more we postulate, the harder it is to believe in all of it, and very rich theories of properties court the danger of paradox (a nice word for inconsistency). If numbers are abstract objects it may seem that we can explain how claims about them can be timelessly and necessarily true. But it becomes harder to see how we can get into epistemic touch with them, and this raises questions about whether we could even have beliefs *about them*, much less justified beliefs. This in turn raises questions about how we could link our words to them; if we can't, this would subvert a number of the explanations (e.g., of logical form) that properties were introduced to provide.

This dialectic is especially dramatic in disputes between realists and antirealists, but it can arise in family quarrels between identificationists. For example, someone like Armstrong can argue that since he identifies numbers with properties that are instantiated in the actual world, we have epistemic access to them in a way that we couldn't have to properties existing outside space and time.

There are other trade-offs as well. Is a simple account of the logical form of the sentences of arithmetic that is homogeneous with a semantics for the rest of English (to the extent that we have one) sufficiently valuable to justify a rich ontology? (A nominalistic program like Hellman's [1989], which requires a lot of reparsing, looks more plausible if the answer is "no.") Is it better to have a richly detailed explanation of a narrower range of phenomena or a less detailed explanation of a wider range? Should we accept more entities in order to have fewer primitive notions? Are the primitives of one account more perspicuous than those of another, and how much should it matter if they aren't? Such considerations are unavoidable—what else *could* we go on? But once we eliminate the most obviously unpromising theories, the issues among those that remain are often nebulous or delicate, and arguments about them rarely look demonstrative.

There are various accounts in the foundations of mathematics that I haven't considered, but I have tried to say enough to make three claims plausible. First, there are good arguments for property identificationism, and most of them turn on the ability of properties to *explain* various mathematical phenomena. Second, most of these arguments proceed in tandem with arguments that property identificationism (or some particular version of it) provides *better* explanations than its rivals. Third, although the arguments in both of these stages may be strong, they are *not demonstrative*, and there is little prospect of strengthening them so that they are. If this is right, it is difficult to resist the conclusion that such arguments are attempts to provide inferences to the best explanation.

6. SEMANTICS AND LOGICAL FORM

Language and logic have always been a fruitful source of data for ontologists. In the paper in which he announced his theory of definite descriptions, Russell said that a logical theory should be tested by its capacity for dealing with puzzles, and he urged that his theory solved three problems about substitutivity, truth, and negative existentials. Russell's motivations were partly metaphysical and epistemological, but it is quite possible to view his theory of descriptions as a piece of semantic theory about the meanings of English definite descriptions. And he is surely right that if a theory explains things that its rivals cannot, things like the informativeness of certain identity statements or the nonsubstitutivity of coreferential expressions in belief contexts, that is a mark in its favor.

In recent years several philosophers and linguists have devised theories of properties with the express purpose of providing semantic theories of natural language (e.g., Chierchia and Turner 1988), and several other writers have invoked properties to account for various semantic features of natural language (e.g., Bealer 1982; Zalta 1983, 1988; Menzel 1993).

6.1. Semantics: What Is to Be Explained

The surface structure of an English sentence is often an unreliable indicator of its logical capacities, telling us little about which sentences it entails or which sentences entail it. Sentences that appear quite similar may behave quite differently in these respects, and sentences that appear quite different may behave similarly. This has led many thinkers to embrace a theoretical notion of *logical form*. The aim is to provide *theoretical redescriptions* of sentences in terms of their logical forms in way that allows us to *explain* semantic properties like logical truth, consistency, and entailment.

In the context of such accounts properties have been invoked in an effort to explain the following:

1. General terms like "red" and "round" can apply to different individuals. Furthermore, many predicates that in fact have the same extension might have had different extensions; even if exactly the same things are red and round, for example, this is an empirical accident, not a deep or necessary feature of either language or the world.
2. Some words and phrases, for example, nominalizations like "honesty," seem to be referring singular terms, and many of the sentences containing these terms are not easily paraphrased in ways that dispel this appearance. Cases in point include "Honesty is a virtue" and "Red resembles orange more than it resembles blue."
3. We use pronouns and other singular terms in subject position that are anaphorically linked back to predicates: "Washington was honest, and *that* is a good feature for a President to have."
4. Many English sentences appear to quantify over the semantic values of predicates, and often these quantifications are not easily paraphrased away or otherwise dismissed as mere figures of speech. Examples include "Napoleon had all the properties of a great general, but Custer did not," "There are several different properties that account for the forces that particles exert on each other," and "There are some properties that will never be named." (If the last sentence is true, it precludes a semantic account of these sentences that treats their quantifiers substitutionally.)
5. These apparent quantifications seem to be entailed by their substitution instances. For example, "Clinton and Gingrich are both tenacious" seems to entail "There is some property (feature, quality) that Clinton and Gingrich both have."
6. We can count the things that predicates seem to stand for; for example, "Clinton and Gingrich have two important things (features, qualities, properties) in common."
7. Some sentences seem to involve identity claims about properties: "According to some versions of the doctrine of the unity of virtue, courage and temperance are the same thing."
8. Various English constructions, including relative clauses and conjoined and disjoined verb phrases, are naturally construed as *complex predicates*. For example, "Rover is an Alsatian that bit someone Tom hit" is naturally parsed as predicating "is an Alsatian that bit someone Tom hit" of "Rover." Such expressions are also employed as parts of generalized quantifiers like "some high and mighty politicians" and "most six-year-olds who don't believe in Santa."
9. Complex predicates can involve subtle scope distinctions. For example, "The color of my true love's hair is necessarily black" can mean that she necessarily has black hair *or* that the actual color of her hair, namely black, is necessarily black.
10. English brims with intentional idioms like *believes*, *imagines*, and *desires*, and these present difficult problems for any theory of meaning for English.

