The Significance of the Theory Analogy in the Psychological Study of Concepts

ERIC MARGOLIS

Abstract: Many psychologists think that concepts should be understood on analogy with the terms of scientific theories, yet the significance of this claim has always been obscure. In this paper, I clarify the psychological content of the theory analogy, focusing on influential pieces by Susan Carey. Once plainly put, the analogy amounts to the view that a mental representation has its semantical properties by virtue of its role in a restricted knowledge structure. One of the commendable things about Carey's work is that, unlike many other psychologists who appeal to the theory analogy, she takes seriously the need to specify how these structures are constrained. At the same time, the constraints she offers are insufficient. Her account also faces challenges from recent work in the semantics of natural kind terms.

1. Introduction

Within cognitive psychology there is a growing consensus about the nature of concepts, that concepts should be understood on an analogy with the terms of scientific theories. Despite the widespread agreement on this matter, the trend has been to draw the analogy and leave it at that, with little explanation of its content or motivation. Susan Carey is one of the few exceptions. She has been a leading defender of the analogy and has gone further than most in trying to give it some substance (Carey, 1985a, 1985b, 1988, 1991). Still, even in Carey's work, the psychological content of the theory analogy is unclear. In this paper, I want to unpack the analogy and assess its merits. My focus will be on Carey's discussion, since her defence of the analogy is one of the more promising. However,

to the extent that Carey's views are representative—as I think they are—my critique addresses the new consensus as a whole.[1]

Carey's research focuses on issues of psychological development, in particular, lexical acquisition and conceptual change. I begin, in Section 2, by discussing the nature of these issues, placing both in a particular mentalistic framework, where concepts are understood as mental symbols or representations. Next, in Section 3, I show how Carey's theorizing commits her to the importance of a special set of human concepts and, in turn, how these might be thought to motivate the theory analogy. The essence of the analogy, as Carey uses it, is that these concepts (what she calls the 'ontological' ones) have their semantical properties by virtue of their roles within theory-like cognitive structures. This view has several difficulties, which I explain in Section 4. I end, in Section 5, with some remarks on how rejecting this view might affect one's take on the issue of conceptual change.

2. Two Problems in Cognitive Developmental Psychology

The framework in which most defenders of the theory analogy work is one that treats mental processes as computations over mental symbols or representations. Concepts are the symbols which constitute thoughts. The conceptual system is composed of a stock of primitive concepts—primitive in the sense that they aren't composed of other concepts—and a set of rules for generating complex concepts from the primitives. Each concept is either primitive or complex, and each complex concept decomposes into a set of primitives under some rule (or rules) of combination. Carey is explicit in her commitment to this model of concepts. 'In keeping with current theorizing in cognitive psychology, I take concepts to be structured mental representations' (Carey, 1991, p. 258). Note that this is a different use of the term 'concept' than one often finds in philosophical contexts. Philosophers tend to think of concepts as abstracta—Fregan objects. But these two ways of looking at things needn't be in competition. The philosophers' concepts may be viewed as the semantical values of the psychologists'. In any event, I will stick to psychological usage: concepts are mental symbols.[2]

The mental symbol framework allows for a perspicuous characterization of many traditional issues in developmental psychology. Carey concentrates on two of these—lexical acquisition and conceptual development. In this section, I clarify the nature of these problems. The reason to be

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[1]   For other endorsements of the theory analogy, see Murphy & Medin, 1985; Gopnik, 1988; Medin, 1989; Keil, 1989; Karmiloff-Smith, 1992.

[2]   I adopt the following notation: mentioned words are indicated by quotation marks, mentioned concepts/representations are indicated by capitals, mentioned properties are indicated by italics.

familiar with them is that they motivate Carey's appeal to the theory analogy.

2.1 The Mapping Problem and Non-Natural Concepts

Children learn words with remarkable ease and speed. At one point in development, children learn an average of ten words a day (Gleitman and Gleitman, 1991). How do they do this? What goes on when a child learns a word? Given the mental symbol framework, the shape of a theory of lexical acquisition is fairly clear. Acquiring a word involves, among other things, pairing a representation of the word's form with a representation of its meaning. The process that effects this pairing is inductive. The language learner frames hypotheses about the meaning of a word, testing these against such data as are available. The data might include information about the scene co-occurring with the utterance, syntactic information, information about past word meanings, and so on.

Because the process of acquisition is inductive, language learners face familiar difficulties. In particular, they must impose severe constraints on the hypotheses they are willing to entertain, since, at any moment in the learning process, an unbounded number of hypotheses are consistent with the available data.

Consider a simple case of learning a word when the principal data comes from an ostensive definition. Someone points to a cup and says, 'This is a cup.' The child's task is to learn what 'cup' means, to pair /cup/ (the sound) with *cup* (the meaning). But for all the data she's been given, the child might focus on the cup's handle, or colour, or position, or substance. Then she might wrongly conclude that 'cup' means something other than it does, even something very odd like *cup or handle*. What's to stop her from drawing the wrong conclusion? The point here is not to introduce a kind of scepticism into the study of lexical acquisition; it is not to suggest that the child may have actually failed to learn words like 'cup'. What we have, instead, is the outline of a poverty of the stimulus argument. The idea is that the child *does* learn the words of her language despite that many incorrect hypotheses are consistent with whatever data she might have, so she must be ignoring certain hypotheses and favouring others. (For an insightful review of these issues, see Gleitman, 1990.)

Let me stipulate a bit of terminology. A concept is 'natural' just in case it is one that is licensed to serve as a word meaning. If it is excluded, then it is a non-natural concept. Presumably, CUP-OR-HANDLE is non-natural in this sense; that is, CUP-OR-HANDLE is excluded by the constraints that govern word learning in development.[3]

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[3]   The notion of conceptual naturalness is meant to be tied to the task-specific mechanisms devoted to language acquisition. One way to think of it is that these mechanisms have a restricted set of inputs, including a restricted set of conceptual inputs, over which they operate. Other concepts may be encoded lexically—perhaps by stipulated definitions—but only by circumventing the language acquisition device.

We can now think of the study of lexical acquisition as dividing into two parts, though in practice these may be inseparable. The first part addresses the problem of conceptual naturalness, distinguishing the natural concepts from the non-natural ones. The second part addresses what is sometimes called the mapping problem, explaining how children select the right natural concept for a given word form. Carey focuses on the first of these, employing the theory analogy as part of a solution to the problem of conceptual naturalness. I present her solution in Section 3.

2.2 Characterizing and Explaining Conceptual Development

The other place where Carey aims to use the analogy is in the characterization of conceptual development. According to many developmental psychologists, children pass through stages of development, yielding, as Carey puts it, a restructuring of their knowledge. Knowledge restructurings are supposed to contrast with ordinary instances of belief acquisition. In a case of knowledge restructuring, the change amounts to a shift in theoretically-salient cognitive capacities.

