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Research Article

Geographical categories: an ontological investigation

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Abstract. This paper reports the results of a series of experiments designed to establish how non-expert subjects conceptualize geospatial phenomena. Subjects were asked to give examples of geographical categories in response to a series of differently phrased elicitations. The results yield an ontology of geographical categories—a catalogue of the prime geospatial concepts and categories shared in common by human subjects independently of their exposure to scientific geography. When combined with nouns such as *feature* and *object*, the adjective *geographic* elicited almost exclusively elements of the physical environment of geographical scale or size, such as mountain, lake, and river. The phrase *things that could be portrayed on a map*, on the other hand, produced many geographical scale artefacts (roads, cities, etc.) and fiat objects (states, countries, etc.), as well as some physical feature types. These data reveal considerable mismatch as between the meanings assigned to the terms 'geography' and 'geographic' by scientific geographers and by ordinary subjects, so that scientific geographers are not in fact studying geographical phenomena as such phenomena are conceptualized by naïve subjects. The data suggest, rather, a special role in determining the subject-matter of scientific geography for the concept of *what can be portrayed on a map*. This work has implications for work on usability and interoperability in geographical information science, and it throws light also on subtle and hitherto unexplored ways in which ontological terms such as 'object', 'entity', and 'feature' interact with geographical concepts.

1. Introduction

What is the field of geographical information science about? What is 'geographical' about geographical information? What makes an object a *geographical* object? Geographers and others have debated these questions for many decades, and we do not propose to resolve the underlying issues here. Instead, we offer a preliminary overview of ontology as this term is currently used by philosophers, information scientists and psychologists. We then use this overview as background

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to the presentation of detailed evidence as to how the geographical is distinguished from the non-geographical by non-experts. Thus we report on how the domain of geography is defined and conceptualized *from the outside*.

We believe that this work is of more than simple curiosity value, telling geographers and geographical information scientists how the subject-matter of their work is conceived by others (although already in this respect it contains a number of results which many will find surprising). Our results are also of theoretical importance: they throw light on one common type of human cognition that has seldom been studied (whether by geographers, cognitive scientists, or philosophers). And our results are also of practical importance, in that they can help us to understand how different groups of people exchange (or fail to exchange) geographical information, both when communicating with each other and also when communicating with computers. With the proliferation of GIS and GIS-related applications on the world wide web, there is an ever-increasing need to know how non-experts conceptualize the geographical domain. A sound, empirically supported ontology of geospatial phenomena will thus form a central part of the foundation for geographical information system design in the future.

2. Categories and ontology

2.1. *Cognition and pre-scientific theories*

With many scientific disciplines we can associate what we might call a *pre-scientific* or '*folk*' counterpart. Psychologists and cognitive anthropologists have in recent years studied theories of naïve physics, of folk psychology, and of folk biology, and the importance of such studies is now widely accepted. Naïve physics, for example, is of practical importance to those confronting the problems involved in the design of mobile robots which would possess sensorimotor capacities equivalent to those of human beings. Folk psychology is important to evolutionary psychologists, whose studies of the biological roots of our inherited psychological capacities are beginning to transform our understanding of human cultural and psychological universals. The importance of folk biology is revealed in fields such as ethnobotany, a scientific discipline devoted to the study of folk theories of plants and of their medicinal properties: it studies the objects and processes identified in the corresponding folk theories from a scientific point of view.

Each such folk discipline is like its properly scientific counterpart in having its own determinate subject-matter. But our pre-scientific thinking taken as a whole, too, has its own subject-matter, which we might think of as 'common-sense reality': this is the niche, or the environment, which we all share in our everyday perceiving and acting. It is the world of affordances, in J. J. Gibson's sense (Gibson 1979).

2.2. *Eliciting ontologies*

Is it legitimate to put these various folk and scientific domains side by side with each other in this fashion? Are we not lending too much credence to folk *lore* in supposing that it, too, can have its own peculiar objects, analogous to the objects of genuine sciences such as physics or chemistry? These are difficult questions, which have been studied for some two thousand years by the branch of philosophy known as ontology. Ontology is distinguished from all the special sciences, and from all the branches of folk theory, in that it seeks to study in a rational, neutral way all of the various types of entities and to establish how they hang together to form a single whole ('reality'). It studies, in other words, the totality of objects, properties, processes and relations which make up the world on different levels of focus and granularity, and whose different parts and aspects are studied by the different folk and scientific disciplines.

In the work of Quine (1953) ontological theorizing seeks to *elicit* ontologies from scientific disciplines. Ontology thus takes the form of the study, using logical methods, of the ontological commitments or presuppositions embodied in different scientific theories. These methods were extended to the domain of common-sense theories in the papers collected in Hobbs and Moore (1985). Casati *et al.* (1998) and Smith and Varzi (2000) attempted to apply similar formal methods to the domain of folk or naïve geography; that is, they attempted to elicit the folk ontologies of common-sense geospatial reality to which ordinary human subjects are committed in their everyday cognition in much the same way in which philosophers of science, earlier, had attempted to elicit the ontological commitments of scientific theories by examining the logical structure of such theories.

In relation to the folk domains, however, we have not only such abstract logical methods at our disposal, but also the empirical methods of psychology. It is these empirical methods which have been applied, in the studies of Keil (1979, 1987, 1989, 1994), Medin (Murphy and Medin 1985, Medin and Atran, 1999), Atran (1994). and others, to the task of eliciting the folk ontologies of naïve subjects in such areas as folk physics, folk biology and folk psychology. And it is these same empirical methods which were used in the experiments reported on below.

2.3. *Ontology and information systems*

The term ‘ontology’ has another use, however, which arose in recent years within the domain of computer and information science to describe the results of eliciting ontologies (in Quine’s sense) not from scientific theories or from human subjects but rather from information systems, database specifications, and the like. To understand the nature of this ontological (data) engineering, it will be useful to introduce first of all the technical notion of a ‘conceptualization’.

We engage with the world from day to day in a variety of different ways: we use maps, specialized languages, and scientific instruments; we engage in rituals and we tell stories; we use information systems, databases, ATM machines and other software-driven devices of various types. Each of these ways of engaging with the world, we shall now say, involves a certain *conceptualization*. What this means is that it involves a system of concepts and categories which divide up the corresponding universe of discourse into objects, processes and relations in different sorts of ways. Thus in a religious ritual setting we might use concepts such as *God, salvation* and *sin*; in a scientific setting we might use concepts such as *micron, force* and *nitrous oxide;* in a story-telling setting we might use concepts such as *magic spell, dungeon* and *witch*. These conceptualizations are often tacit, that is, they are often invisible components of our cognitive apparatus, which are not specified or thematized in any systematic way. But tools can be developed to render them explicit (to specify and to clarify the concepts involved and to establish their logical structure). Tom Gruber, one of the pioneers of the use of ontological methods in information science, defines an ontology precisely as ‘a specification of a conceptualization’ (Gruber 1993).