6.2. Semantics: How Properties Explain

The basic idea is to explain these phenomena by postulating properties to serve as the semantic values of predicates and their nominalizations. We need a very rich theory of properties to supply enough semantic values, and we will also need some substantive auxiliary hypotheses.

6.2.1. *Auxiliary hypotheses.* First, we need a hypothesis about the underlying logic (as determined by the recursion clauses in a truth definition) that will be used in an account of logical form. In programs like Davidson's this is basically first-order logic, but in most accounts that invoke properties it is much richer. For example Zalta's (1983, 1988) theory incorporates a full theory of types along with modal and tense operators, predicates that denote properties and relations, devices for forming complex predicates, and a powerful logic that delivers every instance of a comprehension schema (according to which every well-formed condition on objects expressible by any formula meeting certain restrictions determines a property).

Second, we need a linguistic hypothesis that the sentences of English have certain logical forms; for example, we might claim that the logical form our sentence about Rover really does contain a complex predicate.

Third, we need hypotheses—bridge principles—pairing linguistic expressions with the properties that are to serve as their semantic values. Among other things we need a hypothesis that predicates (at least often) express properties, and that their nominalizations denote the property that the predicate expresses. For example, "honest" expresses the property *honesty* and "honesty" denotes it.

Fourth, we eventually need an account of the way in which actual expressions in a natural language come to have the semantics values they do (although no one now is close to having a detailed and general account about this).

6.3. Semantics: The Explanations

We can explain the behavior of simple general terms (item 1) with a fairly rudimentary account of properties. An English sentence of the form $\ulcorner a$ is $F \urcorner$ is true just in case a denotes some object α, F denotes (or expresses) some property ϕ, and α exemplifies ϕ. With the right auxiliary hypotheses a rich theory of properties can also explain items 2–7, and it can do so without requiring a wholesale regimentation of English. Thus, in many recent accounts nominalizations seem to function like referring singular terms (item 2) because they *are* singular terms that refer to properties. This also enables us to adapt any standard account of anaphora (item 3) to handle properties, since an anaphoric pronoun can now refer back to the property that is the semantic value of an earlier predicate or nominalization.

When a Lamarkian says "There is some acquired characteristic that Lassie has," the sentence behaves like an existential quantification because it *is* an existential quantification and, indeed, an objectual one. Hence, the sentence is true just in case there is at least one property that is an acquired characteristic of Lassie's, and this is so whether that property is the semantic value of any English expression or not (item 4). This also allows us to use completely standard and familiar logical principles to explain why existential quantifications are entailed by their substitution instances; if an object exemplifies the property expressed by a predicate "*F*," then there is some property that it exemplifies (item 5). And since properties are genuine things, we can count them (item 6) and use different expressions to stand for the same property (item 7).

These rough and ready explanations can be made precise if we develop a formal logic (of the sort described briefly below) and represent English sentences by interpreted sentences of the formalism. One might view the sentences in the formal language as providing deep structures of English sentences and develop transformation rules mapping them to surface structures of English sentences. But current accounts are less precise about the match between the formal sentences and sentences of English, relying primarily on heuristics and rules of thumb, so-called "translation lore."

The next step is to introduce a semantic account for the logic that places a domain of properties alongside the domain of individuals in each model (e.g., Zalta 1988); alternatively, we can employ an untyped formal language, and simply dump all of the properties and relations into a single domain alongside the individual objects (e.g., Bealer 1982; Menzel 1993). Either way, we then add an extension function to each model that assigns the appropriate sort of extension to each property; it assigns a (possibly empty) set of things to each one-place property, a (possibly empty) set of ordered pairs of things to each two-place relation, and so on. If we like, we can extend this machinery by adding sets of times, worlds, or other indices to our model structures and assigning extensions to properties at times, worlds, or other indices.

We then define satisfaction for monadic atomic formulas in terms of our primitive notion of extension: a value assignment satisfies the open sentence $\ulcorner x \text{ is } \phi \urcorner$ just in case the individual it assigns to x is in the extension of the property denoted (or expressed) by ϕ (this extends routinely to predicates with any number of argument places). We can then define satisfaction for complex sentences, including existential quantifications, with the usual sorts of recursion clauses (except that we now allow quantification over the semantic values of properties). There are various ways to implement the details, but most of them are variations on this approach (see Zalta 1983; Menzel 1993; Swoyer 1998; Bealer's [1982]) approach is somewhat different but secures essentially the same results). We can then make our intuitive explanations of the first seven items on our list quite precise. For example, existential quantifications are entailed by their substitution instances (item 5) because the recursion clause for existential quantifications in our truth definition guarantees that existential generalization is necessarily truth-preserving.