Carey distinguishes two kinds of knowledge restructuring. Strong restructuring (or strong conceptual change) occurs when the shift involves the acquisition of new concepts. Weak restructuring (or weak conceptual change) occurs when the shift involves the acquisition of knowledge that implicates only previously available concepts. Carey tends to use novice-to-expert shifts as examples of weak restructurings. Take the difference between a novice chess player and an advanced one. Clearly, something important happens in the process of becoming an advanced chess player. One learns a batch of strategies and heuristics and builds up a store of experiences that help in later matches. In short, one learns more about chess. But it is not at all clear that new concepts are acquired. In this sense, the development may stop at weak conceptual change. In contrast, it has often been understood to be Piaget's claim that, in passing through developmental stages, children acquire a richer representational system, one with expressive power that was missing at earlier stages. If this is the case, then some cognitive development amounts to strong conceptual change.

Insofar as there may be strong conceptual change in development, two problems must be addressed. The first amounts to a demonstration that the change has occurred. We need a way of telling for any given case whether a change is strong or not. This is no easy task. Gross observable behaviour can be misleading. Even in cases where children and adults vary systematically in an experimental situation, the underlying competence for each may be the same, the two differing largely in computational resources, experience, or breadth of knowledge. Indeed, a small industry exists in

which classic Piagetian data are reinterpreted in this deflationary manner (see e.g. Klahr and Wallace, 1976; Gelman and Baillargeon, 1983).[4]

The second problem is the mechanism by which the change occurs. Do children learn new concepts? And if they do, how? These questions are the hardest in developmental psychology. If conceptual change is effected by a mechanism other than learning, then the change may be left unexplained by psychology and become the burden of biology. But if it is effected by learning, we will need a plausible account of how the learning takes place. As I read Carey, she proposes to avoid this second problem and to focus on the first. She thinks that the theory analogy contributes to the characterization of strong conceptual change.

To understand her suggestion, it is helpful to put the issue in terms of the mental symbol framework. If concepts are mental symbols, the expressive power of a conceptual system is a function of the primitive representations of that system and the rules of combination. In principle, the way to tell whether a person has undergone strong conceptual change is to figure out which primitive representations and which rules of combination are available to that person. If there are either new primitives or new rules, then the person has undergone strong conceptual change. If not, then the restructuring, if any, is weak. How are we to tell if a person has acquired new conceptual primitives or rules of combination? At the very least, we will need an empirically motivated account of the nature of mental symbols or, as philosophers like to put it, an account of the individuation conditions for mental symbols. In Carey's hands, the theory analogy does just this. It explains how certain mental symbols are to be individuated.

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[4] Consider, for instance, Piaget's claim that young children are unable to conserve number. The experimental basis for the claim is this. First, young children are shown two rows that stand side by side, contain the same number of objects, and are identical in length. Then one row is spread out, so that it is longer than the other, though the two remain composed of the same number of objects. The classic finding is that children below the age of five report that the longer row contains more objects. Piaget and others have concluded from this that young children lack the representational resources to conserve number. But further experimental work shows that the conclusion has been hasty; if the test conditions are suitably arranged, children as young as three will conserve number.

Gelman's version of the conservation task illustrates the point (Gelman, 1972). She showed children two plates, one with two toy mice on it, the other with three. After designating one plate the winner, she covered both of the plates, moved them around (as in a shell game), and then had the children point to the winner in its new position. Once a number of successful trials were completed, Gelman surreptitiously substituted a new plate for the winner during the shuffling stage. In one variation, the length of the row was preserved while the number of mice was altered. In the other variation, the number of mice was preserved while length of the row was altered. The result was that spatial arrangement had little impact yet changes in number often invoked great surprise. It remains an open question how to explain Piaget's data. However, given the outcome of Gelman's study, these data don't argue for young children having a representational deficit.

Carey's chief motivation for addressing this issue is that she herself has uncovered data which suggest that children undergo a knowledge restructuring of some kind, though she is sometimes hesitant to say whether the restructuring is strong or weak.

Her seminal book, *Conceptual Change in Childhood* (Carey, 1985a) is perhaps her best known study. The point of the study was to test a suggestion of Quine's, that children's initial conceptualizations are determined by an innate similarity metric defined over a largely perceptual 'feature space', and that, in development, this system gives way to one where conceptualizations are determined by theoretical commitments. The transition, Quine thinks, is effected by language acquisition, where the language of a child's community ultimately determines the sophistication of her conceptualizations.

Carey has tested this hypothesis by tracing the development of such concepts as ANIMAL and LIVING THING in children from ages four to ten. She has found that, pace Quine, even the youngest of these children will override perceptual similarity when projecting properties from one object to another. For example, when told that people have a green thing inside them called a 'spleen', even the four-year-olds are more likely to attribute spleens to worms than to a mechanical monkey that wears clothes and bangs cymbals together (cf. Gelman and Wellman, 1991). There are, however, differences between four-year-olds and both older children and adults, and Carey sees these differences as suggesting a restructuring of biological concepts. For instance, four-year-olds tend to project biological properties from people to other things more readily and more easily than the other way around, while older children and adults are fluent in both directions (see Chapters 3–5 for the relevant experiments and data).

3. The Theory Analogy

So far, we've looked at two areas of study in developmental psychology, placing both in a context where concepts are understood to be mental symbols or representations. The first area of study concerns lexical acquisition. Here the project is to demarcate the natural concepts and to explain how children correctly map individual natural concepts onto word forms. The second area of study concerns conceptual development. Here the project is to explain how concepts are to be individuated. Only with a principled way of individuating concepts will we be able to figure out whether children undergo a strong conceptual change in development. For Carey, the point of the theory analogy is that it contributes to a solution to both of these problems. In this section, I explain how, in her view, the theory analogy does this.

Carey's strategy is to reduce some of the difficulties that arise with the issue of conceptual naturalness to issues that arise with the problem of conceptual individuation and tackle both there. She focuses on a special

set of concepts that she calls the 'ontological concepts'. Intuitively, these are the concepts that encode our most central conceptualizations, for example, that people distinguish physical objects from kinds of stuff, that people distinguish animate objects from inanimate ones, that people distinguish plants from animals, and so on.[5] For Carey, the study of ontological concepts is crucial to an account of conceptual naturalness, and the theory analogy explains how ontological concepts, in particular, are to be individuated. In Section 3.1 I explain why Carey thinks ontological concepts are so important. This will take us into a discussion of Frank Keil's work, since Carey defines her views in reaction to his. In Section 3.2 I explain how the theory analogy may be understood to provide conditions for the individuation of ontological concepts.

3.1 Ontological Concepts and Conceptual Naturalness

Carey borrows the notion of an ontological concept from Frank Keil, who urges the study of ontological knowledge in his book *Semantic and Conceptual Development* (Keil, 1979). Though Keil addresses numerous important questions in developmental psychology, the part of his theory that is relevant for us is how it handles conceptual naturalness. This is because Keil's proposal serves as a foil for Carey. The way she explains her solution to the problem of conceptual naturalness is to display what she thinks are certain inherent flaws in Keil's, flaws which, once pointed out, motivate an alternative approach. So we begin with Keil.

3.1.1 Keil on conceptual naturalness: the M constraint Because Keil addresses the problem of conceptual naturalness indirectly, in terms of constraints upon linguistic items and sets of objects, his theory is difficult to understand. Nonetheless, the outlines of the theory are sufficiently clear. Keil proposes that certain concepts must form a kind of hierarchy and that the naturalness of a concept is determined by whether it fits into the hierarchy. Concepts that can't fit into the hierarchy are, for this reason, non-natural. The way Keil develops the theory, we can see it as dividing into three theses, one about ontological concepts, one about other concepts, and one about the difference between young children and adults.