Gruber proposed this definition in the context of his work on the Knowledge Interchange Project at Stanford, an attempt to address what we might call the Tower of Babel problem in the field of information systems. Different groups of data-gatherers each have their own idiosyncratic terms and concepts which they use to represent the information they receive. When the attempt is made to put this information together, methods must be found to resolve terminological and conceptual incompatibilities. Initially, such incompatibilities were resolved on a case-by-case basis. Gradually, however, it was realized that the provision, once and for all, of a 'concise and unambiguous description of principal, relevant entities of an application domain and their potential relations to each other' (Schulze-Kremer 1997) would provide significant advantages over the case-by-case resolution of successive incompatibilities as they arise in the interactions of specific groups of users or collectors of data. This is because each such group would then need to perform the task of making its terms and concepts compatible with those of other such groups only once: by calibrating its results in the terms of the single canonical description. The term 'upper-level ontology' is used by information scientists to refer to a canonical description of this sort or to an associated classificatory theory, and the IEEE has a study group to define a 'Standard Upper-Level Ontology' (IEEE 2000), which would specify the general ontological concepts—such as part, whole, number and so on—used across all domains.

An ontology, in the information science sense, is thus a neutral and computationally tractable description or theory of a given domain which can be accepted and reused by all information gatherers in that domain. From the ontological engineering perspective, ontology is a strictly pragmatic enterprise: it concerns itself not at all with the question of ontological realism, that is with the question whether its conceptualizations are *true of* some independently existing reality. Rather, it starts with conceptualizations, and goes from there to a description of corresponding domains of objects or 'closed world data models'. Note that the ontological method so conceived is not restricted to the information systems domain. Indeed it can be used to deal indiscriminately with the generated correlates of conceptualizations of all sorts, and it ends up treating each of these as 'universes of discourse', as 'posits' or 'models', as surrogate created worlds, all of which are treated as being on an equal footing.

2.4. *Good and bad ontologies*

The relevance of this ontological engineering background to our concerns here is as follows. The project of a common ontology which would be accepted by different information communities in different domains has (thus far at least) failed. We hold that one reason for this failure has been precisely that the attempt at ontology integration was carried out on the basis of a methodology which ignored the real world of flesh-and-blood objects in which we all live, and focused instead on closed world *models*. Ontological engineering has been, in fact, an exercise not in ontology at all, but rather in model-theoretic (set-theoretic) semantics.

This choice of semantic methodology was understandable for pragmatic reasons: closed world models are much simpler targets, from a mathematical point of view, than are their real-world counterparts. If, however, the real world itself plays a significant role in ensuring the unifiability of our separate ontologies, then it may well be that the project of unification on the basis of a model-based methodology is doomed to failure.

To see what the alternative methodology might be, we need to recognize that not all conceptualizations are equal. Bad conceptualizations (rooted in error, myth-making, astrological prophecy, or in antiquated information systems based on dubious foundations) deal *only* with created (pseudo-)domains, and not with any transcendent reality beyond. Good conceptualizations, in contrast, are transparent to some corresponding independent domain of reality. Only ontologies based on good conceptualizations, we suggest (Smith 1995b), have a chance of being integrated in a robust fashion into a single unitary ontological system.

Of course to zero in on good conceptualizations is no easy matter: there is nothing like a Geiger counter which we can use to test for truth. Rather, we have to rely at any given stage on the best endeavours of our fellow human beings and proceed, in critical and fallibilistic fashion, from there. Our best candidates for good conceptualizations are then illustrated by those conceptualizations of the developed sciences which have undergone rigorous empirical testing. But there are almost equally good candidates also in the realm of naïve cognition: for many of our folk category systems, too, have undergone rigorous empirical tests, sometimes stretching over many thousands of years, and we can assume that they, too, are to a large degree transparent to the reality beyond: that mothers, apples, milk, and dogs truly do exist, and they have the properties we commonsensically suppose them to have.

We will focus in what follows on good conceptualizations in the folk domain, a notion which we will make more precise in terms of Robin Horton's doctrine of 'primary theory', to be discussed below. We are concerned primarily with the ontology underlying such conceptualizations. However the study of folk conceptualizations along the lines here presented may also be of interest in helping us to provide better theories of common-sense reasoning, for if common-sense reasoning takes place against a background of common-sense beliefs and theories, then we cannot understand the former unless we also develop good theories of the latter. The study of the ways non-experts conceptualize given domains of reality might then help us also in our efforts to maximize the usability of corresponding information systems. The work of ontological engineers such as Nicola Guarino and his co-workers (Guarino 1998, Guarino and Welty 2000) shows further that, for reasons related to those presented here, the study of good conceptualizations can have advantages also in eliminating certain kinds of errors in data-collection and data-representation.

2.5. *Ontology in the geographical domain*

We will henceforth take it for granted that the geographical concepts shared in common by non-experts represent a good conceptualization in the sense proposed above. They too are transparent to reality: mountains, lakes, islands, roads truly do exist, and they have the properties we commonsensically suppose them to have. The task of eliciting this folk ontology of the geographic domain will turn out to be by no means trivial, but we believe that the effort invested in focusing on good conceptualizations in the geographical domain will bring the advantage that it is more likely to render the results of work in geospatial ontology compatible with the results of ontological investigations of neighbouring domains. It will have advantages also in more immediate ways, above all in yielding robust and tractable standardizations of geographical terms and concepts.

If many of the common-sense concepts of our folk disciplines are transparent to reality, then clearly they are often transparent to different aspects and dimensions of reality than are the concepts illuminated by science. Different conceptualizations may accordingly represent cuts through the same reality which are in different ways skew to each other. The opposition between naïve physics and scientific or sophisticated physics reflects above all a difference in levels of *granularity*. Naïve physics reflects a mesoscopic partitioning (that is to say: it is concerned with objects at the human scale), whereas scientific physics involves also microscopic and macroscopic partitions (corresponding to atomic and sub-atomic physics on the one hand and to astronomy and cosmology on the other).