What about the last three items on our list? If we view phrases like "is high and mighty" and "does not believe in Santa" as complex predicates that express "compound" properties, we can explain why they seem to apply to a variety of objects (item 8). We can also draw various useful scope distinctions (item 9; cf. Swoyer 1997; Linsky 1984). But what *is* a compound property?

Many complex predicates have what looks like a logical structure; for example, the first predicate in the previous paragraph looks like a conjunction and the second looks like a negation. The idea is to take these appearances at face value by postulating a set of logical operations that carry properties into more "complex" properties. For example, a conjunctive operation would carry the properties *being* *red* and *being square* into the conjunctive property *being red and square*. We then place constraints on extension assignments so that something exemplifies this conjunctive property just in case it exemplifies both *redness* and *squareness*. We needn't think of this property as literally being structured or compound; to say that it is conjunctive is just to say that something exemplifies just in case it exemplifies *redness* and *squareness.*

Similar operations guarantee the existence of properties like *loving Sam* and *loving someone*. We then classify predicates into kinds (e.g., conjunctions, existential quantifications) and provide a recursive definition of the denotation (or expression) of these predicates. This can be done in such a way that conjunctive predicates denote conjunctive properties, negative predicates denote negative properties, and so on (Zalta 1983 contains a particularly elegant way of doing this), and this machinery enables us to explain many features of the behavior of complex predicates.

Explanations of the semantic behavior of intentional idioms (item 10) like "believes that" typically require properties that are very finely individuated, probably as finely individuated as the linguistic expressions that denote them. For example if the properties *redness and squareness* and *squareness and redness* are distinct, we can account for the fact that Sam believes that the cube on the table is red and square while doubting that it is square and red. Few people would be guilty of a blatant lapse like Sam's, but we can all fail to realize that two properties necessarily have the same extensions when they are described in complicated ways.

We can obtain very fine-grained identity conditions for compound properties by placing tight constraints on the operations that generate them. We may wonder whether this gives us distinctions without differences (as when it distinguishes a relation like *loving* from the converse of the converse of itself). And it is not clear that we can dissolve all of the paradoxes of intensionality with even the most fine-grained properties. But if we think that really finely individuated properties will help solve some of the puzzles of intensionality, this approach provides a principled way to get them.

6.4. Semantics: Why Explanations Using Properties Are Best

There are two general alternatives to property-based semantic theories.

6.4.1. *The competition: Sets.* The first alternative takes the semantic values of predicates to be sets of individuals. Various general semanticists have adopted this approach, but the best-known example of it is Davidson's (1984) program, which aims to provide a theory of meaning for a fragment of English by providing a first-order theory of truth for it.

Although a great deal in ingenuity has gone into Davidsonian accounts, they face several serious problems, and some of them would persist even if we employed a logic with more resources (e.g., devices for dealing with predicate modifiers or complex predicates). The program requires a great deal of regimentation, some of which seems rather unnatural, but the main problem is that some kinds of sentences seem almost certain to resist treatment in this framework. The chief difficulty is that sets are much too coarse-grained to provide semantics for the predicates of a natural language. If the set of red things and the set of round things happened to have the same extensions (including an empty extension), then they would have the same semantic values. There are many problematic constructions for this approach, several of which are illustrated by the sentence "Red resembles orange more than it resembles blue, and Sally thinks that Tom believes that there are only two colors that she prefers to it."

6.4.2. *The competition: Intensions.* Other theorists have identified properties with functions, sometimes called *intensions,* that assign an extension to each predicate at each time in each possible world (or in terms of other set theoretical constructions that encode the same information). These approaches typically use more powerful formal languages than first-order logic, and in the hands of Montague (e.g., 1974) and philosophers and linguists he inspired (e.g., Lewis 1970), they have led to work of great depth and elegance. But their treatment of predicates still leads to problems.

First, we learn the meanings of many predicates by ostension, and we seem to group objects together when they share a property (rather than thinking they share a property because they are all members of some set). Property theorists explain this by saying that we learn to recognize a property, and we can then determine whether other objects fall into its extension. But these simple facts become mysterious on the possible-worlds approach, since it treats the meaning of a predicate as an incredibly complicated set-theoretic entity that involves infinitely many times in infinitely many possible worlds. We might overlook this difficulty by viewing intensions simply as parts of a formal model that reflects various features of English. But the account of the semantics of predicates would still be too coarse-grained, since it treats predicates that are necessarily coextensive, like "lasted a fortnight" and "lasted two weeks," as expressing the same property. This will make it very difficult to explain how "Wilbur believed the jail term lasted two weeks" could be true while "Wilbur believed the jail term lasted a fortnight" was false.