Keil's first thesis is that ontological concepts enter into a hierarchy with the constraint that the extensions of any two ontological concepts must relate as either subset to superset or be completely disjoint. What this means is that it is psychologically impossible for someone to have two ontological concepts such that each has some member in its extension that the other has and each has some member in its extension that the other

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[5] So PHYSICAL OBJECT, PHYSICAL STUFF, ANIMATE OBJECT, INANIMATE OBJECT, PLANT, and ANIMAL are all supposed to be ontological concepts. How to extend this list is unclear. Still, these examples suffice to ground the discussion. For other examples, see the concepts cited in Figure 1, below.
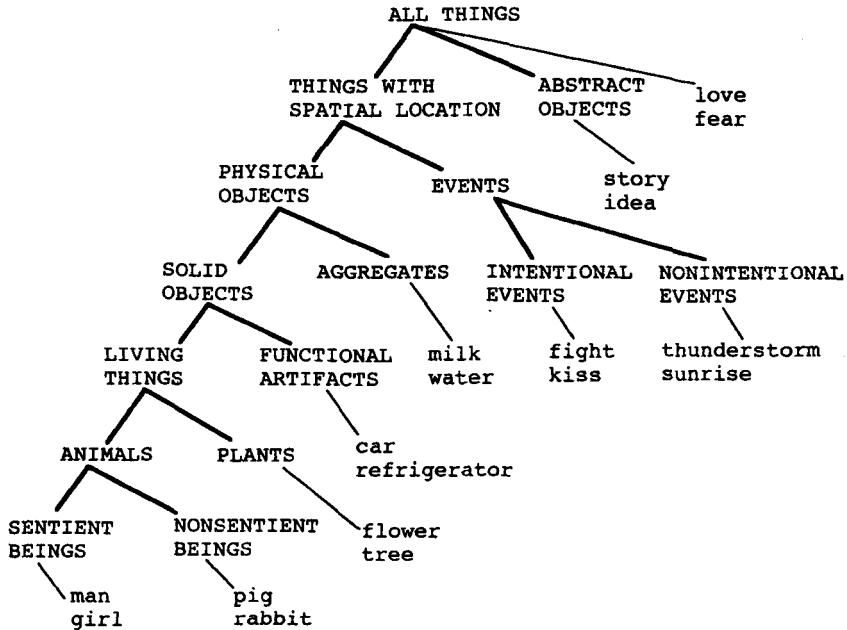
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                          ALL THINGS
                          /    |    \
              THINGS WITH      ABSTRACT    love
              SPATIAL LOCATION OBJECTS     fear
              /         \          \
        PHYSICAL         EVENTS     story
        OBJECTS         /    \      idea
        /      \       /      \
    SOLID     AGGREGATES  INTENTIONAL  NONINTENTIONAL
    OBJECTS       \       EVENTS       EVENTS
    /    \         \         \            \
 LIVING   FUNCTIONAL  milk    fight    thunderstorm
 THINGS   ARTIFACTS   water   kiss     sunrise
 /    \        \
ANIMALS  PLANTS  car
 /    \       \  refrigerator
SENTIENT  NONSENTIENT  flower
BEINGS    BEINGS       tree
  \          \
   man        pig
   girl       rabbit
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Figure 1   Ontological Tree

does not have. Figure 1 reproduces Keil's representation of adults' ontological knowledge (Keil, 1979, p. 16). Each non-terminal node represents an ontological concept. Dominance among non-terminal nodes represents transitivity of application—e.g. the concept ANIMALS applies to whatever the concept SENTIENT BEINGS applies to, since the node labelled 'ANIMAL' dominates the node labelled 'SENTIENT BEINGS'.

Keil's second thesis is more difficult to state, because he frames it as a condition upon predicates (not concepts), taking these to contrast with terms. The difficulty here is not so much that Keil puts his point, in the first instance, as pertaining to linguistic items. We can—indeed, we should—interpret the claim as extending to the concepts that linguistic items express. No, the main problem is that Keil's notion of a predicate, as opposed to a term, is obscure, so it is hard to tell which concepts are at issue. In any event, his second thesis addresses how predicates relate to one another. Keil's concern is with what he calls 'spanning' relations. A predicate is said to span a term when it is possible that the predicate could apply to that term even if it doesn't actually apply (Keil, 1979, p. 11). The idea is much the same as what philosophers have in mind when they speak of category mistakes. 'Numbers are purple' is supposed to be a category mistake, since numbers, being abstract objects, aren't the sorts of things that have colour. In contrast, 'Blood is purple' is merely false;

while blood isn't purple, at least it is the sort of thing that has colour and hence could be purple. In Keil's terminology, this is to say that (the predicate) 'is purple' spans (the term) 'blood' but not (the term) 'number'. Keil's second thesis is that predicates (correspondingly, the concepts they express) are prohibited from spanning terms of different ontological types, that is, predicates form a hierarchy that corresponds to the hierarchy of ontological concepts. Consequently, it is psychologically impossible for someone to have two predicates such that each spans a term that the other spans and each spans a term that the other does not. Keil dubs this thesis the M constraint, because it prohibits an 'M'-shaped tree.[6]

Keil's last thesis is that the conceptual difference between young children and adults turns on the number of distinctions young children are willing to make, not the structural patterns. According to Keil, children make less fine-grained ontological distinctions, but ones that still manifest a strict hierarchy of ontological concepts. Additionally, children's predicates, like adults', are M constrained. That is, even children can't have two predicates such that each spans a term that other other spans and each spans a term that the other does not.

Figures 2–4 (adapted from Keil) represent predicate trees from adults, five-year-olds, and seven-year-olds (Keil, 1979, p. 15, p. 72, p. 73, respectively). Predicates are represented in capitals, terms in lowercase. Each node of a tree represents either a set of predicates or terms, of which only a few members are explicitly represented, and each predicate is to be understood as spanning all the terms it dominates. We can think of these trees as also representing the corresponding conceptual hierarchies. Notice that the tree for seven-year-olds is a collapsed version of the adult tree and that the tree for five-year-olds is even more collapsed. For instance, five-year-olds, if this tree is correct, fail to distinguish sentient beings from non-sentient ones, grouping 'girl' with 'tree'.

Given this apparatus, Keil distinguishes natural concepts from non-natural ones through his M contraint (Keil, 1979, p. 19):

> For a class to be natural, there must be some node in the [predicate] tree that exhaustively dominates all and only the terms in that class. Conversely, non-natural classes are those classes that include terms on different branches but fail to include all terms that are common to those branches. For example, the class consisting of humans and plants is non-natural since it fails to include also nonhuman animals. This is because nonhuman animals are dominated by the node containing the predicate 'is alive', which is the lowest predicate that spans both humans and plants.