As J. J. Gibson expressed it:

> The world can be analysed at many levels, from atomic through terrestrial to cosmic. There is physical structure on the scale of millimicrons at one extreme and on the scale of light years at another. But surely the appropriate scale for animals is the intermediate one of millimeters to kilometers, and it is appropriate because the world and the animal are then comparable. (Gibson 1979, p. 22)

Note that there are in addition disciplines that are not naïve but yet relate to the very same mesoscopic objects as are associated with our naive-level partitions of reality. As the already mentioned case of ethnobotany shows, there is trained as well as untrained (critical as well as uncritical) knowledge of the common-sense world. Thus there are various specialist extensions of folk disciplines, including: law, economics, land surveying, planning, engineering, paleontology, cookery—and geography. The design of Geographical Information Systems, too, involves a specialist extension of common sense along these lines (Egenhofer and Mark 1995). One not inconsiderable reason why we need to get the ontology of common-sense reality right is that such systems are engineering products in which common-sense reality is embedded.

One task of geographical ontology will be to study the mesoscopic world of geographical partitionings in order to enable the construction of mappings between these mesoscopic partitions and the partitions of associated scientific domains such as geology and meteorology. Mesoscopic geography deals mostly with qualitative phenomena, with phenomena which can be expressed in the qualitative terms of natural language; the corresponding scientific disciplines, in contrast, deal with the same domain but consider features which are quantitative and measurable. GIS thus requires methods that will allow the transformation of quantitative geospatial data into the sorts of qualitative representations of geospatial phenomena that are tractable to non-expert users—and for this purpose, once again, we need a sound theory of the ontology of geospatial common sense.

In earlier work we have claimed that the geographical domain is ontologically distinct from non-geographical domains (Smith and Mark 1998). One of the most important characteristics of the geographical domain is the way in which geographical objects are not merely *located* in space, but are typically *parts* of the Earth's surface, and inherit mereological properties from that surface. At the same time, however, empirical evidence suggests that geographical objects are organized into categories in much the same way as are detached, manipulable objects (Mark *et al.* 1999). Against the background of our remarks on good conceptualizations above, we shall attempt to do justice to these two aspects of geographical common sense in what follows.

3. Primary theory

3.1. *The limits of common sense*

What are the limits of the common-sense world? Does the belief that the Earth is flat belong to common sense? Did it ever belong to common sense? Does common sense evolve over time? Does the belief that babies are brought by storks belong to common sense, even if everyone in some culture at some given time believes it? To answer these questions, it is useful to divide the messy and problematic totality of naïve or untutored beliefs into two groups, following the anthropologist Robin Horton's distinction between 'primary' and 'secondary' theory.

For Horton (1982) 'primary theory' is that part of common sense which we find in all cultures and in all human beings at all stages of development. 'Secondary theories', in contrast, are those collections of folk beliefs which are characteristic of different economic and social settings. Primary theory consists of basic (naïve) physics, basic (folk or 'rational') psychology, the total stock of basic theoretical beliefs which all humans need in order to perceive and act in ordinary everyday situations. (Forguson 1989, Smith 1995c) Secondary theory consists of folk beliefs which relate to gods and evil spirits, heaven and hell, molecules and microbes.

Our primary naïve beliefs relate to mesoscopic phenomena in the realm that is immediately accessible to perception and action: beliefs about tables and boats, table-tops and snow, neighbourhoods and streets. (This is, once again, the realm of affordances in Gibson's terms.) Our secondary naïve beliefs relate to phenomena which are either too large or too small to be immediately accessible to human beings in their everyday perception and action, or to objects and processes which are otherwise hidden. Primary theory is, as Horton points out, developed to different degrees by different peoples in its coverage of different areas (the primary theory of snow, for example, may be underdeveloped in tropical climates). In other respects, however, it differs hardly at all from culture to culture. In the case of secondary or 'constructive' theory, in contrast, differences of emphasis and degree give way to startling differences in kind as between community and community, culture and culture. For example, the Western anthropologist brought up with a purely mechanistic view of the world may find the spiritualistic world-view of an African community alien in the extreme (Horton 1982, p. 228).

Agreement in primary theory has evolutionary roots: there is a sense in which the theory about basic features must correspond to the reality which it purports to represent, for if it did not do so, its users down the ages could scarcely have survived. At the same time, its structure has a fairly obvious functional relationship to specific human aims and to the specific human equipment available for achieving these aims. In particular, it is well tailored to the specific kind of hand-eye coordination characteristic of the human species and to the associated manual technology which has formed the main support of human life from the birth of the species down to the present day (Horton 1982, p. 232).

From the perspective of survival, we can believe what we like concerning micro-spirits and macro-devils residing on levels above or below the levels of everyday concern, but we have been constrained, as far as the broad physical structures of everyday reality are concerned, to believe the truth—*otherwise we would not be here.* The commonsensical world as the world that is apprehended in primary theory is thus to a large degree universal. It is apprehended in all cultures as embracing a plurality of enduring substances possessing sensible qualities and undergoing changes (events and processes) of various regular sorts, all existing independently of our knowledge and awareness and all such as to constitute a single whole that is extended in space and time. This body of belief about general regularities in the mesoscopic domain is put to the test of constant use, and survives and flourishes in very many different environments. Thus no matter what sorts of changes might occur in their surroundings, human beings seem to have the ability to carve out for themselves, immediately and spontaneously, a haven of commonsensical reality. Moreover, our common-sense beliefs are readily translated from language to language, and judgments expressing such beliefs are marked by a widespread unforced agreement.

Folk disciplines insofar as they are of concern to us here are based exclusively on beliefs in the domain of primary theory. Such beliefs are also of maximal scientific interest, since they satisfy the constraint of universality (as scientists we are interested primarily in what humans share in common, not in the particular beliefs of this or that culture or community).

3.2. *How is primary theory organized?*

Primary theory is to a large degree organized qualitatively, and in terms of *objects falling under categories* (such as *dog, table, hand*). Such categories, like all common-sense categories, are marked systematically by the feature of prototypicality. This means that, as Rosch (1973, 1978), Keil (1979) and others have shown, for most such categories, some members are better examples of the class than others and they are cognized as such. That is to say, humans can distinguish easily between the *prototypical instances* at the core of common-sense categories and the *fringe instances* in the penumbra. Furthermore, there is a great degree of agreement among human subjects as to what constitute good and bad examples. For example, robins and sparrows are widely considered to be good examples of *bird,* whereas ostriches and penguins and even ducks are considered bad examples.