The possible worlds account requires a rich ontology, but property-based theorists are ill advised to throw stones here, since the most obvious way to deal with puzzling intensional constructions is to employ a semantics that assigns an extension to each property at every time in every world. It may be that worlds and times can be constructed from properties (cf. Zalta 1988) or that possible worlds can be avoided entirely (Bealer 1982, esp. §46). But property-theoretic approaches to semantics still require a great many properties, and it isn't clear that they offer a substantially leaner ontology than possible-worlds accounts do.

6.4.3. *Family quarrels.* Of course there are alternative ways to use properties in the semantics for natural languages. One key difference is between accounts that employ a typed language (e.g., Zalta 1988; Swoyer 1993) and those that do not (e.g., Bealer 1982; Menzel 1993). The former may reduce the risk of paradoxes stemming from self-predication, but judiciously designed versions of the latter may do so as well, and they are much more flexible. With enough ingenuity, though, both approaches can handle a wide range of phenomena, and there are no utterly decisive arguments for (or against) either approach.

6.4.4. *Evaluating the alternatives.* There are two types of arguments that a semanticist can give against a competitor's account. The first cites specific kinds of constructions that her own account can handle but the competing account cannot. For example, a sentence that takes the semantic values of predicates to be sets will have a very difficult time explaining the semantical behavior of sentences attributing propositional attitudes. Indeed, some sentences, like "The temperature is ninety and rising," have almost become test cases for various approaches.

Since the arguments here depend on the details of the specific case, there is nothing very general to say about all of them. But it is worth noting that they often end in a grudging admission that perhaps a rival account *can* handle certain constructions, but it does so in a way that is unnatural or ugly. For example, "The King of France is bald" looks like a subject-predicate sentence, but on Russell's account of definite descriptions, it dissolves into an existential quantification containing a cloud of logical constants. Again, Davidson's paratactic account of belief sentences seems unnatural to many. But although such arguments often carry a good deal of weight, they are far from being demonstrative.

The second kind of arguments involves trade-offs between one desideratum and another. Is it better for a theory to assign logical forms that stick closely to the syntactic structures of sentences (at the price of a powerful logic and rich ontology), or is it better to employ a lot of regimentation in order to scrimp by on a simpler logic and sparser ontology? Is it worth trading a compositional semantics—one in which the semantic values of complex syntactic expressions are functions of the semantic values of their constituents—to avoid problems with belief sentences? Again, arguments for alternative answers to these questions are often important, but they are rarely decisive.

6.4.5. *There are no crucial experiments.* It is also difficult to make tests bear directly on the *ontologies* of competing semantics accounts. A semantic theory for a natural language will include several complex auxiliary hypotheses, and when something goes wrong it is always possible, and often plausible, to pin the blame on one of them.

For example, semantic theories pass judgments about the validity or invalidity of many of the arguments in their jurisdiction, and we can check our intuitions to see whether their verdicts are right. But our intuitions about validity are often cloudy and unsystematic. It may seem extremely odd for someone to endorse the premises of a particular argument while rejecting its conclusion. It doesn't follow that the argument is valid, though, since there may well be alternative explanations for the oddity. For example, it may seem odd because of a conversational implicature; it may violate some norm of conversation (like being relevant) to endorse the premises without endorsing the conclusion. Or the argument from the premises to the conclusion may be valid, but not formally so; for example, if "Today is Sunday" is true, then "Tomorrow is Monday" must be true as well. Again, there may be some lawlike regularity that leads speakers to think that if the premises are true the conclusion must be true as well: "Sue had a baby, so Sue is female."

The point is that if a semantic theory fails to count an intuitively good argument as valid, its proponents can often explain this away by urging that any intuitions that it seems valid actually stem from some other source (e.g., we mistake a conventional or a conversational implicature for a logical entailment). After a certain point such maneuvers may be ad hoc, but there is no definite point at which they are forbidden, and so once again such considerations are not decisive.

My aim in this section has been (1) to shed light on the ways in which properties might help explain a range of semantic phenomena, (2) to note that their proponents also try to show that their explanations are better than alternatives, and (3) to indicate several reasons why their arguments are not demonstrative. In short, the uses of properties in semantics represent an attempt to draw an inference to the best explanation.

7. LAWS OF NATURE

7.1. Natural Laws: What Is to Be Explained

In recent years several writers (e.g., Armstrong 1978, 1984; Dretske 1977; Tooley 1977, 1987; Swoyer 1983) have argued that properties or universals, along with an auxiliary hypothesis about the nature of laws, explain the central features of natural laws and explain them better than rival accounts can. I will call these theories *universalist accounts of laws*. I will focus on deterministic laws. (Probabilistic laws are at least as important, but if the current accounts can't get deterministic laws right they aren't likely to work for anything else.) There are a number of features of laws that we might want to explain (Armstrong 1983, 99ff, lists thirteen), but the following five are among the most central:

1. Laws are objective. We don't invent laws, we discover them.
2. Laws, unlike accidental generalizations, are confirmed by their instances and they underwrite predictions.
3. Laws have genuine explanatory power. They play a central role in scientific explanation that mere universal generalizations do not.
4. Laws have some sort of modal force. This shows up when we describe laws (or their implications) using words like "must," "cannot," and "impossible."
5. Laws entail, but are not entailed by, their corresponding universal generalizations.