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[6] Maybe what Keil means by the distinction between predicates and terms is the distinction between predicates and their extensions. In his explanation of conceptual naturalness, which we will come to, he slips between these two ways of talking. Still, I don't propose to settle the issue here.
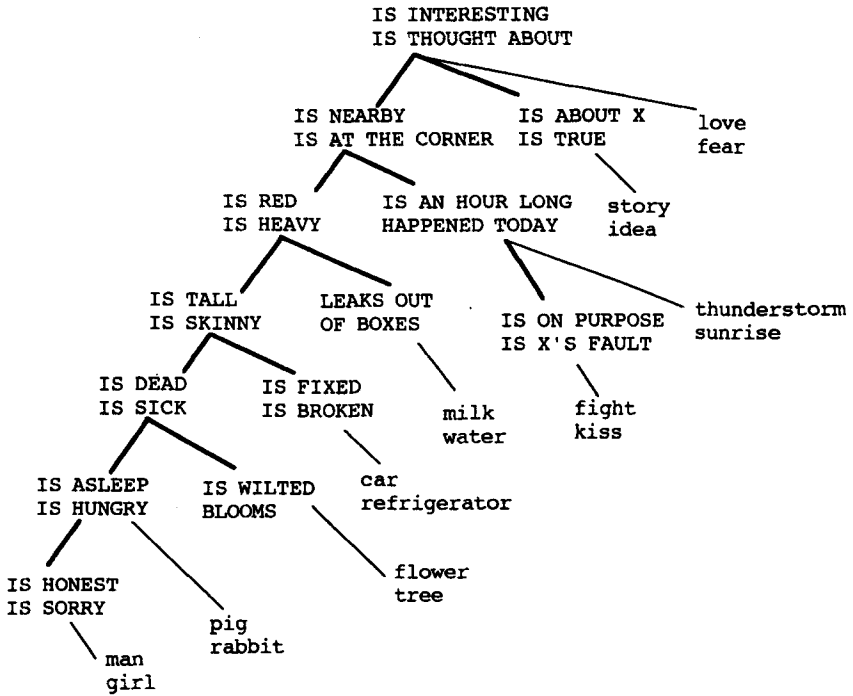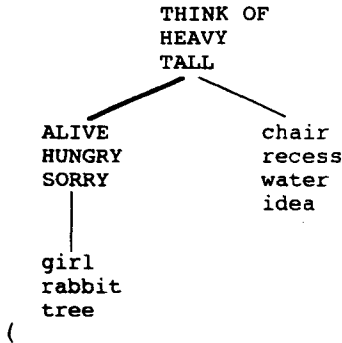
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                             IS INTERESTING
                             IS THOUGHT ABOUT

                    IS NEARBY          IS ABOUT X    love
                    IS AT THE CORNER   IS TRUE       fear

               IS RED        IS AN HOUR LONG   story
               IS HEAVY      HAPPENED TODAY    idea

          IS TALL     LEAKS OUT                       thunderstorm
          IS SKINNY   OF BOXES         IS ON PURPOSE  sunrise
                                       IS X'S FAULT

       IS DEAD    IS FIXED
       IS SICK    IS BROKEN      milk        fight
                                 water       kiss

   IS ASLEEP    IS WILTED    car
   IS HUNGRY    BLOOMS       refrigerator

IS HONEST                        flower
IS SORRY                         tree
            pig
     man    rabbit
     girl
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Figure 2 Adult's Predicate Tree

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                        THINK OF
                        HEAVY
                        TALL

                ALIVE             chair
                HUNGRY            recess
                SORRY            water
                                 idea

                girl
                rabbit
                tree
            (
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Figure 3 Five-year-old's Tree