Each family of common-sense categories is organized hierarchically in the form of a tree, with more general categories at the top and successively more specific categories appearing as we move down each of the various branches. (Deviations from the tree structure, for example kinds having multiple superordinates, are occasionally proposed. Guarino and Welty (2000), however, provide methods to resurrect the tree structure in such cases, for example via elimination of terminological ambiguities.)

One special level of generality within each such tree is distinguished as consisting of categories which play a special role in learning and memory and in common-sense reasoning. Why do children so readily learn category-terms such as *duck*, *zebra*, *clock*, and *fork*, while they experience difficulties learning terms like *mammal* or *utensil*? This is because the former belong to what Rosch (1978) called the 'basic level' of cognitive classification, while the latter belong to a level that is superordinate to this basic level. Basic-level categories represent a compromise in cognitive economy between two opposing goals, that of informativeness, on the one hand, and that of minimizing categories based on irrelevant distinctions, on the other. The basic level (*chair*, *apple*) falls between the superordinate level (*furniture*, *fruit*), which is in general insufficiently informative, and the subordinate level (*lounge chair*, *golden delicious*), which adds too little informativeness for its additional cognitive cost. Measures of our perception of stimuli, of our responses to stimuli, and of our communication, all converge on this same basic level.

But naïve categories do not walk alone. Each family of naïve categories is organized in such a way as to participate in a corresponding naïve theory. This insight, which we see as providing an important supplement to the work of Rosch on basic-level categories, was first advanced by Murphy and Medin (1985) and it has been applied above all in the sphere of language acquisition by Keil and many others. When we learn categories, we learn them in such a way that they come organized into theory-like structures. Thus we learn how the things falling under given categories are related to each other and how they interact causally. When we acquire the category *bird*, for example, we do this in such a way that we learn, in part through observation, that birds (typically) have wings, that birds (typically) fly, and that these two features are interrelated.

Associated with each family of naïve categories, therefore, is a certain unified domain, analogous to the subject-matter of a scientific theory. As Dowty (1998) expresses it:

> A key idea in the 'concepts-in-theories' view is that concepts are grouped into large-scale domains, each of which is organized by significantly different principles. Causation in the domain of the physical world is governed by laws of (naïve) physics, whereas in the domain of human individuals, an individual's actions are caused by the desires and beliefs of the individuals and so are predictable to an extent from these. Such a view is made more plausible by results of cognitive psychological research not involving language: from a very early age, long before the onset of language acquisition, children have been shown to perceive causation differently, depending on whether human figures or inanimate figures are used to simulate causation.

Children later differentiate further domains: the purposes a manufactured thing can serve for its user yield criteria for distinguishing *artefacts* of different kinds: what makes a chair a chair is that it is something made to sit in—not its colour, its material composition, or its precise shape or size.

In Keil's version of the concepts-in-theories view, there is a two-way interaction between (*i*) understanding (having a theory of) the causal and other properties associated with the categories in a given domain, and (*ii*) identifying the perceptual or other attributes which can be used to identify instances of the corresponding categories in experience. As Rosch has shown, when the child acquires the concept associated with some new word, for example in the domain of animals or artefacts, he or she will attend only to certain kinds of attributes as potentially diagnostic for the concept and ignore other attributes as irrelevant. And then, as Keil notes, in learning concepts:

> People do not simply note feature frequencies and feature correlations; they have strong intuitions about which frequencies and correlations are reasonable ones to link together in larger structures and which are not. Without these intuitions, people would make no progress in learning and talking about common categories given the indefinitely large number of possible correlations and frequencies that can be tabulated from any natural scene. These intuitions seem much like intuitive theories of how things in a domain work and why they have the structure they do (Keil 1994)

Some examples of domains that have been isolated in developmental studies are listed in table 1(*a*) (taken from Dowty 1998). We note that in each domain specific kinds of causal and explanatory principles are at work.

3.3. *The primary theory of the geographical domain*

Studies of wayfinding and navigation abilities of pre-literate children have shown that by the age of 4, young children can kind their ways around familiar neighbourhoods and interpret some aspects of maps and aerial photographs (Hazen *et al.* 1978, Spencer and Blades 1985, Freundschuh 1990, Blaut 1997, Blades *et al.* 1998). However, we know of no literature on other aspects of geographical concepts that young children have mastered, especially the development of geospatial object concepts. We hypothesize that the child conceptualizes the geospatial world as a large unitary background of *what does not move*, and that, early on (long before 4 years), she or he has learned to appreciate that there is a difference between things that move, whether by themselves or because caused to move by another object, and the

Table 1(*a*). Major theory domains.

Domain	Nature of theories for domain	Characteristic causal relations and explanations	Age acquired
Physical	Naive mechanics (physics)	Does not move except when caused to by another object	By 6 months
'Alive'	Self-initiated action, goal-directed	An object is animate if and only if it moves by itself	By 6–11 months
Human	Capable of actions, perceptions, beliefs, intentions, etc.	Actions can be caused by beliefs and desires	By 3 years (?)
Biological	Notion of species	Properties are explained by their utility to the individuals themselves	3–6 years
Artefacts	Manufacture, use	Properties are explained by their utility to others	By 3–4 years

framework within which things move, and which allows him or her to get from place to place. One issue is the point at which infants begin to distinguish between the fixed background spatial world at the level of individual locations (the immediate perceptual environment of single rooms and dwellings) and the larger world of geospatial forms in the strict sense. When do infants first apprehend the difference between location in stationary objects such as rooms and buildings, and location in moving objects such as cars? Is there a distinction, in the spatial background domain, between what is natural and what is constructed or built by human beings (analogous to the distinction, on the table-top scale, between artifacts and non-artefacts)? At what point do young children acquire the capacity to distinguish between natural geographical features such as mountains and lakes on the one hand and *places* and other fiat geographical objects (Smith 1995a) on the other? How do place concepts relate to children's (and adults') conceptualizations of notions of *environment* and *surroundings* (Smith and Varzi 1999, Smith 2000). Leaving such issues to one side, we can conjecture that the relevant extension to table 1(*a*) for geographical categories is given in table 1(*b*).

This addendum is hypothetical only, since supporting data pertaining to cognitive categories is based almost entirely on *studies of categorizations of entities at surveyable scales*. Rosch and her associates studied first of all categorization of pets, tools, and other manipulable artifacts. Work has also been done on more abstract categories such as colours, emotions, events, and on social categories (personal relations, social roles, crimes, ethnic groups). Even when account is taken of the results of the experimental work described below, however, the question has still not been resolved *whether the structure and organizing principles governing our cognitive categories remain the same as we move beyond these families of examples to objects at geographical scales.*

Table 1(*b*). An additional major theory domain.