None of the *explananda* on this list are completely uncontroversial. But they are standardly cited symptoms of nomologicality and most philosophers would agree that, other things being equal, the more of them an account of laws can explain, the better.

7.2. Natural Laws: How Properties Explain

Universalists have developed their accounts in somewhat different ways, but here I will focus on the simple, common core of their accounts. The universalist's thesis is that laws are relations among properties. Universal generalizations (sentences of the form ⌜All *F*s are *G*s⌝) are often used to gesture toward laws, but they are not laws themselves. The real law involves a relation among the properties *F* and *G*, which will typically be determinate physical magnitudes like a mass of 0.56 kg or a kinetic energy of 3×10^{-2} joules. The law does *not* hold because all of the individuals that are *F*s are also *G*s. It holds because there is something about being an *F* that makes a thing (or a thing related to it in the appropriate way) be a *G*.

For example, in a Newtonian world any body that has the (conjunctive) property of having a certain net force *f* (a vector, and hence a relational property) acting on it and a mass *m* (a scalar, and hence a monadic property) would also have a determinate acceleration property *f*/*m*. Some writers call this higher-order relation among physical magnitudes *nomic necessitation* ("***N***," for short). So on this account statements of at least the simpler deterministic laws have the logical form $\ulcorner \boldsymbol{N}(F,G) \urcorner$.

One advantage of construing the universalists' arguments as inferences to the best explanation is that it enables them to respond to two recent criticisms of universalism. The first criticism is that we have no idea what the relation ***N*** is like (the second is the identification problem that is mentioned below). But if we view the arguments for universalism as inferences to the best explanation, we should approach this question by asking what ***N*** would *have* to be like in order to explain the things it is postulated to explain. So the answer (to the extent that there is one) will emerge only as we look at the explanations the account offers.

In the preceding sections I discussed the explanations offered by property theorists in one subsection and their arguments that their explanations are better than their rivals' in another. But the development of universalism is so thoroughly intertwined with criticisms of its chief rivals, regularity theories of laws, that it will be clearer to consider the two stages together.

7.2.1. *Regularity theories.* There are many versions of the regularity theory, but they share the core idea that laws are simply contingent regularities (or the sentences expressing them), differing from accidental generalizations only in having some special epistemic, pragmatic, or logical trappings (e.g., containing projectible predicates like "rest mass" rather than "grue," or being part of a powerful yet simple deductive theory of nature). The most prominent variant nowadays is the Ramsey-Lewis account, according to which laws are those universal generalizations that would be part of the overall systematization of our theories about the world that best combines simplicity and strength.

Earlier in this century regularity theories typically talked about predicates and sentences rather than properties. This is not surprising, because such theories were favored by empiricists who often found properties epistemically suspect, but a regularity theorist could talk about regularities among properties. Even if the regularity theorist and the universalists both invoke properties, however, we will see that there are still large differences between their accounts.

There are various problems with regularity theories (see Carroll 1994, chap. 2, for a good discussion), but the major issue between universalists and regularity theorists involves—yet again—the fundamental ontological trade-off. Regularity theories have a relatively low epistemological cost. We observe instances of regularities here in the actual world, and the additional features used to upgrade universal generalizations to laws don't seem epistemically problematic in any deep or ineluctable way. The problem, according to the universalist, is that this epistemic security is only achieved by making the account so weak that it can't explain the fundamental, distinctive features of laws.

7.3. Natural Laws: The Explanations

To bring these points down to earth, it will be useful to consider a few universalist attempts to explain the items on our list above.

7.3.1. *Objectivity.* The universalist argues that laws are objective because the ***N***-relation relates those properties it does quite independently of our language and thought (in the case of properties that don't specifically involve us or our language or thought). By contrast, regularity theories depend on features that are too subjective or anthropomorphic to account for the objectivity of laws. Which predicates are entrenched in our language, what explanations we actually give, and perhaps even what theories are simplest depend too much on contingent facts about us and our practices.

7.3.2. *Confirmation and prediction.* According to the universalist, it is unclear what could justify accepting a mere generalization short of checking all of its instances. If laws merely record regularities, why should the fact that observed *F*s are *G*s lead us to conclude that *F*s we haven't encountered will be *G*s too? If the *F*s I have observed are to be relevant to my belief that unobserved *F*s will be *G*s, then there needs to be something about an object's being *F* that requires (or, in the case of probabilistic laws, makes it probable) that it will be a *G*. And if the properties stand in a nomic relation, there is something about an object's being an *F* that will make it be a *G*, and the examined cases will be related to the unexamined cases in the relevant way.

7.3.3. *Explanation.* The accidental regularity that all of the cars I saw today were red doesn't explain why any particular one of them is red. But, universalists sometimes argue, if one property nomically necessitates a second, that does explain why anything having the first property has the second.