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                        THINK OF
                       /        \
              HEAVY                idea
              TALL                 recess
              /      \
             /        chair
            /         water
         SICK
         /    \
        /      \tree
    AWAKE
    SORRY
       |
     girl
     rabbit
```
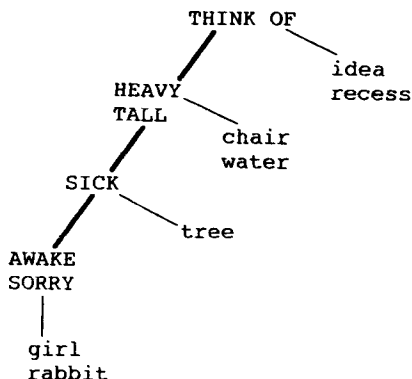
Figure 4 Seven-year-old's Tree

While Keil speaks here of the naturalness of classes, his point can be understood as pertaining to concepts. Let's say that a concept is a predicative concept if it corresponds to a predicate and a term concept if it corresponds to a term. Then, for Keil, a predicative concept is natural just in case in the conceptual hierarchy a node exists that exhaustively dominates all and only those things (term concepts?) to which it applies (see Note 6). Keil cites as a non-natural concept, the concept HUMANS-AND-PLANTS. His reason that HUMANS-AND-PLANTS is non-natural is that it violates the M constraint: there is no node in the hierarchy that exhaustively dominates all and only humans and plants. The closest thing is one that exhaustively dominates all animals and plants, that is, the node that corresponds to LIVING THINGS in the ontological hierarchy.

Again, for our purposes what's important about Keil's proposal is that it serves as a foil for Carey; Carey characterizes her theory by contrasting it with Keil's. Her intention is to manifest what she thinks are inherent flaws with his approach and, in turn, to motivate an alternative that does best just where a structural solution, like Keil's, is at its worst. The irony of the situation is that Carey doesn't recognize the full extent to which Keil's theory fails. Let me explain.

Already we have seen that, given the adult hierarchy, the M constraint may exclude some non-natural concepts. Carey's chief criticism of Keil is that the M constraint is, nonetheless, too permissive in the case of young children's hierarchies in that it licenses many blatantly non-natural concepts.[7] The example she cites is LIGHTBULB-OR-IDEA. 'A child with a collapsed tree ... [as in Figure 3] would be blocked from positing *rabbit or light bulb* as a candidate word meaning, but not *light bulb or idea*. But

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[7] Carey also notes that Keil's theory is too restrictive in that it rules out clear cases of natural concepts. See Davis, 1979.

children under 8 are prodigious word learners; surely they do not consider such hypotheses' (Carey, 1985b). Carey's criticism is that that LIGHTBULB-OR-IDEA is M constrained for the young child and hence that Keil's theory incorrectly predicts that LIGHTBULB-OR-IDEA is a natural concept (i.e. that *lightbulb or idea* is a possible word meaning). But presumably LIGHT-BULB occurs in the same node as CHAIR. If this is the case, then, pace Carey, LIGHTBULB-OR-IDEA is *not* M constrained for the young child: the five-year-old's hierarchy lacks a node which exhaustively dominates all and only the things to which LIGHTBULB-OR-IDEA applies. Since, for Keil, the naturalness of a concept depends upon its being M constrained, his theory actually dictates that LIGHTBULB-OR-IDEA is *non*-natural (i.e. that *lightbulb or idea* is not a possible word meaning). Contrary to Carey's claim, Keil's theory makes the correct prediction that young children are blocked from positing *lightbulb or idea* as the meaning of a word.

Basically, Carey's criticism is that Keil's theory is too weak for failing to prohibit clear cases of non-natural concepts. Though her example does not work, she *is* right to be suspicious, for whether or not his theory is too weak, it is patently incomplete. Recall that Keil employs an artificial distinction between predicates and terms and that he restricts his characterization of naturalness to classes and concepts that correspond to predicate nodes. But is there really any difference between his examples of predicates and his examples of terms as far as the present issues are concerned? In his trees, 'is honest', 'is tall', 'is wilted' all figure as predicates, while 'man', 'pig', 'chair', and 'idea' figure as terms. The difference doesn't seem to amount to much. For example, the concept HONEST appears to resemble the concept CHAIR in all the relevant respects. Both enter into class inclusion relations if either does, and the question of naturalness arises for both. HONEST is a natural concept for Keil because it is M constrained. But it isn't clear that his theory has anything to say about CHAIR or IDEA or LIGHT BULB or any other concepts that correspond to the "terms" a hierarchy. For all that's been said, Keil's account leaves it an open question whether a whole range of paradigmatic natural concepts are in fact natural. We need an alternative account of conceptual naturalness.

3.1.2 Carey's alternative: using ontological concepts to explain conceptual naturalness   Carey's proposal is that we preserve the use of ontological knowledge in the distinction between natural and non-natural concepts, but she rejects the viability of the M constraint (Carey, 1985b, p. 386):

> In his writings Keil concentrates on the role of the structural constraint . . . in limiting hypotheses. But, for the M constraint to work in any particular case, an equally important condition must also be met. The word learner must already represent nodes in the tree that are defined by predicate clusters like *is dead, has bones* (animate objects) and *is broken, is made in a factory* (artifacts);

that is, particular spanning relations between predicates and terms must be represented such that an M violation could be generated. Let us call this source of constraint the *present state constraint*.

This alternative suggestion is a bit obscure, yet I think we can discern her intention. Carey seems to think that, if we were to include amongst the concepts that are available early in development a privileged set of ontological concepts, these might exclude the non-natural ones. How might this work? Perhaps Carey has in mind that children project word meanings according to principles that are framed in terms of these ontological concepts.

Ellen Markman's work on lexical acquisition serves to illustrate the proposal (Markman, 1989). Markman suggests that young children learn words, or perhaps just nouns, by employing the whole-object assumption. The whole-object assumption is a constraint about what can serve as the meaning of a word. It is that words refer to whole physical objects, as opposed to parts of an object, substances, colours, and so on. If Markman is right, young children prefer whole objects as the meanings of words. For instance, they think it is more likely that 'cup' means *cup* than *porcelain*. This, of course, presupposes that young children operate with a sufficiently detailed object concept to exclude substances and other alternative interpretations. Markman and others tend to assume that the relevant notion is one that encompasses spatially and temporally bounded middle-sized objects.[8] In fact, it is not unreasonable to think that young children parse the world in these terms, given the results of independent neonate research (for reviews, see Spelke, 1990; Baillargeon, 1993).

Notice that Markman's proposal makes essential use of the concept PHYSICAL OBJECT—an ontological concept, according to Keil and Carey. On the present account, it is because young children operate with an inductive constraint that involves this concept that they favour certain possible word meanings to others. More to the point, this constraint excludes many impossible word meanings, such as *lightbulb-or-idea*. The assumption is that children know enough about physical objects to realize that LIGHTBULB-OR-IDEA applies to things that aren't physical objects.

Carey is cagey about the exact role she thinks ontological concepts play in an account of conceptual naturalness. The view I'm attributing to her is, I think, exegetically plausible. It makes sense of both the attention she gives to ontological concepts and her insistence that we will have to study preverbal children in order to explain conceptual naturalness. (The reason

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[8] Markman's constraint probably needs to be revised so that it ranges over just count nouns. It is possible, as well, that the constraint is too specific in its reference to whole physical objects. Perhaps, instead, it should be pitched over a generic notion of 'individual', so that it can operate in the acquisition of a wider range of count nouns, including ones that pick out events and abstract objects. See Bloom, 1993, for a suggestion along these lines.

we will have to study preverbal children is to determine independently whether they have certain ontological concepts.) What's more, the account I've outlined has some promise. The serious questions concern particulars:

> What ontological concepts do children have available to them by the time they start acquiring words or particular classes of words?
>
> What are the principles (framed in terms of these concepts) that guide children's inductions?
>
> Are these principles language-specific or are they general?
>
> Are they innate or learned?

We have, in short, a research program, and it's one whose initial results are encouraging. If there is any part of Carey's proposal that is doubtful, it is the part that refers specifically to the theory analogy.

3.2 Carey on Conceptual Individuation

We are finally in a position to see what the content of the theory analogy amounts to for Carey. Recall the importance for Carey of specifying individuating conditions for concepts. First of all, she needs a format for expressing strong conceptual change, given her studies in conceptual development. This in turn requires that she specify how representations are to be individuated, so that we can tell whether a given instance of knowledge restructuring is strong or weak. Because her studies concern, in particular, the development of concepts that she and Keil would characterize as ontological concepts (e.g. ANIMAL), her focus is on these. Plus, her stake in ontological concepts is compounded by her solution to the problem of conceptual naturalness.

For Carey, the theory analogy provides an answer to the question about the individuation of ontological concepts. She writes (Carey, 1985b, p. 394):