Geographical	What things move in and through	Properties are explained in relation to systems of landmarks and paths which do not change or move	Before 4 years

We said that primary theory is to a large degree organized qualitatively, and in terms of objects falling under categories. This holds, too, in regard to the primary theory of phenomena in the geographic domain, which is organized around categories such as *mountain, lake, island*. The primary axis of a folk ontology is its system of objects. The attributes (properties, aspects, features) and relations within the relevant domain form a secondary axis of the ontology, as also do events, processes, actions, states, forces and the like. The system of objects remains primary, however, because attributes are always attributes *of* objects, relations always relations *between* objects, events always events *involving* objects, and so forth, in ways which, as already Aristotle saw, imply a dependence of entities in these latter categories upon their hosts or bearers in the primary category of objects.

Among properly scientific disciplines we can draw an opposition between those, such as particle physics, molecular chemistry, cell biology, human anatomy which employ an ontology based centrally on the category of *objects*, and those, such as quantum field theory, the physics of electromagnetism and hydrodynamics, which are based centrally on the category of *fields*. We hypothesize that there is no parallel opposition in the realm of folk disciplines. The latter work exclusively (or at least overwhelmingly) with object-based categories. This holds, too, in the realm of geospatial folk categories. Places, for example, are conceptualized by non-experts as objects, and this holds too of the whole of space, which is conceptualized as the totality of places. Since almost all of the experimental data reported in what follows relates to object-categories, we do not claim to have confirmed this hypothesis here. We will see, however, that such relevant data as we have does seem to lend it support.

We are less confident in relation to the claim of Millikan (1998) to the effect that the category of *stuffs* (such as 'gold' or 'milk') is as deeply rooted in our cognitive architecture as are individuals (such as 'Mama', 'Bill Clinton', 'the Empire State Building') and kinds (such as 'cat' and 'chair'). Here again, however, such data as we have seems not to lend it support, at least in relation to geospatial categories of the sort here under review.

3.4. *The ontology of geospatial objects*

The ontology of objects is itself organized on two conceptual levels: the level of *individuals* (*tokens, particulars*) and the level of *kinds* (*types, universals*). Our cognition of individuals is marked by our use of proper names (such as 'Fido', 'Mary' or 'Boston') and of indexical expressions (such as 'this' or 'that' or 'here'). Our cognition of kinds is marked by the use of common nouns such as 'dog' or 'mother' or 'lake'.

As we noted already above, kinds or categories are organized hierarchically in the form of a tree. The lower nodes in such a tree were called 'species' by Aristotle, and the upper nodes were called 'genera', although biologists since Linnaeus and the eighteenth century have used 'genus' and 'species' to refer to two particular levels in the taxonomic tree of organisms (and we note in passing that Aristotle's ideas on hierarchical classification were not only exploited by Linnaeus in his system of biological classification and naming, but also remain alive today, for example in hierarchical database organization, and in the organization of your hard-drive into folders and sub-folders).

Aristotle himself reserved the term 'category' for the topmost node in such a species-genus tree. Here, however, we use 'category' to refer indiscriminately to all such nodes, including nodes corresponding to basic-level categories in the sense of Rosch. Aristotle himself provided various lists of top-level categories, of which the most important, for our purposes are the categories of *object* (or 'substance' in Aristotle's own terminology) and various attribute and event categories (referred to by Aristotle as the 'accidents' of substances, because they pertain to what holds of the substance *per accidens*). Accidental categories listed by Aristotle include: quantity, quality, action, relation and place. Both substances and accidents have instances. The prototypical instances of substances in Aristotle's eyes were biological organisms. The prototypical instances of accidents were *whiteness, running, sitting*, and *in the agora* (which must be taken as referring to particular instances of whiteness or to particular runnings or sittings, or to particular cases of being in the agora). Weather phenomena such as storms would have been categorized by Aristotle as accidents of the Earth.

In what follows we are interested, not in instances (tokens, individuals), but rather in types. And we are interested not in accidents (processes, attributes) but rather in substances, or objects, and more precisely still we are interested in the hierarchical classification of object categories within the geospatial realm. Aristotle himself thought that it was possible to give a *definition* (for example *man is a rational animal*) for each category, from which it would then be possible to infer the necessary and sufficient conditions for any given individual's being an instance of that category. At the same time however he recognized that species and genera are organized in such a way that we can distinguish a central core of focal (or typical, or standard) instances and a surrounding penumbra of non-typical or non-standard instances (for example an albino whale or a six-toed man). It is this idea of prototypicality which underlies the empirical work on cognitive categories by Rosch and her associates, and which is presupposed also in our present work.

4. Category norms

If the primary axis of a folk ontology is its system of objects, then our study of the folk ontology of the geospatial realm must begin with an elicitation of the object categories used by non-expert subjects (Smith and Mark 1999). To this end we replicated an experiment carried out by Battig and Montague (1968) to elicit what they called *category norms*.

The norms for a given category are those instances of that category most commonly offered by subjects as exemplifying the category itself. They may be prototypical examples of the category, although this is not necessarily the case. Battig and Montague themselves used an elicitation-of-examples procedure to determine norms for 56 categories. A total of 442 undergraduate subjects in Maryland and Illinois were given category titles, and asked to write down in 30 seconds as many 'items included in that category as you can, in whatever order they happen to occur to you'. Each subject went through all 56 categories in this manner.

Typical of the variety of non-geographical categories tested in the Battig-Montague experiment are: *precious stones*, *birds*, and *crimes*.

> Most frequent *precious stones* (442 subjects) were: diamond (435 responses), ruby (419), and emerald (329).
> Most frequently mentioned *birds* were: robin (377), sparrow (237), cardinal (208) and blue jay (180).
> Most frequently mentioned *crimes* were: murder (387), rape (271), and robbery (189).

It is important to note that some perfectly good members of a category may be given infrequently; for example, perjury, which almost all would agree is a crime, was listed by only 22 subjects, about 5% of the total. The number of examples per subject appears to reflect some combination of the familiarity of the category itself and the richness and diversity of familiar category members. Among all 56 categories, the greatest number of examples per subject were recorded for 'parts of the human body' (11.34), and the fewest were observed for 'member of the clergy' (3.82). Subjects listed an average of 5.16 examples of precious stones, 7.35 examples of birds, and 4.97 examples of crimes, numbers which give some measure of the richness and familiarity of the corresponding categories.