This isn't the universalist's best argument. If there are many different explanatory virtues, this may well afford a glimmer of understanding; it tells us that the correlation holds as a matter of law and that we shouldn't look around for particular facts in the world to explain it (as we might for the fact that all the cars I've seen today have been red). Of course this won't be a very deep or informative explanation; it doesn't provide causal mechanisms, for example, or a more fundamental and far-reaching story about the relevant properties. But with the most basic laws something like this may well be all we can offer by way of explanation. At some point we may hit the end of the explanatory road; perhaps it simply is a law that bodies that have certain forces acting on them accelerate in certain ways. And, says the universalist, better there should be genuine laws at this point then mere, brute regularities (however the regularity theorist might propose to deck them out).

7.3.4. *Modal force.* Perhaps the most distinctive features of laws is their modal force, the way they seem to require some things and preclude others. Pauli's exclusion principle *requires* that two fermions occupy different quantum states; the special theory of relativity *doesn't allow* a signal to be propagated at a velocity exceeding that of light; the laws of thermodynamics show the *impossibility* of perpetual motion machines. Conservation laws assure us that such quantities as angular momentum, mass-energy, and charge *cannot* be created or destroyed. The modal force of laws may seem to show up in the way that laws commonly support counterfactuals; if there had been a tenth planet, it too would have obeyed Kepler's laws.

Regularity theorists maintain that laws are contingent universal generalizations with some special, but nonmodal, additional features, so it isn't surprising that it is difficult for them to account for the modal force of laws. It is also difficult to explain this modal force if it is a *purely contingent* fact that two properties stand in the ***N***-relation. How, for example, does such an account support claims about the impossibility of a perpetual-motion machine? Indeed, if it is purely contingent whether two properties stand in the ***N***-relation, then this relation doesn't unite them because of what they are like; it just happens to link some properties in the actual world while linking completely different properties in others. On this account light could have had the phenomenal properties of molasses, photons the mass of the solar system, and elementary particles could retain their identity while swapping all their quantum numbers.

The moral is that you can't derive a *must* from an *is*. Not a *genuine* nomological *must*, anyway (though perhaps you can pull some sort of ersatz *must* out of a hat full of nonmodal facts). If we want genuine modal force to fall out at the end, we have to build it in at the beginning, and on the universalist account there is no place to put it except in the relation ***N*** itself. If this is correct, there is reason to think that ***N*** involves a fundamental *de re* connection among properties (as it would if such connections among properties were metaphysically necessary). But if we move in this direction, the fundamental ontological trade-off becomes more pressing, and the epistemic cost of universalism begins to rise.

7.3.5. *Laws necessitate their corresponding generalizations.* If it is a law that all *F*s are *G*s, it follows that each particular *F* is a *G*. It is easy for regularity theorists to explain this. According to them a law is, in effect, a conjunction of a universal generalization and something else, so the law certainly entails the universal generalization. But it is more difficult for a universalist to explain why the inference from $\ulcorner N(F,G) \urcorner$ to $\ulcorner$All *F*s are *G*s$\urcorner$ is legitimate (van Fraassen 1989, 96, calls this the *inference problem*).

Universalists have produced some very subtle solutions to the inference problem (e.g., Tooley 1987, 128ff), but I think that it would be better just to bite the bullet here. There is no obvious reason why there should be any familiar (or even *un*familiar) *logical* principle that would carry us from $\ulcorner N(F,G) \urcorner$ to $\ulcorner$All *F*s are *G*s$\urcorner$. It would be enough if the second sentence had to be true whenever the first sentence was.

When we invoke ***N*** as part of the best explanation of various phenomena we have to invest it with whatever features it needs to have in order to explain those phenomena. Consider the less controversial case of conjunctive properties. An individual will have the conjunctive property of *being F and being G* just in case it has the property *being F* and it also has the property *being G*. This is just a brute fact about conjunctive properties; to postulate the existence of conjunctive properties is to hypothesize the existence of properties that behave in this way. Similarly, one of the features of the ***N***-relation is that if it relates the properties *F* and *G*, then all *F*s will be *G*s. We can say a certain amount about this relation. But its introduction is part and parcel of a philosophical account of laws, and it is supported (to whatever extent it is) by the ability of that overall account to explain the nature of laws better than any of its competitors.

The *explananda* and explanations involving laws are murkier than their counterparts in the two preceding sections. Moreover, as they stand some of the universalists' explanations leave much to be desired. But as in previous sections, I have tried to say enough to make three claims plausible. First, there are plausible (though scarcely overwhelming) arguments for universalism, and they turn on the ability of properties to *explain* various features of laws. Second, most of these explanations go hand in hand with arguments that universalism provides *better* explanations that its competitors, particularly regularity theories. Third, the arguments for, and against, current accounts of laws are *not demonstrative*, and there is no prospect of strengthening them so that they will be.