> A theory consists of three interrelated components: a set of phenomena that are in its domain, the causal laws and other explanatory mechanisms in terms of which the phenomena are accounted for, and the concepts in terms of which the phenomena and explanatory apparatus are expressed. Some concepts within theories are extraordinarily important, those that figure in the important laws of the theory and those that are involved in the explanatory work of the theory. As theories develop, changes in these central concepts have ramifications for the whole theory. For example, the change from the Newtonian to the Einsteinian conception of mass dictated that kinetic energy is not $\frac{1}{2}$ mv². Such core concepts participate in what empiricists and logical positivists held to be the analytic truths in that theory . . .

> If there is an ontological level of concepts, the set of core concepts in our theories is the best candidate.

And (Carey, 1985a, p. 198):

> One solution to the problems of identifying the same concepts over successive conceptual systems and of individuating concepts is to analyze them relative to the theories in which they are embedded. Concepts must be identified by the roles they play in theories.

Carey is adopting in these passages a particular view of scientific theories and giving it a psychological twist. The view of theories is one associated with the philosophers Thomas Kuhn (1962), Wilfrid Sellars (1956), David Lewis (1970, 1972), Paul Churchland (1979), and others. Carey cites Kuhn, in particular. Essentially, the view pertains to the semantics of theoretical terms. Carey co-opts this semantics and applies it to concepts as psychologists conceive of them, that is, to mental representations. Let me first explain how the semantics works in its original setting, and then explain how it applies to representations.

Suppose, as Carey says, that a scientific theory consists of a set of phenomena, a set of explanatory principles, and a set of concepts in which the phenomena and principles are expressed. To simplify matters, let's speak of 'terms' instead of 'concepts', to avoid confusing scientific theories with psychological structures. Then the issues of theory change and theory identity depend heavily on the identity conditions for theoretical terms. That is, whether two theories are really one and the same (perhaps with minor variations) is determined, in part, by whether they are framed with identical theoretical terms. Supposing that theoretical terms are to be individuated by their semantical properties, the question of theory identity turns on the question of the semantics of theoretical terms. Following this line of reasoning, we come to the main question: In virtue of what does a theoretical term have its semantical properties?

According to the Kuhnian tradition, theoretical terms have their semantical properties in virtue of their roles within their respective theories. The idea is that the explanatory principles of a theory are *constitutive* of the meaning of the terms in which they are expressed. So if two theories have different explanatory principles, then, as a matter of course, the terms in which they are expressed mean different things. David Lewis provides a sophisticated method for explicitly defining theoretical terms along these lines. The gist of it is that a theoretical term can be paired with a definite description that expresses how the term figures in the explanatory principles in which it occurs (Lewis, 1970). We needn't go into the mechanics of the suggestion. The main point is that on some accounts the explanatory principles associated with a theory are constitutive of the meaning of its terms.

What's more, it is natural on this sort of account to suppose that the meaning of a term determines its reference through the satisfaction of the individual principles that are constitutive of its meaning. In other words, whatever unique entity is accurately described by the explanatory principles associated with a term is the term's reference. Lewis illustrates this mechanism with a story, which he would have us understand as a rudimentary theory. In the story, a detective attempts to solve a murder case and in the process speaks of persons X, Y and Z, assigning to each a certain role in the events preceding the murder. The detective doesn't yet know who X, Y and Z are, but his reasoning compels him to think that there are three people who have done the things that he attributes to them. Lewis goes on to explain (Lewis, 1972, p. 209):

> In telling his story, the detective set forth three roles and said that they were occupied by X, Y and Z. He must have specified the meanings of the three T-terms 'X','Y' and 'Z' thereby; for they had meanings afterwards, they had none before, and nothing else was done to give them meanings. They were introduced by an implicit functional definition, being reserved to name the occupants of the three roles. When we find out who are the occupants of the three roles we find out who are X, Y and Z. . . .
>
> If, as I claim, the T-terms are definable as naming the first, second, and third components of the unique triple that realizes the story, then the T-terms can be treated like definite descriptions. If the story is uniquely realized, they name what they ought to name; if the story is unrealized or multiply realized, they are like improper descriptions. If too many triples realize the story, 'X' is like 'the moon of Mars'; if too few triples—none—realize the story, 'X' is like 'the moon of Venus'.

Lewis is offering what philosophers have come to call a 'description theory'. In short, the reference of a term is determined by the definite description with which it is paired, where the relevant description for a theoretical term is the one that expresses how it figures in the explanatory principles in which it occurs.

If I'm right, Carey endorses this type of semantics for theoretical terms and wants to import it to the realm of mental representations. In this she is not alone. Many psychologists follow Carey in adopting this type of semantics. Henry Wellman, for example, is quite explicit about the matter. Like Carey, he expects an analogy to scientific theories to serve a psychological purpose. And when he comes to talk about theories, he just takes it for granted that Lewis is right (Wellman, 1990, pp. 6–7):

> [I]n theories it becomes impossible to consider a single concept in isolation because its meaning and significance are determined by its role in an interrelated web of other constructs and terms.

The notion of a planet, for example, is a concept entrenched in a larger understanding of the solar system, comets, and asteroids and how bodies revolve around others because of differing mass and gravitational forces. In the extreme, concepts within a theory—theoretical terms—get their meaning through their interconnections with other terms in the theory, by virtue of their place in a context of cohesive propositions.

In the next section, I take exception with Wellman and Carey. For now let me just mention how their understanding of theories is supposed to help with mental representations.

The idea is to take seriously that some cognitive structures are theory-like, so that the mental representations of which they are composed compare with theoretical terms. Then these mental representations would be individuated according to how they figure in the relevant mental correlates to the explanatory principles of scientific theories.

Many people in the cognitive sciences would agree that at least some cognitive structures are significantly like theories. We are all now accustomed to speaking of 'folk psychology', 'folk physics', and so on. Carey is uneasy about this practice. She thinks that in order for the analogy to do any work, we must be able to distinguish theory-like cognitive structures from scripts, frames, and other information-bearing structures. Thus her view differs from that of Gregory Murphy and Douglass Medin, who also advance an analogy to theories but count just about any cognitive structure as theory-like.[9] Carey also restricts her account of the individuation of representations to what she and Keil call the ontological ones. This may be because she thinks that most concepts aren't part of a mental theory or it may be because she thinks that, for whatever reason, more peripheral concepts have to be individuated in some other way. I don't propose to press Carey on this or on any of the details about when a cognitive structure is really theory-like. While details on these matters deserve scrutiny, there are more immediate difficulties with her view.

4. Criticism of the Theory Analogy

The view I've been attributing to Carey can be summarized as follows:

(1) Ontological concepts are embedded in cognitive structures that are

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[9] 'When we argue that concepts are organized by theories, we use *theory* to mean any of a host of mental "explanations," rather than a complete, organized, scientific account. For example, causal knowledge certainly embodies a theory of certain phenomena; scripts may contain an implicit theory of the entailment relations between mundane events; knowledge of rules embodies a theory of the relations between rule constituents; and book-learned, scientific knowledge certainly contains theories.' (Murphy & Medin, 1985, p. 290). On this characterization, nearly any relation between two or more concepts amounts to a mental theory.

sufficiently theory-like that ontological concepts are to be individu-
ated as theoretical terms are.

(2) Theoretical terms are individuated by the explanatory principles in
which they occur; the explanatory principles are constitutive of
their meaning.

(3) The reference of a theoretical term (and hence of an ontological
concept) is determined by the definite description that expresses
how it figures in the explanatory principles in which it occurs.

Within psychological circles, the controversial aspect of this picture has
been the claim that cognitive structures are theory-like. Few have ques-
tioned the conception of scientific theories which it presupposes. My focus,
however, will be on points (2) and (3). I intend to cast doubt on Carey's
conception of scientific theories and hence on extending it to the realm
of the mental.[10] I have three arguments. The first concerns a burden