Of the 55 categories that Battig and Montague tested, 7 were at least somewhat geographic in nature: *a unit of distance*; *a type of human dwelling*; *a country*; *a natural earth formation*; *a weather phenomenon*; a *city*, and a (US) *state*. Some of these (*country*, *city*, *state*) produced examples that were specific instances (tokens) rather than types or kinds. Of the remainder, it is significant that *a unit of distance* had a geographical-scale unit—mile—as the most frequent example (438), closely followed by some common non-geographic units such as foot (417) and inch (411). *A type of human dwelling* showed much lower consensus, with only two examples, house (396) and apartment (316), being listed by at least half of Battig and Montague's subjects. The next most frequent, tent, was listed by just 198 of the subjects. In Battig and Montague's study, *a weather phenomenon* elicited 318 instances of hurricane, 303 of tornado, 297 of rain, and 266 of snow. Higher consensus among the lists of examples from one subject to another is an indicator that the category in question is a natural category in the sense of a category that is rooted more firmly in our cognitive architecture than are categories offered for elicitation which produce lower consensus or no consensus at all.

Most relevant to the geographical domain among Battig and Montague's categories was *a natural Earth formation*. A total of 34 different Earth formations were listed by at least 10 of the subjects. Here, the ten most frequently listed terms, with their frequencies among 442 subjects, are listed in table 2 (where *N* is the number of subjects who listed the given feature).

Despite the fact that the category-phrasing offered for elicitation was not prefixed by *a kind of* or *a type of*, only one particular named token was listed: the Grand Canyon, which was mentioned by only 14 subjects. All other terms given five or more times were names of categories, and all but five were at a geographical scale. Nothing movable was on the list, except glacier (very slow moving; 23 subjects) and iceberg (3 subjects).

Table 2. Most frequent responses to *a natural Earth formation*.

A natural Earth formation	*N*
Mountain	401
Hill	227
Valley	227
River	147
Rock	105
Lake	98
Canyon	81
Cliff	77
Ocean	77
Cave	69

Given these encouraging and intriguing results, we decided to replicate Battig and Montague's experiment using additional geographical categories. Results of these experiments are reported in the next section.

5. Experimental design and subjects

In our partial replication of Battig and Montague's (1968) study, subjects were tested simultaneously in a large classroom, at the beginning or end of a lecture. Subjects were students in two large sections of a first-year university course called 'World Civilization'. Versions 1 to 5 of the experiment were administered in one classroom, and versions 6 to 10 in the other. Versions 6–10 differed from versions 1–5 only in the order of presentation of stimuli, so that we could test for inter-category priming effects. Within each class, the five versions were printed on different colours of paper, and handed out from piles interleaving the five versions, in order to maximize the chance that the subject pools for the five versions were as similar as possible. Subjects were given a series of nine category names, each printed at the top of an otherwise blank page. They were asked to wait before turning to the first category, and then to write as many items included in that category as they could in 30 seconds, in whatever order the items happened to occur to them. After each 30-second period, they were told to stop, turn the page, and start the next category. A total of 263 subjects completed the first geographic category, with between 51 and 56 subjects responding to each version of the survey. Chi-squared tests showed no significant differences between responses from the two classrooms for any of the questions.

Following a pre-test reported by Mark *et al.* (1999), we chose nine categories to test with larger numbers of subjects. The first category tested was a non-geographic category (*a chemical*), which we hoped would provide a neutral, unprimed basis for the remaining questions. This was followed by a somewhat neutral phrase, *a type of human dwelling*. The third stimulus give to the subjects presented one of five variations on the phrase *a kind of geographic feature*. In this paper, we will focus on the results of our testing of the basic geographic domain, as explored in the third phrase tested; results for the remaining items will be presented in a companion paper.

In reporting on our pre-test (*locum cite*), we had observed that the compound noun *geographic feature* elicited solely natural and not artificial geographical features. This was surprising in light of the fact that academic geography—and the school geography curriculum to which most of our subjects had been exposed—is much more strongly a social rather than a natural science, and thus has a greater emphasis on cultural and economic geospatial phenomena than on physical ones. The presence of exclusively natural phenomena in elicited examples of *geographic feature* is thereby in and of itself *prima facie* evidence of a geographical component in our non-expert cognitive architecture that is independent of what subjects learn about the corresponding phenomena in academic settings.

However, as suggested by some commentators on our study, the predominance of physical or natural examples under *geographic feature* may have resulted from effects of the term 'feature', rather than reflecting the subjects' ideas of the meaning of the adjective 'geographic' to which it was attached. The geographical use of the word 'feature' appears to be less familiar among non-experts than, for example, among cartographers and among those accustomed to working with spatial data. We therefore formulated five different wordings of our target phrase, and presented these alternative wordings to five different groups of subjects, in effect changing the base noun of the superordinate category. The five variations we selected were:

a kind of geographic **feature**
a kind of geographic **object**
a geographic **concept**
something geographic
something that could be **portrayed on a map**

6. Results

6.1. *General geographical things*

Although we had taken the trouble to give five different phrasings of our basic geographical question, we nonetheless expected little difference in subject responses to these different phrasings. As it turned out, however, the responses showed sharp divergences. Evidently, the base nouns in the stimulus phrases placed the geographical categories into different superordinate categories in the minds of the subjects we tested. Our selected superordinates: *feature*, *object*, *thing* and *concept* appear to interact with the adjective 'geographic' in distinct ways. Moreover there is a significant displacement among non-experts as between the extensions of 'geographic' and of 'what can be portrayed on a map'. We shall discuss the implications of these interactions below.

When singular and plural versions of terms were combined and misspellings merged with correctly spelled words, the subjects together gave a grand total of 308 words and phrases as examples of these basic geographical categories. A Chi-square test confirmed that the frequencies of terms in the responses to the different versions of the basic geographical question differed significantly. Also, as shown in table 3, the mean number of examples listed per subject varied considerably across the five phrasings. For reasons already noted, we assume that the mean number of responses per subject within the 30-second time period reflects some combination of the familiarity and richness of the corresponding category. The results suggest that our subjects were very familiar with maps and with the sorts of things that appear on them. But they were also (somewhat counter-intuitively) thoroughly comfortable with the category *geographic feature*, and *less* comfortable with the other phrasings tested. Only 12 of Battig and Montague's original 56 categories produced more examples per subject than did our *something that could be portrayed on a map*. On the other hand all of the phrasings yielded numbers of responses large enough to establish that the categories in question were no less familiar to our subjects than were the categories used by Battig and Montague.