8. MORALS

8.1. Explanation and Unification

We have now seen cursory sketches of three types of explanations properties have been said to provide. What can we say about them? Even in science it seems doubtful that there is a single point to explanation, much less that there is only one format explanations can assume. In the right context we can explain something by subsuming it under general laws, by noting its causes, or by citing statistically relevant phenomena, and the last two, anyway, don't occur in philosophical explanations involving properties. But we can also explain by invoking principles or entities that unify and integrate a range of phenomena. By redescribing a host of seemingly diverse objects as bodies with inertial and gravitational mass, Newton gave a unified explanation of the motions of the planets, projectiles, colliding bodies, and the tides. And Michael Friedman (1974) and Philip Kitcher (1989) are surely right in urging that such unification is *a* key feature of explanation (though I wouldn't go on to claim that it is the only explanatory virtue).

Seeing a pattern, a common structure, yields one sort of understanding. Newton allowed us to see superficially diverse phenomena as similar in theoretically important ways. The notions, like inertial mass, gravitational mass, and force, involved in his explanations are not intrinsically clearer or more familiar than the notions to be explained, but that isn't a defect, because the explanatory gain is global.

Analogously, properties offer unified and integrated accounts of the items on our lists of mathematical, semantical, and nomological *explananda*. This way of thinking about properties may be as old as philosophical accounts of properties themselves. In a classic paper on Plato's theory of Forms, Cherniss (1936) argues that Plato saw his theory as solving difficult problems in ethics (explaining how ethical principles could be objective), epistemology (explaining the difference between knowledge and belief), and metaphysics (explaining how change is possible). We might add that it also helped him explain the semantics of general terms (cf. *Republic*, 596A; *Phaedo*, 78e; *Timaeus*, 52a; *Parmenides*, 133d). This isn't to say that all of Plato's explanations were successful—far from it. But the general pattern of *explanation by unification and integration* was at work in one of the first accounts of universals. This isn't enough to show that such explanation is legitimate, though, and I will briefly consider several challenges to it before closing.

8.2. Inference to the Best Explanation

Some philosophers have argued that explanations don't *ever* justify belief in the existence of postulated entities (at least not in entities that are in principle unobservable). Are they right? There can be no question of demonstrating that the entities postulated in an inference to the best explanation always exist (since they don't). Nor is it possible to demonstrate that such inferences will, more often than not, yield true conclusions when we start out with true premises. Inference to the best explanation is a form of ampliative inference, and Hume was surely right that such inferences cannot be justified in non-question-begging ways.

But inference to the best explanation is *not* some arcane concoction of metaphysicians. We often infer that something exists on the grounds that its existence would explain something that would otherwise be puzzling (Wilbur must have had an accomplice—there is no other way to account for his immaculate getaway). Such inferences also seem common in science. (If molecules exist, that would explain why grains of pollen dance along on the surface of water.) Moreover, we typically think that a theory must do more to save the phenomena than merely be consistent with them, and explanation seems a key addition. These issues are still being debated in discussions of scientific realism; I agree with those writers who think that explanation sometimes leads, legitimately, to inference, but since my reasons are similar to ones that are now familiar in the literature, I won't rehearse them here.

8.3. Philosophical Explanation

Even if inference to the best explanation is legitimate in science it doesn't follow that it's legitimate in philosophy. There are two obvious differences between the two. First, there are incontrovertible paradigms of successful scientific explanations. Newton explained the motions of the tides; Einstein explained gravitational phenomena. There is simply nothing comparable to such success stories in philosophy. Second, many inferences to the best explanation in science are inferences to the existence of *causes*. One of the first reasons people had for believing in the existence of molecules was that they explained Brownian motion, and they explained it because they caused it. But although properties may confer causal powers on their instances, they are not causes in the same way that the jostlings of molecules are.

Kuhn has remarked that partisans of competing scientific paradigms often disagree not only about what counts as a genuine explanation, but also about what stands in need of explanation in the first place, and it may be tempting to conclude that a similar situation obtains in philosophy. The kernel of truth here is that it typically *is* difficult to show that something is a genuine philosophical problem, and it isn't something we could ever hope to prove. Still, although philosophical explanations are not nearly as deep as our best scientific explanations, there are several reasons to think that the sorts of phenomena discussed in this paper can receive philosophical explanations.

First, many of the greatest philosophers in history have struggled to provide explanations for philosophically puzzling phenomena. They may have been misguided, but it seems unlikely that so many acute thinkers from such different historical periods were all in the grip of some simple confusion about what can, or should, be explained. Moreover, many of us still find some of these phenomena genuinely puzzling, so we needn't rely solely on authority for thinking that they are.

Second, claims that the sorts of items on our various lists cannot be given philosophical explanations are typically asserted with little argument, and the few arguments I know of are unimpressive. Not so long ago, for example, we often heard that talk about properties rested on grammatical confusions or linguistic errors, and we were assured that with the proper sort of therapy we could dissolve such pseudoproblems. But such diagnoses often turned on dubious views about meaning, for example, some sort of verificationism, which would also eviscerate much of our talk outside of philosophy.