incurred by Carey's semantics, the second brings attention to cases where
her semantics doesn't seem to work, and the third addresses the inad-
equacy of Carey's argument for endorsing this semantics.

4.1 Theory Individuation[11]

According to Carey, ontological concepts have their semantical properties
by virtue of their roles within restricted knowledge structures. The restric-
tion upon these structures is that they be mental theories of a sort, consti-
tuted by sets of explanatory principles, sufficiently unified and theory-
like in character.

Notice her strategy. The initial question was how ontological concepts
are to be individuated. Carey's answer to this question reduces it to
another, namely, how mental theories are to be individuated. The problem
with this strategy, however, is that the individuation of theories is nearly
as problematic as the individuation of the concepts they include. In fact,
the individuation of theories remains a long-standing problem in the
philosophy of science, and Carey says little to further our understanding
of this difficult issue. So it is questionable whether Carey's proposal about
concepts amounts to any kind of advance.

Nonetheless, suppose for the sake of argument that she does have an
account of theory individuation. There is a residual problem. One might
have thought that, with an account of theory individuation at her disposal,

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10   Of course, an analogy between concepts and theoretical terms might still be correct,
depending on the true nature of scientific theories. But the point of drawing the
analogy in psychology is to liken concepts to theoretical terms *as understood in the
Kuhnian tradition*. Appealing to a different conception of scientific theories would
change the subject of debate.

11   Jerry Fodor's comments on an early draft of this paper helped me to clarify the
points in this section. Cf. Fodor, 1994.

Carey could specify the explanatory principles that are constitutive of a concept in much the way that David Lewis does for theoretical terms. Lewis, you will remember, incorporates all of a theory's explanatory principles in the descriptions that serve as the meanings of its terms. But this holistic approach is notoriously problematic, since it entails that meanings aren't preserved under discrepancies of theory. For Carey, this is to say that differences of conceptual identity accompany differences in the beliefs which constitute a mental theory. If, for instance, two people come to have different beliefs about animals and these beliefs are incorporated into their folk biologies, then the concepts that constitute their respective folk biologies cannot be the same. The point extends to individuals over time. Changes in a person's mental theory yield new concepts. But surely not just any changes are so momentous. Conceptual identity is more robust than that.

In the philosophy of mind, much the same issue has arisen in the context of discussion about conceptual role semantics, an approach to the question of mental symbol content that resembles Carey's. For conceptual role semanticists, a mental symbol has its content by virtue of its role in the inferential patterns in which it participates, where inference is construed loosely to include not only deductive reasoning but also nondemonstrative reasoning, practical reasoning, and most cognitive and perceptual processes (see e.g. Block, 1986). Used this way, the notion of inference guarantees that people have unique inferential systems. So if concepts are individuated by their total inferential roles, no two people will ever share the same concept.[12]

A conceptual role semanticist might try to avoid this difficulty in a number of ways. The most obvious—and perhaps the most preferable— is to employ constraints that would isolate the part of the inferential apparatus that is relevant to conceptual identity from extraneous parts. One of the commendable things about Carey's semantical program is that, at the very least, she tries to constrain the notion of a mental theory, providing a base condition of this sort. Consequently, her account contrasts sharply with others in the psychological literature which are entirely unconstrained and thus hopeless (see e.g. Murphy and Medin's characterization of mental theories cited in Note 9). At the same time, Carey needs a stronger constraint if she is to allow—as she must—that our mental theories undergo innocuous changes.

Perhaps this is why she wishes to restrict her account to ontological concepts, which are supposed to be highly central in our mental theories. Recall that Carey says that central or 'core' concepts 'participate in what empiricists and logical positivists held to be the analytic truths [of a theory]'. Analytic truths, for empiricists, mark a principled distinction

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[12] Jerry Fodor and Ernest Lepore cite this point as a criticism of holistic theories of conceptual content. For discussion, see Fodor & Lepore, 1992.

between those parts of a theory that determine the meanings of its terms and those that don't. Were Carey to follow this route and endorse a suitable account of analyticity, she would have a mechanism to isolate a foundation of constant beliefs, preserving the identity of at least the core concepts.

But it is doubtful that Carey endorses this picture.[13] Instead, she seems tempted by an analog of the empiricist model. 'The distinction between the core concepts of a theory and the peripheral ones is a matter of degree, as is the distinction between conceptual structures that play major explanatory roles and those that don't' (Carey, 1985b, pp. 395–6). Applied to mental theories, her idea seems to be that a graded centrality metric can be defined over the beliefs that make up a theory and that it is the most central beliefs of a mental theory that constitute its core concepts. In other words, Carey is proposing that we trade the difficulty of specifying the identity conditions upon ontological concepts for a specification of the central beliefs of mental theories. The problem with this approach is that we are now owed an account of centrality; without one, no advance has been made. And Carey says nothing to suggest that she has an account of centrality or to boost the hope that one will be forthcoming.

4.2 An Alternative Semantics

The second problem I want to raise for Carey's view of concepts is that there appear to be counterexamples to her semantical program, originating with Saul Kripke's and Hilary Putnam's work on natural kind terms. The Kripke/Putnam critique of the description theory of reference has been so well-integrated into the current philosophical scene that a full review of their arguments is probably unnecessary. Instead, let me remind you of the pattern of their argument. (For a useful summary, see Devitt and Sterelny, 1987; the original arguments are to be found in Kripke, 1972, and Putnam, 1970, 1975).

Kripke and Putnam illustrate cases in which the relevant description associated with a particular kind term fails to pick out the right referent or any referent at all yet the term continues to have the correct and determinant referent. They note, for example, that people are typically ignorant or mistaken about the condition for membership within a kind. Since they often don't know these conditions, the descriptions they associ-

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[13]   Nor is it clear that she should. Since Quine's famous critique (Quine, 1951), the most viable accounts of analyticity have been ones that address the semantics of verbs with inherently rich relational structures, manifested by the argument positions they specify. E.g. it isn't implausible, despite whatever Quine said, that 'John killed Bill, so Bill is dead' is an analytic truth, in particular, true in virtue of the meaning of 'kill'. For a possible treatment of verbs like this—and the concepts they express—see Jackendoff, 1976. Such models are of little use to Carey, however, since they don't extend to the cases that concern her, concepts like ANIMAL and LIVING THING.

ate with a kind term are insufficient for picking out its referent. Yet, for all that, people are semantically competent with the kind terms of their language, using 'water' to refer to water, 'gold' to gold, and so on. So the mechanism that fixes the reference of these terms can't depend much on our current knowledge. Kripke and Putnam both suggest as an alternative that the reference of a natural kind term depends upon causal relations people bear to the relevant kind.

Within the philosophy of language, the Kripke/Putnam critique of the description theory has been devastating. Few philosophers are still prepared to defend the theory. What's more, it is clear that their examples are not proprietary to natural languages. If their arguments work at all, they will apply to natural kind concepts just as they apply to natural kind terms.

These considerations are probably more devastating for Carey's colleagues who endorse the theory analogy than they are for her. This is because she restricts her account to the ontological concepts, and only some of these pick out natural kinds. On the other hand, the trend in psychology is to view the theory analogy as a general claim about concepts, where most, if not all, concepts have their semantics by virtue of their roles within mental theories. In addition, amongst the few psychologists who, like Carey, wish to restrict what counts as a mental theory, the tendency has been to focus rather explicitly on natural kinds concepts (see e.g. Keil, 1989). So most defenders of the theory analogy aren't in a position to ignore the challenge that Kripke's and Putnam's work presents.

What about Carey? This is one place where it would be nice to have a better characterization of ontological concepts. Some of the concepts of concern to her are natural kind concepts (e.g. ANIMAL and PLANT); others are not. Thus the Kripke/Putnam critique offers a counterexample to her project, but nothing decisive.[14]