Table 3. Mean numbers of examples per subject.

Category label	Mean responses per subject
Something that could be portrayed on a map	8.21
A kind of geographic feature	7.15
Something geographic	6.17
A kind of geographic object	5.48
A geographic concept	5.15

6.2. *Frequent terms: differences among the phrasings*

Many of the 308 terms on our list—for example 'soil', 'fjord', 'state park'—were mentioned by very few subjects. Because the relative concentrations of such infrequently mentioned terms across the five phrasings would be heavily influenced by chance, we decided to concentrate our analysis on terms mentioned with a statistically more significant frequency, and arbitrarily chose to study only terms that were listed by at least 10% of the subjects for at least one of the five phrasings.[1] Thirty-five terms met this criterion, and are presented in tables 4–7. These terms give an illuminatory overview of the geographical ontology of our subjects, but they also reveal how difficult it is to extract this ontology in the form of a *single* hierarchy of kinds or types of the sort envisaged by Aristotle or Linnaeus and presupposed also in much contemporary work in folk biology and related fields.

Our geographic ontology is a sinewy thing: as our data shows, it breaks down into categories in significantly different ways according to the terms we use in elicitation. What is noteworthy, however, is the degree to which *physical geography* predominates. For even when five different elicitation terms are employed, this does not affect in any significant way the predominance of items within the domain of physical geography (and the correspondingly low profile of human geographical items) that we had observed already in our much more limited pilot study. Only five terms reached the 10% threshold on all five versions of this question and all of these are physical: mountain, river, lake, ocean, and sea. This suggests that, for this population of subjects at least, it is the physical environment that provides the most basic examples of geographical phenomena. This predominance of physical geography lends support to the view that concepts for (some) types of geographical objects are very deeply rooted in our primary-theoretic cognitive architecture, namely those—like mountain, river, lake, ocean, and sea—referring to objects of a kind which were (surely) strongly relevant to the survival of our predecessors in primeval environments.

The variation in elicited responses for the five different phrasings also has philosophical import. Philosophical ontologists have long been aware of the problematic character of ontological terminology. What term, for example, should be used for the ontological supercategory within which all beings (things, entities, items, existents, realities, objects, somethings, tokens, instances, particulars, individuals) would be comprehended? Each of these alternatives has its adherents, yet each also brings problems. Thus some of the terms suggested can be held to narrow the scope of ontology illegitimately to some one particular *kind* of being, for example to beings which *exist*, or are *real*, or come ready-demarcated into *items*. Similar arguments have also been seen in the international spatial data standards community. Given the particular meanings of the terms object, entity, and feature in the US Spatial Data Transfer Standard, for example, how should these terms be translated into other natural languages?

Our experiment—which is we believe the first of its kind to address differences in the ways non-expert subjects use general terms of ontology—shows that some counterpart of these problems is present already in the uses of such terms by

[1] Complete data resulting from our elicitation of examples task for the five basic geographical categories can be found on the Web at http://www.geog.buffalo.edu/ncgia/ontology/BuffaloGeographicNorms.html

non-experts (in a way which has posed difficulties for us also in reporting the results of our experiments here).

6.2.1. *A kind of geographic feature*

Of all the five phrasings, the responses to *a kind of geographic feature* still stand out as most strongly dominated by aspects of the physical environment. In fact, the most frequently listed potentially non-natural item under 'a kind of geographic feature' was 'country', which was listed by only two out of 54 subjects. In other respects however the responses under the *geographic feature* heading are relatively heterogeneous. Subjects listed shape-based landforms such as mountain, hill, and valley; water bodies such as lake and ocean; water-courses such as river and stream; shore-bounded land features such as island, and other geophysical features such as plain, plateau, desert, and forest. Table 4 gives the most frequent examples listed under this heading, with the corresponding frequencies for these items insofar as they were listed under the other headings.

6.2.2. *A kind of geographic object*

Geographic object stands out from the other phrasings listed in the degree to which it elicits examples of *small*, *portable* items. *Map* is the most common term among all of those listed more frequently under this than under any other heading. This heading also elicited a somewhat low mean frequency of responses per subject, suggesting that the English term *object* so strongly connotes a portable, detached thing that many subjects could not readily imagine *objects* existing at geographical scales. (It is true that *mountain* and *river* were listed as examples of *geographic objects* even more often than was *map*, but they had much higher frequencies in the *geographic features* column.) The predominance, here, of *map* is a clear indication that our subjects were thinking of small objects with some geography-related purpose—every subject who listed *globe*, *compass*, or *atlas* also listed *map*, and of the 17 map-listing subjects, only one mentioned *mountain* and only two mentioned *lake*. Other results for *geographic object* are shown in table 5.

Table 4. Terms most frequent for *A Kind of Geographic Feature*.

Term	Feature	Object	Something	Concept	Map	Total
Number of subjects	54	56	51	51	51	263
Mountain	48	23	32	23	25	151
River	35	18	26	19	31	129
Lake	33	13	25	10	21	102
Ocean	27	16	18	16	18	95
Valley	21	7	4	7	0	39
Hill	20	9	11	3	0	43
Plain	19	6	5	4	1	35
Plateau	17	4	6	8	0	35
Desert	14	6	6	4	0	30
Volcano	10	4	5	3	0	22
Island	8	7	7	7	3	32
Forest	6	4	5	1	3	19
Stream	6	2	2	3	1	14

Table 5. Terms most frequent for *A Kind of Geographic Object*.

Term	Feature	Object	Something	Concept	Map	Total
Number of subjects	54	56	51	51	51	263
Map	0	17	11	7	0	35
Globe	0	11	4	0	0	15
Peninsula	8	10	5	6	1	30
Compass	0	8	0	1	2	11
Rock	1	6	3	2	0	12
Atlas	0	6	2	2	0	10

Table 6. Terms most frequent for *Something Geographic*.

Term	Feature	Object	Something	Concept	Map	Total
Number of subjects	54	56	51	51	51	263
Land	2	6	6	5	0	19
The world	0	0	5	1	3	9

Table 7. Terms most frequent for *A Geographic Concept*.

Term	Feature	Object	Some-thing	Concept	Map	Total
Number of subjects	54	56	51	51	51	263
Sea	9	8	9	11	5	42
Delta	4	1	0	6	0	11

6.2.3. *Something geographic*

Something geographic is perhaps the most general way to describe in English the domain under review. Not surprisingly, then, this phrasing of the category label picked up a mixture of the responses typical of the other phrasings. Terms predominating also under *geographic feature*—such as mountain, lake, river, ocean—are here most frequent, but then (albeit with a markedly lower frequency) comes map (which is listed by 11 subjects as against 32 for mountain). The only term that was more frequent here than for any of the other phrasings was *the world*, while another term, land, was listed equally often under *something geographic* and under *geographic object*. Both land and the world are very general kinds of geographical phenomena.