Third, accounts involving universals are sometimes said to be vacuous, to simply introduce obscure phrases to relabel everyday phenomena like qualitative recurrence (e.g., Quine 1961, 10; Quinton 1973, 295). But many of the explanations we have seen rely on general principles about properties that have enough content to be disconfirmed. In connection with various auxiliary hypotheses, these principles can be tested, and they can certainly fail some of those tests. Nor does the fact that items on our lists call for philosophical explanation ensure that realism, much less any particular version of realism, will emerge victorious. Competing accounts that don't involve universals, for example, a resemblance theory or a theory of tropes, might turn out to afford better explanations.

Fourth, many philosophers who are not devotees of ontology nevertheless agree that there are genuine philosophical puzzles concerning mathematical truth, logical form, and natural laws. So these areas provide a less controversial testing ground for theories of properties.

Finally, it is worth remembering that it is often easier to engage in a practice than to explain it. Scientists can recognize explanations in their fields without being able to give an account of explanation; indeed, there is no generally accepted account of scientific explanation. This doesn't mean that explanations are possible in philosophy, but it does mean, I think, that we can be more certain that there are explanations than we can be about their exact nature. At all events, my aim here is not to provide an account of philosophical explanation. But I hope I have assembled enough examples to suggest that arguments for properties, though they often fall short, are best construed as attempts at inferences to the best explanation. And such examples are the kind of data on which any account of inference to the best metaphysical explanation must be based.

8.4. Good, Better, and Best

The quality of an explanation matters. The best available explanation may be too feeble to underwrite inference, and many of the debates among property-theorists concern the relative merits of rival explanations.

Sometimes straightforwardly philosophical constraints play a role in evaluating explanations in ontology. For example, empiricists like Russell sometimes endorsed a principle of acquaintance, a requirement that the primitive entities in the ontological menagerie be observable. Other philosophers have urged that if one thing is to figure in an ontological explanation of a second, it has to be *in* that second thing, or that at the very least the entities must partake of the natural, causal order. For example, this seems to lie behind Aristotle's objection that Plato separated the Forms from the natural world. The sense of *in* may be metaphorical, but the intuition here is that *x*'s standing in some (not very clearly described) relation to something outside space and time can't really explain anything about *x* and its earthly vicissitudes. Such issues can be quite complex, and some (like the principle of acquaintance) involve an entire philosophical orientation. I don't know whether anything general can be said about them, but they do play a role in our evaluations of philosophical explanation.

But less parochial, more familiar considerations are often more central. Other things being equal, we want breadth, precision, simplicity (in as many of its myriad forms as possible), freedom from ad hoc hypotheses, and an account that coheres with the rest of our views about the world. Such criteria are nebulous, and they can pull in opposite directions. But without them much ampliative inference would be impossible.

8.5. Convergence or Fragmentation

I must, alas, end with what may turn out to be bad news. It would be gratifying to find a single, unified account of properties that helped explain a wide range of phenomena. We could then build a cumulative case for the existence of properties, and we could triangulate in on their nature by seeing what they would need to be like in order to play these diverse explanatory roles. But there is a danger that the sorts of entities that are good for explaining some phenomena may not be good for explaining others. In particular, the identity and existence conditions of entities well suited to one task may be ill suited for entities with a different job to do.

For example, the identity conditions best suited to properties used to explain causation, measurement, and natural laws seem to be that properties are identical just in case they bestow the same causal (or nomological) roles on their instances. By contrast, the properties needed in semantic accounts of intentional idioms of a natural language would have to be individuated in a much more fine-grained way. Again, there may be good reasons for thinking that the properties needed to explain things like causation or laws must be instantiated in the natural world if they are to explain what they are supposed to (e.g., Armstrong 1978; Swoyer 1996). But explanations of such things as mathematical truth or the semantic values of English predicates will require a very rich realm of properties, and especially in the latter case it is unreasonable to suppose that all of them could actually be instantiated.

If such fragmentation occurs (and there is some reason to fear it will; Swoyer 1996, 1998), we could settle for the conclusion that there are several different sorts of property-like entities (as Bealer does with his concepts and qualities). But this would make it more difficult to build a cumulative case for the existence of any one sort of entity and harder to use a range of explanations to triangulate in on the natures of those with which we end up.

9. CONCLUSION

Friends and foes of properties often talk past each other. I think this frequently results from deep (and often unarticulated) disagreements about whether explanations are possible in ontology, what things (if any) can be explained, and what such explanations (if possible) would be like. These are not easy disagreements to settle, but I have tried to take one step in the direction of clarifying them.

NOTE

1. I have discussed some of these issues elsewhere (Swoyer 1983, 1996), though in less detail, without the case studies, and without drawing the morals drawn here. When I speak of *realism* I will mean realism with respect to properties unless the context makes it clear that some other sort of realism is at stake. To avoid frequent qualifications I will use "property" and "universal" interchangeably, and I will treat relations as properties; I will also use "metaphysics" and "ontology" interchangeably. Distinctions among these things are often important, but they won't matter here. I am grateful to Monte Cook, Ray Elugardo, and Jim Hawthorne for helpful comments on the first draft of this paper.

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