Still, I think more needs to be said. Since the description theory of reference came under attack in the philosophy of language, many philosophers of mind have taken to the idea that causal theories of one kind or another should be appropriated for large classes of concepts, not just the natural kinds. Currently, there are a number of fruitful proposals for explaining conceptual identity in terms of nomic relations between a concept and the property it expresses (Dretske, 1981; Fodor, 1990). These proposals aim to reconstruct the intuition that conceptual identity depends upon mind–world relations rather than internal factors, as is the case with the Theory Theory.[15] Minus all of the qualifications the idea they share

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[14] Carey is aware of the Kripke/Putnam critique (see Carey, 1982). So far as I can tell, however, she never comes to terms with the importance of their arguments for her view of concepts.

[15] By the 'Theory Theory' I mean the family of theories that make use of the analogy between concepts and theoretical terms.

is that a concept expresses the property it covaries with: BIRD expresses the property *bird* because birds reliably cause BIRD-tokenings.

Psychology is typically concerned with the character of mental processes. What's so striking about the nomic theories is that they hold that the mental processes that a concept participates in—and hence its relations to other concepts—aren't essential to its identity. I suspect that it is for this reason that many psychologists and psychologically-oriented philosophers are skeptical; if a theory entails that the nature of concepts abstracts from the facts of cognitive processes, one may feel that something has gone drastically wrong. In my view, this line of reasoning ought to be resisted. While the nomic accounts do hold, in the first instance, that the nature of concepts has little do with psychological processes, they needn't be interpreted as saying that the study of concepts can proceed without empirical constraints.

The crucial point is that the mind–world relation that determines conceptual identity needs to hold for a reason. Barring miracles there must be a mechanism to sustain the relation between a concept and the property it expresses. Now in some cases the sustaining mechanism is going to be non-cognitive. This is likely to be true in lower-level perceptual processing, where sensory transducers can provide the link. In most cases, however, nothing is available to ground the mind–world relation apart from the informational structures associated with a concept. If this is right, then a concept's role in mental processes, while not relevant to its identity, is nonetheless responsible for sustaining the relation that is. The burden of empirical research won't concern the nature of concepts per se, but the nature of the mechanisms that support concept possession.[16]

At this point it may look as though we've come full circle. On the one hand, the Theory Theory of concepts says that a concept's identity is determined by its role in a restricted knowledge structure—a mental theory. On the other, the nomic accounts inevitably require the presence of certain knowledge structures, including, I suppose, some that are as theory-like as you wish. But there is a difference. The Theory Theory ties particular knowledge structures to a concept, yielding intra-conceptual relations that hold of necessity. The nomic theories, in contrast, are much more flexible. They only require that there be some knowledge structure or other that gives rise to the right mind–world relation.

Suffice it to say that the nomic treatments of conceptual identity prove to offer a substantive alternative to the Theory Theory. Given this alternative approach and the difficulties Carey faces from the Kripke/Putnam critique, her account is in need of an argument. This brings us to my third criticism.

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[16]   In Margolis (in preparation) I discuss this matter in detail, paying special attention to the way in which theories of concept acquisition are affected by the adoption of a nomic account of concepts.

4.3 Carey's Argument

Despite the importance of Carey's theory of the individuation of concepts—this being the heart of the theory analogy—she barely offers an argument in its favour. In this passage, she mentions the importance of Elizabeth Spelke's work on the neonate's understanding of physical objects (reported in Spelke, 1985). Spelke's research, Carey thinks, illustrates the reason we should endorse her theory of concept individuation (Carey, 1985b, p. 397):

> [T]he infants concept of *object* cannot be specified apart from related concepts such as *space*, *number*, and *physical causality*. Spelke shows that bounded entities that occupy a unique position in space, or maintain a single trajectory through space, are seen as single objects. The 4-month-old infant knows that objects out of sight persist, and that a solid object cannot pass through the space occupied by another solid object. Spelke shows that we cannot diagnose the infant's concept of object without examining the expectations the child has about the behavior of objects. More crucially, she shows that the child's concept cannot be explicated except relative to other concepts that articulate a set of physical beliefs.

The argument is a bit murky and, I suppose, open to interpretation. However, a very plausible reading is that Carey is saying this: because we cannot diagnose whether someone has a concept C without implicating other concepts and beliefs that she has that are connected with C, this whole apparatus—the other concepts and beliefs—are constitutive of C.

If this is the argument, it's a non sequitur. Certain beliefs may very well be diagnostic of whether someone has a concept without their being constitutive of that concept. Carey is conflating an epistemic claim, concerning the evidence for the presence of a concept, with a metaphysical claim, concerning the conditions for having a concept. Perhaps I've misread her, but is hard to see how else to interpret her remarks. One possibility a commentator has suggested to me is that we view Carey's premise as the claim that the infant's object concept can't be characterized independently of her beliefs about space, number and so on. But this interpretation would hardly be more charitable. For the question at stake just is whether the infant's object concept can be characterized independently of her beliefs. I don't see that there is much else to say in favour of her argument.

It is important, at this point, not to confuse Carey's motivation for introducing the theory analogy with the question of whether she has an argument to support it. We saw in Section 2 that her motivation stems from her research in developmental psychology; she needs an account of conceptual individuation, at least for the ontological concepts. Notice, however, that nothing about needing an account of conceptual individuation necessitates any particular account. While the Theory Theory is a

possibility, so are the nomic accounts that treat conceptual identity in terms of mind–world relations. In other words, Carey needs an argument to bridge her developmental concerns with her account of the nature of concepts. But to repeat: the argument she gives—the only argument in all of her writings on the theory analogy—is flawed.

5. Concluding Remarks

The theory analogy, once plainly put, amounts to the view that concepts have their semantic properties by virtue of their roles in restricted knowledge structures. The concept ANIMAL is the concept that it is because of the role that it plays in an internal, rudimentary biological theory, which is common to normal adults.

This view of concepts, despite its widespread acceptance, must overcome a number of severe challenges. First, it works only against the background of an account of the individuation of theories, an outstanding problem in the philosophy of science. And even if we had a way of individuating theories, we would still need to solve the apparently intractable problem of isolating the parts of a theory that are relevant to conceptual content. Second, it goes against convincing reasons for rejecting the description theory of reference. Poignant examples from the philosophy of language impair its treatment of natural kind concepts, yet these are some of the principal concepts for which the theory has been devised. Third, there is no positive argument in favour of the view; as things stand, we've been given no reason to believe it.

I'd like to end this discussion by pointing out a connection between Carey's theory of concepts and her work in conceptual development, a connection which bears importantly upon some of the best work in current developmental psychology.

We've already seen that, for Carey, a theory of conceptual individuation is motivated by data that suggest that children undergo a strong conceptual change. Carey has found that young children reason about biological phenomena differently from older children and adults and has urged the possibility that young children and adults have partly incommensurable conceptual systems. Young children, she thinks, don't have the concept ANIMAL or LIVING THING but have related concepts which figure in a rudimentary theory of animal behaviour, giving way in development to a rudimentary biology (Carey, 1985a, 1988).

Carey is certainly right that this is a possibility, and her data are intrinsically interesting whether her explanation is right or not. It should be noted, however, that Carey's explanation is plausible only to the extent that her theory of conceptual individuation is plausible. Where concepts are individuated by their roles in knowledge structures, strikingly different knowledge structures yield distinct concepts. But, where concepts are not individuated by their roles in knowledge structures, two people might

have the same concepts despite gross differences in what they believe, including gross differences in the 'theories' that effect their judgments in the sorts of experiments that generate Carey's data. In short, the exciting idea in developmental psychology, that children and adults employ fundamentally different conceptual systems, presupposes that concepts are individuated in much the way Carey says they are. But, as I have argued, Carey's account of conceptual individuation is without support and has a number of serious obstacles. The conclusion we should draw is that children may be more like adults than Carey and others would have us believe.

Department of Philosophy
Rice University

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