6.2.4. *A geographic concept*

The category elicited by the phrasing *a geographic concept* manifests in our subjects' responses the lowest degree of internal coherence for all the five phrasings. The analysis of mean numbers of examples of categories under the different phrasings suggests that subjects had more difficulty determining what we meant by *a geographic concept*, and thus more difficulty in coming up with examples, than they did for any other phrasing. In everyday English, the term 'concept' refers to something rather abstract. We have no hypothesis to account for *sea* and *delta* appearing here more frequently than elsewhere.

The data under this heading are of some general significance, however, since, of all the five phrasings tested, this was the one least tilted in the direction of eliciting examples of geographic *objects*. In light of our discussion, above, of the object-field dichotomy and of Millikan's (1998) proposal concerning *stuffs*, it is thus significant that this phrasing did not yield significant numbers of examples under headings which could be classified as *field-based* or *stuff-based* geospatial concepts. Thus the field-based term 'elevation' was elicited from only one subject under this heading, and no other field-based term occurred here at greater frequency than under other headings. Our data is less revealing as concerns the issue of stuff-based concepts. Terms such as 'land', 'desert', 'rock' and 'tundra' did indeed occur with a certain frequency (though with no higher frequency here than under object-phrasings), and the data is in any case difficult to interpret in virtue of the fact that all of these terms have both an object- (count) and a stuff-based (mass) reading.

6.2.5. *Something that could be portrayed on a map*

Prior to running the experiment, we thought that maps generally showed all and only geographical things (phenomena, features, items), and thus we expected 'something that could be portrayed on a map' would turn out to be roughly synonymous with 'something geographic'. But such was not the case. Things from the domain of human geography—geographical things produced by people, either through construction or by fiat—appeared far more often in response to this wording than to any other. The subjects apparently were well aware that maps tend to portray cities, states, and counties, roads and streets, yet few listed them under the other categories of geographical things, and especially not under *features*. *Being geographical*, and *being portrayable on a map* are definitely different concepts, at least in terms of the priorities of terms included under them according to our subjects. Moreover, it seems that—again surprisingly—it is *being portrayable on a map* which comes closest to capturing the meaning of 'geographic' as this term is employed in scientific contexts. *Geographers, it seems, are not studying geographical things as such things are conceptualized by naïve subjects. Rather, they are studying the domain of what can be portrayed on maps.*

7. Summary, conclusions, and further work

Evidence presented in this paper has shown that geospatial concepts together form a coherent knowledge domain in the minds of non-experts in the United States. Although we had a very large sample of subjects, it is important to note that all

Table 8. Terms most frequent for something that could be portrayed on a map.

Term	Feature	Object	Some-thing	Concept	Map	Total
Number of subjects	54	56	51	51	51	263
City	1	4	5	0	30	40
Road	1	2	3	1	27	34
Country	2	6	8	4	23	43
State	0	5	3	1	15	24
Continent	1	10	8	9	12	40
Street	0	1	1	1	8	11
Town	0	5	2	0	8	15
Highway	1	0	0	0	7	8
Park	0	0	0	0	6	6
Building	0	1	0	0	5	6
County	0	2	0	0	5	7
Elevation	0	0	0	1	5	6

subjects were native speakers of one language, English. Also, all subjects were from one institution, and most were educated in one region, the State of New York. However, preliminary data from parallel experiments carried out in Finland, Croatia, and the United Kingdom produced very similar trends, suggesting that the effects reported here are not an artefact of our particular pool of subjects or of American English.

We believe that our results are of significance both to geographers in general—in throwing light on how the geospatial domain is integrated into the primary cognitive architecture of human beings—and also to those working in the field of geographic information science, in giving a first overview of the geospatial ontologies shared by the users of GISystems. But the results are also of broader significance, and they have implications not only for ontology but also for linguistics and for other cognitive sciences. They show that the interface between language and ontology is not as simple as has hitherto been held. Our data have demonstrated that this is true for ontological terms in the specific realm of geography, but they give strong reason to believe that it will be true in general.

One of the most surprising and potentially significant results of this empirical study is that the base term for the superordinate category to 'geographic' made a considerable difference to subjects' opinions of class members. Depending on whether we asked for *geographic features*, *geographic objects*, or *something geographic*, we observed significant differences in frequencies of terms listed. *Feature* elicited almost exclusively natural geographical things, to the near exclusion of constructed or fiat entities. *Object* apparently triggered on the part of many subjects a mindset wherein they felt they were called upon to provide examples of manipulable, detached objects and this, when combined with *geographic*, caused them to list artefacts with a geographical purpose or meaning such as *map*, *atlas*, *globe*, and *compass*. We also expected that the phrase *can be portrayed on a map* amounted to just another way of saying *geographical*, but it was exclusively under the *mappable* heading that fiat objects such as geopolitical subdivisions and geographical-scale artefacts such as roads and cities were listed with any frequency. In spite of all of this, however, all of the terms produced under any of these questions appear to be terms which to a large degree denote geographical things (items, entities, beings). Thus the results summarized above provide a first approximation to the basic noun lexicon for geographical ontologies, even while pointing out unexpected difficulties in the way of completing an ontology of the geographical (folk) domain.

How then should we express the relations between human conceptualizations for geographic *object*, *feature*, for *mappable*, and so forth? We suggest that these conceptualizations represent not different *ontologies* that we might ascribe to the subjects in the groups we tested. Rather, they are a matter of different superordinate categories—objects, features, things—that intersect to varying degrees in virtue of the fact that they share a common domain—the domain of geography. Particular kinds of phenomena, such as mountains or maps or buildings, have different relative prominence or salience under these different superordinate categories. We propose, therefore, that there is just one (folk) ontology of the geospatial realm, but that this ontology gets pulled in different directions by contextually determined salience conditions. To appreciate the pervasive effect of such salience conditions, compare the way in which an ornithologist would give a single unified ontology of birds, but would give different examples, or the same examples in different order, in providing a list of birds he likes, or birds he saw today, or birds he likes to eat, and so forth. What we have shown is that analogous differences are triggered by the use of distinct ontological terms. This outcome is significant not least because the distinctions captured by ontological terms are commonly held to be of low or zero practical significance.

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